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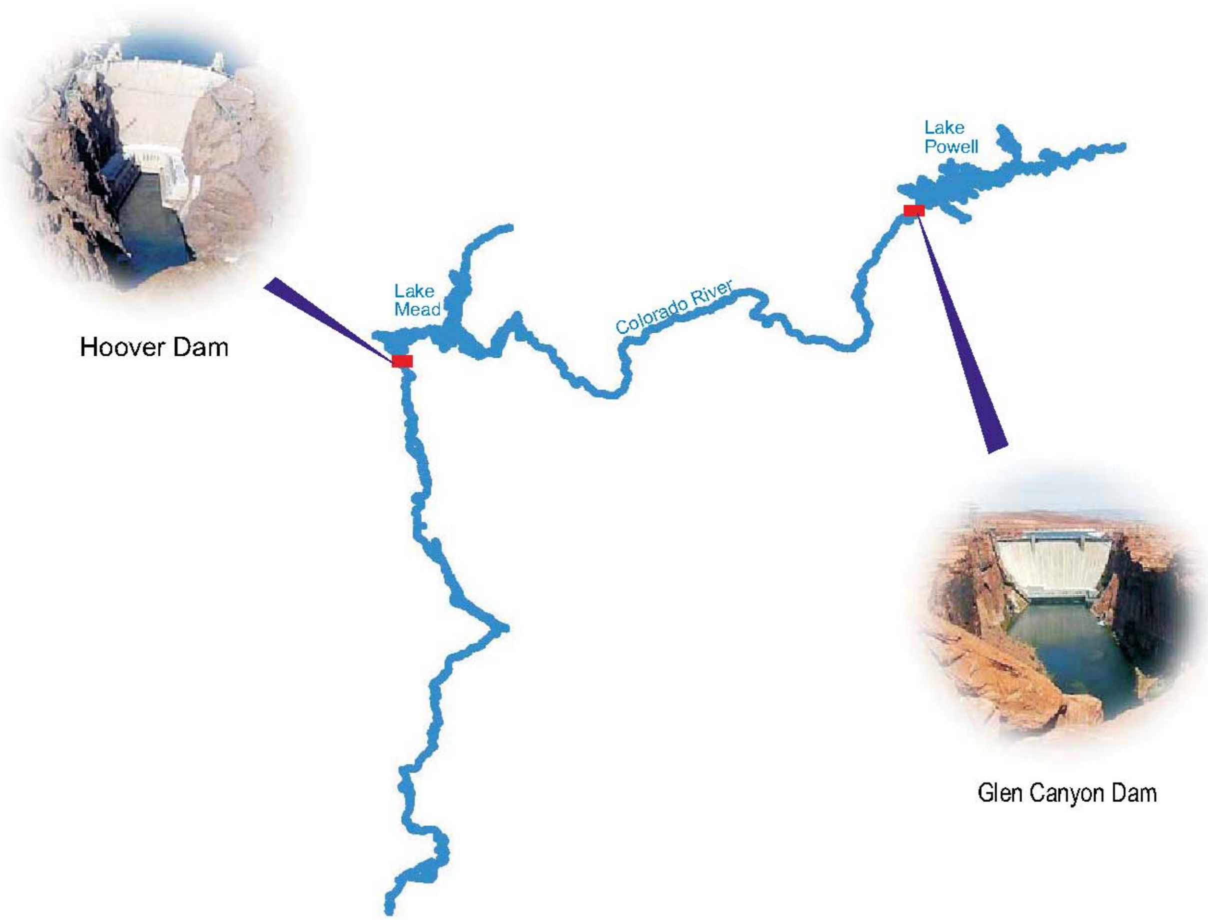
Final

Environmental Impact Statement



Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Volume I

U.S. Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions

October 2007

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Mission Statement

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead
Final Environmental Impact Statement

Lead Agency:

United States Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions

Cooperating Agencies:

Bureau of Indian Affairs
National Park Service
Western Area Power Administration
United States Fish and Wildlife Service
United States Section of the International Boundary and Water Commission

Abstract:

The Secretary of the Department of the Interior (Department), acting through the Bureau of Reclamation, proposes adoption of specific Colorado River Lower Basin (Lower Basin) shortage guidelines and coordinated reservoir management strategies to address operations of Lake Powell and Lake Mead, particularly under drought and low reservoir conditions. This action is proposed in order to provide a greater degree of certainty to United States Colorado River water users and managers of the Colorado River Basin by providing detailed and objective guidelines for the operations of Lake Powell and Lake Mead, thereby allowing water users in the Lower Basin to know when, and by how much, water deliveries will be reduced in drought and other low reservoir conditions. The Department proposes that these guidelines be interim in duration and extend through 2026.

This Final EIS has been prepared pursuant to the National Environmental Policy Act to address the formulation and evaluation of specific interim criteria and to identify the potential environmental impacts of implementing such criteria.

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Table of Contents

Volume I: Table of Contents

EXECUTIVE SUMMARY

CHAPTER 1 PURPOSE AND NEED

CHAPTER 3 AFFECTED ENVIRONMENT

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

CHAPTER 5 OTHER CONSIDERATIONS AND CUMULATIVE IMPACTS

CHAPTER 6 CONSULTATION AND COORDINATION

List of Figures

List of Tables

Volume II: Appendices A through L

See Volume II Table of Contents

Volume III: Appendices M through U

See Volume III Table of Contents

Volume IV: Responses to Comments

See Volume IV Table of Contents

Executive Summary

ES.1 Background

The Secretary of the Department of the Interior (Secretary), acting through the Bureau of Reclamation (Reclamation), proposes to adopt specific interim guidelines for Colorado River Lower Basin (Lower Basin) shortages and coordinated operations for Lake Powell and Lake Mead, particularly under drought and low reservoir conditions.

Reclamation, as the agency that is designated to act on the Secretary's behalf with respect to operation of Glen Canyon Dam and Hoover Dam and managing the mainstream waters of the lower Colorado River pursuant to federal law, is the lead federal agency for the purposes of compliance pursuant to the National Environmental Policy Act of 1969 (NEPA), as amended, for the development and implementation of the proposed interim guidelines. Five federal agencies are cooperating for purposes of assisting with environmental analysis and preparation of this Environmental Impact Statement (EIS). The cooperating agencies are the Bureau of Indian Affairs (BIA), United States Fish and Wildlife Service (FWS), National Park Service (NPS), Western Area Power Administration (Western), and the United States Section of the International Boundary and Water Commission (USIBWC).

Volume I of the Final EIS includes six chapters as outlined below:

- Chapter 1: Purpose and Need;
- Chapter 2: Description of Alternatives;
- Chapter 3: Affected Environment;
- Chapter 4: Environmental Consequences;
- Chapter 5: Other Considerations and Cumulative Impacts; and
- Chapter 6: Consultation and Coordination.

In addition to the above, Volumes II and III contain appendices which are comprised of documents and other supporting materials concerning the proposed federal action. Volume IV contains reproductions of letters received from the public review of the Draft EIS, and Reclamation's responses to comments received.

ES.1.1 Purpose and Need for Action

The eight-year period from 2000 through 2007 was the driest eight-year period in the 100-year historical record of the Colorado River. This drought in the Colorado River Basin has reduced Colorado River system storage, while demands for Colorado River water supplies have continued to increase. From October 1, 1999 through September 30, 2007, storage in Colorado River reservoirs decreased from 55.8 maf (approximately 94 percent of capacity) to 32.1 maf (approximately 54 percent of capacity), and was as low as 29.7 maf (approximately 52 percent of capacity) in 2004. Currently, the Department of the Interior (Department) does not have specific operational guidelines in place to address the operations of Lake Powell and Lake Mead during drought and low reservoir conditions.

The purpose of the proposed federal action is to: 1) improve Reclamation's management of the Colorado River by considering trade-offs between the frequency and magnitude of reductions of water deliveries, and considering the effects on water storage in Lake Powell and Lake Mead, and on water supply, power production, recreation, and other environmental resources; 2) provide mainstream United States users of Colorado River water, particularly those in the Lower Division states, a greater degree of predictability with respect to the amount of annual water deliveries in future years, particularly under drought and low reservoir conditions; and 3) provide additional mechanisms for the storage and delivery of water supplies in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions.

ES.1.2 Proposed Federal Action

The proposed federal action includes the adoption of specific interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead. These interim guidelines would remain in effect for determinations to be made through 2025 regarding water supply and reservoir operating decisions through 2026 and would provide guidance each year in development of the Annual Operating Plan for Colorado River Reservoirs (AOP). This proposed federal action considers four operational elements that collectively are designed to address the purpose and need for the proposed federal action.

The interim guidelines would be used by the Secretary to:

- determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) below 7.5 million acre-feet (maf) (a ''Shortage'') pursuant to Article II(B)(3) of the United States Supreme Court Decree in the case of *Arizona v. California*, 547 U.S. 150 (2006) (Consolidated Decree);

- define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;

- allow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions; and

- determine those conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing Interim Surplus Guidelines (ISG), published in the Federal Register on January 25, 2001 (66 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026.

ES.1.3 Geographic Scope

The geographic region that could potentially be affected by the proposed federal action begins with Lake Powell and extends downstream along the Colorado River floodplain to the Southerly International Boundary (SIB) with Mexico. In addition to the potential impacts that may occur within the river corridor, the alternatives may also affect the water supply that is available to specific Colorado River water users in the Lower Basin. The following water agency service areas are also included in the appropriate affected environment discussions:

- Arizona water users, particularly the lower priority water users located in the Central Arizona Project service area;
- the Southern Nevada Water Authority (SNWA) service area; and
- the Metropolitan Water District of Southern California (MWD) service area.

Figure ES-1 shows the geographic scope for the Final EIS.

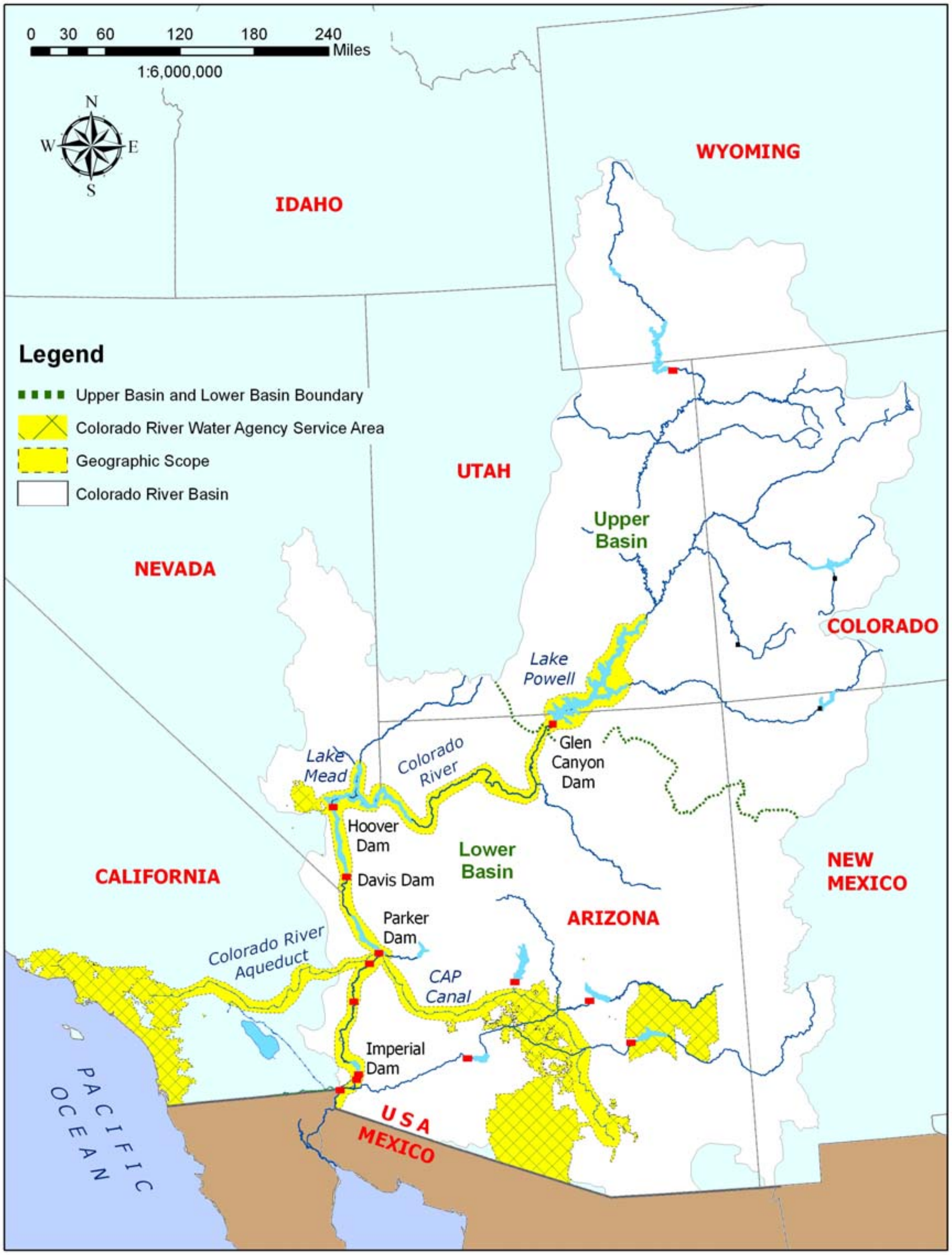
ES.1.4 Alternatives

Six alternatives are considered and analyzed in this Final EIS. The alternatives consist of a No Action Alternative and five action alternatives. The five action alternatives are: Basin States Alternative, Conservation Before Shortage Alternative, Water Supply Alternative, Reservoir Storage Alternative, and the Preferred Alternative. The action alternatives reflect input from Reclamation staff, the cooperating agencies, stakeholders, and other interested parties.

Reclamation received two written proposals for alternatives that met the purpose and need of the proposed federal action, one from the seven Colorado River Basin States (Basin States) and another from a consortium of environmental non-governmental organizations (NGO). These proposals were used by Reclamation to formulate two of the alternatives considered and analyzed in the Final EIS (Basin States Alternative and Conservation Before Shortage Alternative). A third alternative (Water Supply Alternative) was developed by Reclamation, and a fourth alternative (Reservoir Storage Alternative) was developed by Reclamation in coordination with the NPS and Western. The No Action Alternative and the action alternatives analyzed in the Draft EIS were posted on Reclamation's website (http://www.usbr.gov/lc/region/programs/strategies.html) on June 30, 2006.

A fifth alternative, the Preferred Alternative, was developed after consideration of the comments received on the Draft EIS and further analysis. The Preferred Alternative was posted on Reclamation's website (same website address as above) on June 15, 2007 and is composed of operational elements from the action alternatives identified and analyzed in the Draft EIS.

Figure ES-1
Geographic Scope



The Preferred Alternative is the most reasonable and feasible alternative; all environmental effects of this alternative, as well as the No Action Alternative and the remaining four action alternatives have been fully analyzed in this Final EIS. The identified environmental effects of the Preferred Alternative are well within the range of anticipated effects of the alternatives presented in the Draft EIS and do not affect the environment in a manner not already considered in the Draft EIS.

Reclamation selected from among the four key operational elements disclosed in the Draft EIS to formulate the Preferred Alternative. Reclamation has determined that the four operational elements selected under this alternative best meet all aspects of the purpose and need of the proposed federal action. Additionally, Reclamation has developed draft operational guidelines describing how the Preferred Alternative could be implemented during the interim period.

Summary descriptions of the No Action Alternative and the five action alternatives considered and evaluated in the Final EIS are provided below and in Table ES-1.

ES.1.4.1 No Action Alternative

The No Action Alternative provides a baseline for comparison of each of the action alternatives. The No Action Alternative represents a projection of future conditions that could occur during the life of the proposed federal action without an action alternative being implemented.

Pursuant to the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968, or Long-Range Operating Criteria (LROC), the Secretary makes a number of determinations at the beginning of each operating year through the development and execution of the AOP, including the water supply available to users in the Lower Basin and the annual release from Lake Powell. However, the LROC currently does not include specific guidelines for such determinations. Furthermore, there is no actual operating experience under low reservoir conditions, i.e., there has never been a shortage determination in the Lower Basin. Therefore, in the absence of specific guidelines, the outcome of the annual determination in any particular year in the future cannot be precisely known. However, a reasonable representation of future conditions under the No Action Alternative is needed for comparison to each action alternative. The modeling assumptions used for this representation are consistent with the assumptions used in previous environmental compliance documents for the ISG, the Colorado River Water Delivery Agreement, and the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). However, the assumptions used in the No Action Alternative are not intended to limit or predetermine these decisions in any future AOP determination.

Table ES-1
Matrix of Alternatives

Alternatives	Shortage Guidelines to Reduce Deliveries from Lake Mead (elevation in feet msl)	Coordinated Reservoir Operations (Lake Mead & Lake Powell) (elevation in feet msl)	Lake Mead Storage and Delivery of Conserved System and Non-system Water	Interim Surplus Guidelines (ISG) for Deliveries/Releases from Lake Mead
No Action	▪ Determination made through the AOP process, absent shortage guidelines ▪ Reasonably represented by a two-level shortage strategy - probabilistic protection of Lake Mead elevation 1,050 and absolute protection of Lake Mead elevation 1,000	▪ Minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required ▪ Operation at low reservoir levels reasonably represented by a 8.23 maf release from Lake Powell down to Lake Powell dead pool	▪ No water management mechanism for storage and delivery of conserved system and non-system water	▪ No modification or extension of the ISG which end in 2016 ▪ After 2016, determination made through the AOP process, absent surplus guidelines; reasonably represented by the spill avoidance (referred to as the 70R) strategy
Basin States	▪ Shortages (i.e., reduced deliveries in the United States) of 333, 417, and 500 kaf from Lake Mead at elevations 1,075, 1,050, and 1,025 respectively [1] ▪ Initiate efforts to develop additional guidelines for shortages if Lake Mead falls below elevation 1,025 (Note: includes consultation with Basin States)	▪ Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required ▪ Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevations at Lake Powell and Lake Mead	▪ Creation, accounting, and delivery of ICS ▪ Maximum total ICS of 2.1 maf ▪ System assessment of 5% when ICS is created	▪ Modification of ISG to eliminate Partial Domestic Surplus condition ▪ Extension of the modified guidelines through 2026
Conservation Before Shortage	▪ Shortages are implemented in any given year when necessary to keep Lake Mead above SNWA's lower intake at elevation of 1,000 (absolute protection of elevation 1,000)	▪ Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required ▪ Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevations at Lake Powell and Lake Mead	▪ Prior to shortage, conservation of different volumes of water tied to Lake Mead elevation ▪ Creation, accounting, and delivery of ICS ▪ Water for environmental uses ▪ Maximum total ICS of up to 4.2 maf ▪ System assessment of 5% when ICS is created	▪ Modification of ISG to eliminate Partial Domestic Surplus condition ▪ Extension of the modified guidelines through 2026
Water Supply	▪ Release full annual entitlement amounts until Lake Mead is drawn down to dead pool (elevation 895)	▪ Minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required ▪ Balancing if Lake Powell is below elevation 3,575 or Lake Mead is below elevation 1,075	▪ No water management mechanism for storage and delivery of conserved system and non-system water	▪ Extension of the existing ISG through 2026
Reservoir Storage	▪ Shortages (i.e., reduced deliveries in the United States) of 500, 667, 833, and 1,000 kaf from Lake Mead at elevations 1,100, 1,075, 1,050, and 1,025 respectively[1]	▪ Minimum objective release of 8.23 maf from Lake Powell if Lake Powell is above elevation 3,595 unless storage equalization releases are required ▪ 7.8 maf release from Lake Powell between Lake Powell elevations of 3,560 and 3,595 ▪ Balancing below Lake Powell elevation 3,560	▪ Storage and delivery of conserved system and non-system water ▪ Maximum total storage of conserved system and non-system water of 3.05 maf ▪ System assessment of 10% of stored conserved system and non-system water	▪ Provisions of existing ISG terminate after 2007, and during period from 2008-2026, surplus determinations are limited to 70R and Flood Control conditions
Preferred Alternative	▪ Shortages (i.e., reduced deliveries in the United States) of 333, 417, and 500 kaf from Lake Mead at elevations 1,075, 1,050, and 1,025 respectively[1] ▪ Initiate efforts to develop additional guidelines for shortages if Lake Mead falls below elevation 1,025 (Note: Includes consultation)	▪ Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required ▪ Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevations at Lake Powell and Lake Mead	▪ Creation, accounting, and delivery of ICS ▪ Maximum total ICS in Lake Mead of up to 4.2 maf ▪ System assessment of 5% when ICS is created	▪ Modification of ISG to eliminate Partial Domestic Surplus condition ▪ Extension of the modified guidelines through 2026

[1] These are amounts of shortage (i.e., reduced deliveries in the United States). As in the Draft EIS, the Final EIS includes modeling assumptions that identify water deliveries to Mexico pursuant to the 1944 Treaty.

ES.1.4.2 Basin States Alternative

The Basin States Alternative was developed by the Basin States and proposes a coordinated operation of Lake Powell and Lake Mead that would minimize shortages in the Lower Basin and avoid risk of curtailments of Colorado River water use in the Upper Basin. This alternative includes shortages to conserve reservoir storage; coordinated operations of Lake Powell and Lake Mead determined by specified reservoir conditions; a mechanism (i.e., Intentionally Created Surplus or ICS) for the creation, accounting, and delivery of conserved system and non-system water; and a modification and extension of the ISG through 2026.

ES.1.4.3 Conservation Before Shortage Alternative

The Conservation Before Shortage Alternative was developed by a consortium of environmental non-governmental organization (NGOs), and includes voluntary, compensated reductions (shortages) in water use to minimize involuntary shortages in the Lower Basin and to avoid risk of curtailments of Colorado River water use in the Upper Basin. This alternative includes voluntary shortages prior to involuntary shortages; coordinated operations of Lake Powell and Lake Mead determined by specified reservoir conditions; an expanded ICS mechanism for the creation, accounting, and delivery of conserved system and non-system water, including water for environmental uses; and modification and extension of the ISG through 2026.

ES.1.4.4 Water Supply Alternative

The Water Supply Alternative maximizes water deliveries at the expense of retaining water in storage in the reservoirs for future use. This alternative would reduce water deliveries only when insufficient water to meet entitlements is available in Lake Mead. When reservoir elevations are relatively low, Lake Powell and Lake Mead would share water (“balance contents”). This alternative does not include a mechanism for the creation, accounting, and delivery of conserved system and non-system water in Lake Mead. The existing ISG would be extended through 2026.

ES.1.4.5 Reservoir Storage Alternative

The Reservoir Storage Alternative was developed in coordination with the cooperating agencies and other stakeholders, primarily Western and the NPS. This alternative would keep more water in storage in Lake Powell and Lake Mead by reducing water deliveries and by increasing shortages to retain more water in storage and thereby, benefit power and recreational interests. This alternative includes larger, more frequent shortages that serve to conserve reservoir storage; coordinated operations of Lake Powell and Lake Mead determined by specified reservoir conditions (more water would be held in Lake Powell than under the Basin States Alternative); and an expanded mechanism for the creation, accounting, and delivery of conserved system and non-system water in Lake Mead. The existing ISG would be terminated after 2007.

ES.1.4.6 Preferred Alternative

The Preferred Alternative incorporates operational elements identified in the Basin States and Conservation Before Shortage alternatives. This alternative includes shortages to conserve reservoir storage; a coordinated operation of Lake Powell and Lake Mead determined by specified reservoir conditions that would minimize shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin; and also adopts the ICS mechanism for promoting water conservation in the Lower Basin. It is anticipated that the maximum cumulative amount of ICS would be 2.1 maf; however, the potential effects of a maximum cumulative amount of ICS of up to 4.2 maf have been analyzed in the Final EIS. This alternative also includes modification and extension of the ISG through 2026.

ES.2 Summary of Potential Environmental Effects

ES.2.1 Methodology

Hydrologic modeling of the Colorado River system was conducted to determine the potential hydrologic effects of the alternatives. Modeling provides projections of potential future Colorado River system conditions (i.e., reservoir elevations, reservoir releases, river flows) for comparison of those conditions under the No Action Alternative to conditions under each action alternative. Due to the uncertainty with regard to future inflows into the system, multiple simulations were performed in order to quantify the uncertainties of future conditions and as such, the modeling results are typically expressed in probabilistic terms.

Hydrologic modeling also provides the basis for the analysis of the potential effects of each alternative on other environmental resources such as recreation, biology, and electrical power. The potential effects to specific resources are identified and analyzed for each action alternative and compared to the potential effects to that resource under the No Action Alternative. These comparisons are typically expressed in terms of the relative differences in probabilities between the No Action Alternative and the action alternatives.

ES.2.2 Hydrologic Resources

ES.2.2.1 Reservoir Storage

Lake Powell. Under the No Action Alternative and the action alternatives, the elevations of Lake Powell are projected to fluctuate between full and lower levels during the period of analysis (2008 through 2060). At the 90th percentile Lake Powell end-of-July elevation values, the action alternatives and the No Action Alternative are projected to be similar over the period of analysis.

Lake Powell elevations are generally lower under the Water Supply Alternative relative to the No Action Alternative. Conversely, Lake Powell elevations are generally higher under the Reservoir Storage Alternative relative to the No Action Alternative. Lake Powell elevations under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, are similar to each other because these alternatives assume the same operation at Lake Powell. At the 50th percentile, Lake Powell elevations under the Preferred Alternative are approximately ten feet lower than under the No Action Alternative in 2026; at the10th percentile, Lake Powell elevations are nearly the same in 2026.

The probabilities of Lake Powell elevations less than 3,560 feet msl (the approximate minimum elevation for operation of several launch ramps) are higher under the Water Supply Alternative and lower under the Reservoir Storage Alternative relative to all other alternatives including the No Action Alternative. Probabilities under the Basin States and Conservation Before Shortage alternatives and the Preferred Alternative are similar, with a probability of about five percent in 2016. The probability of Lake Powell elevations less than 3,490 feet msl (the approximate minimum elevation for operation of the Glen Canyon Dam Powerplant) is low (three percent or less) for the Preferred Alternative.

Lake Mead. Under the No Action Alternative and the action alternatives, the elevation of Lake Mead is projected to fluctuate between full pool and lower elevations during the period of analysis (2008 through 2060). At the 90th percentile Lake Mead end-of-December elevation values, the Basin States, Conservation Before Shortage, and Water Supply alternatives, the Preferred Alternative, and the No Action Alternative are projected to be similar over the period of analysis. The 90th percentile Lake Mead end-of-December elevation values under the Reservoir Storage Alternative are slightly higher than under the other alternatives.

At the 50th and 10th percentiles, Lake Mead elevations are generally higher under the Reservoir Storage Alternative relative to the No Action Alternative. Lake Mead 50th percentile elevations under the Water Supply Alternative are generally lower than those under the No Action Alternative. However, the Lake Mead 10th percentile elevations under the Water Supply Alternative vary and are sometimes higher and sometimes lower than those under the No Action Alternative. Lake Mead elevations under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative are similar to each other at the 50th and 10th percentiles. At the 50th percentile, Lake Mead elevations under the Preferred Alternative are approximately 16 feet lower relative to the No Action Alternative; however, at the 10th percentile, Lake Mead elevations are approximately 20 feet higher.

The probabilities of Lake Mead elevations less than 1,050 feet msl (the approximate minimum elevation for operation of the Hoover Dam Powerplant and the operation of SNWA's upper intake) are higher under the Water Supply Alternative and lower under the Reservoir Storage Alternative relative to all other action alternatives. Probabilities under the Basin States and Conservation Before Shortage alternatives and the Preferred Alternative are similar, with a probability of approximately 15 to 17 percent in 2016.

The probability of Lake Mead elevations below 1,000 feet msl (the minimum elevation for operation of SNWA's lower intake) is low (between zero and two percent) for all alternatives except for the Water Supply Alternative (up to 12 percent).

Lake Mohave and Lake Havasu. Lake Mohave and Lake Havasu are operated on rule curves and have target end-of-month elevations. This manner of operation for the two reservoirs will continue in the future and would apply to operations under the No Action Alternative and the action alternatives. Therefore, future Lake Mohave and Lake Havasu elevations would not be affected by the proposed federal action.

ES.2.2.2 Reservoir Releases

During the interim period (2008 through 2026), Glen Canyon Dam releases less than the annual minimum objective release of 8.23 maf occurred less than one percent of the time under the No Action Alternative, approximately ten percent of the time under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, and approximately 17 percent of the time under the Reservoir Storage Alternative. During the interim period, releases greater than the annual minimum objective release of 8.23 maf occurred approximately 42 percent of the time under the No Action Alternative, approximately 62 percent of the time under the Basin States and Conservation Before Shortage alternatives, 69 percent of the time under the Water Supply Alternative, 44 percent of the time under the Reservoir Storage Alternative, and 59 percent of the time under the Preferred Alternative.

During the interim period (2008 through 2060), the observed minimum and maximum Hoover Dam annual releases under the No Action Alternative are 7.46 maf and 17.13 maf, respectively. By comparison, the minimum annual release under the action alternatives is 7.3 maf and occurs under the Conservation Before Shortage Alternative. The maximum annual release of 17.16 maf occurs under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative. In general, the observed annual release volumes under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative are similar to those observed under the No Action Alternative. The Hoover Dam annual releases observed under the Water Supply Alternative are generally higher than those observed under the No Action Alternative. The Hoover Dam annual releases observed under the Reservoir Storage Alternative are generally lower than those observed under the No Action Alternative.

Releases from Davis Dam and Parker Dam generally reflect the same pattern of releases under the different action alternatives as those from Hoover Dam. The differences in the release volumes are mostly attributed to the depletions that occur upstream of each respective dam.

ES.2.2.3 Groundwater

Differences in Colorado River flows downstream of Hoover Dam are similar between the action alternatives and the No Action Alternative and these differences are relatively minor. Corresponding effects of the action alternatives relative to the No Action Alternative on groundwater will also be relatively minor.

ES.2.3 Water Deliveries

All of the action alternatives increase the probability that Normal Condition deliveries will be met over the interim period relative to the No Action Alternative. The differences between the action alternatives and the No Action Alternative, in terms of the probability of occurrence for water supply deliveries under a Normal Condition, range from about 15 to 40 percent over the interim period.

The Water Supply Alternative exhibits the same probability of Surplus Condition deliveries as the No Action Alternative (between about 30 to 40 percent) between 2008 and 2016 due to identical assumptions regarding surplus during this period. The ISG provisions terminate under the No Action Alternative in 2016. However, these provisions are retained in the Water Supply Alternative through 2026 and therefore this alternative consistently exhibits the highest probability of surplus deliveries during the interim period. The Reservoir Storage Alternative exhibits the lowest probabilities (between about ten to 20 percent) during the interim period because surplus determinations are limited to Quantified and Flood Control Surplus Conditions beginning in 2008. The surplus provisions under the Basin States and the Conservation Before Shortage alternatives, and under the Preferred Alternative, are similar and the probability of a Surplus Condition from 2010 through 2016 is slightly less than under the No Action Alternative due to the absence of the Partial Domestic Surplus provision in these three alternatives. After the end of the interim period in 2026, the probability for all alternatives converges to between ten and 20 percent.

The storage and delivery mechanism and related storage and delivery of conserved system and non-system water were modeled under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative. This mechanism has the effect of increasing the probability of occurrence of a Surplus Condition since more water is retained in Lake Mead relative to the No Action Alternative. The maximum increase in the probability of occurrence of a Surplus Condition is seven percent, occuring in two years under the Preferred Alternative.

During most of the interim period, the probability of an involuntary and voluntary shortage is less under all of the action alternatives than under the No Action Alternative; however, after 2026, the Water Supply Alternative has the highest probability of shortage due to the relatively depleted storage conditions and the assumption that the operations revert back to the assumptions used in the modeling of the No Action Alternative after 2026. The probability of occurrence of shortages under the Reservoir Storage Alternative is slightly higher than under the No Action Alternative between 2008 and 2013; however, after 2013 shortages under the Reservoir Storage Alternative occur less frequently as compared to the No Action Alternative. The probability of occurrence of shortages under the Basin States and Conservation Before Shortage alternatives and the Preferred Alternative are lower relative to the No Action Alternative throughout the interim period, ranging from 15 to 20 percent lower.

In terms of magnitude, the average shortage volumes during the interim period are lowest under the Water Supply Alternative (between zero and 240 kafy) and highest under the Reservoir Storage Alternative (between 600 and 750 kafy). The average shortage volumes for the Preferred Alternative (between 400 and 530 kafy) are less than the average shortage volumes for the No Action Alternative (between 500 and 610 kafy) during the interim period.

Multi-year shortages with annual shortage volumes equal to or greater than 400 kaf are likely for all alternatives with the exception of the Water Supply Alternative, with the Conservation Before Shortage Alternative and the Preferred Alternative exhibiting probabilities of between ten and 30 percent over the interim period for durations of two or more years. Multi-year shortages with annual shortage volumes equal to or greater than 500 kafy are more likely to occur under the Reservoir Storage Alternative with probabilities of approximately 35 percent for durations of two or more years and 26 percent for durations of five or more years. Multi-year shortages with annual shortage volumes equal to or greater than 600 kafy are likely only for the Reservoir Storage Alternative. No alternatives exhibited shortages of greater than or equal to 1.0 mafy for any duration.

The storage and delivery mechanism and related storage and delivery of conserved system and non-system water were modeled under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives and the Preferred Alternative. This mechanism has the effect of decreasing the occurrence of shortages. Due to the assumptions of increased participation in the storage and delivery mechanism, the greatest differences (up to a ten percent reduction in shortage probability during the interim period) were observed under the Reservoir Storage Alternative and under the Preferred Alternative.

ES.2.4 Water Quality

The future average annual salinity levels under the different action alternatives are not expected to exceed the numeric criteria for salinity at Hoover Dam, Parker Dam and Imperial Dam, established by the Colorado River Basin Salinity Control Forum. The difference between all alternative is less than three percent relative to the No Action Alternative. The ability for the United States to continue to meet the salinity differential at the Northerly International Boundary with Mexico pursuant to Minute 242 will not be affected.

The temperature range for Glen Canyon Dam releases under the Water Supply Alternative could potentially be warmer due to lower Lake Powell reservoir elevations. The Reservoir Storage Alternative generally results in cooler temperatures for Glen Canyon Dam releases since this alternative generally results in higher Lake Powell elevations. The temperature of Glen Canyon Dam releases under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative, are similar to those under the No Action Alternative.

Hydrologic and water quality modeling for Lake Mead for the Boulder Islands North Alternative, the preferred alternative published in the System Conveyance and Operations Program Final EIS (Clean Water Coalition 2006), shows that drawing down Lake Mead elevation to 1,000 feet msl would not have a significant effect on water quality in Lake Mead. The probability that Lake Mead will be drawn down to elevations below 1,000 feet msl over the interim period is low for all alternatives, except the Water Supply Alternative. Therefore, potential effects of the alternatives on Lake Mead water temperatures are considered to be negligible.

ES.2.5 Air Quality

As reservoir elevation decreases and shoreline is exposed, the potential for increased fugitive dust increases. The projected exposed shoreline acreage under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, are similar (i.e., from zero to five percent for the year 2025) to that projected under the No Action Alternative at Lake Powell. In general, the greatest increase in exposed shoreline acreage (i.e., about 30 percent for the year 2025) compared to the No Action Alternative at Lake Powell is projected under the Water Supply Alternative; the greatest reduction (i.e., about 15 percent for the year 2025) is projected under the Reservoir Storage Alternative.

Except for the Reservoir Storage Alternative, all of the action alternatives are projected to have similar or decreased shoreline exposure (i.e., from a less than one percent increase to a nine percent decrease) compared to the No Action Alternative for Lake Mead, and for Glen Canyon Dam to Lake Mead reach (Lake Mead delta). There is a greater potential for reduction in shoreline acreage exposure (i.e., 18 percent for the year 2025) under the Reservoir Storage Alternative and this potential is generally consistent for all years.

As reservoir elevation decreases and more shoreline is exposed, the potential for increased fugitive dust emission increases. However, an increase in fugitive emissions as a result of increased exposed shoreline would be limited at Lake Powell because the increased exposure of acreage would be comprised largely of sandstone.

ES.2.6 Visual Resources

The probability of exposing Cathedral in the Desert ranged from three to 17 percent under the alternatives. The Water Supply Alternative would offer the greatest chance of exposure, while the Reservoir Storage Alternative offers the least chance. There would be no visual effects on attraction features at Lake Mead.

At Lake Powell, the maximum height of calcium carbonate rings ranged from 192 feet under the Water Supply Alternative to 148 feet under the Basin States and Conservation Before Shortage alternatives, the Preferred Alternative, and the No Action Alternative, and to 128 feet under the Reservoir Storage Alternative. At Lake Mead, the maximum height of calcium carbonate rings ranged from 170 feet under the Reservoir Storage Alternative to 221 feet under the Water Supply Alternative, similar to the 218 foot height under the No Action Alternative. The calcium carbonate ring height under the Basin States and Conservation Before Storage alternatives, and the Preferred Alternative was approximately 197 feet. For both reservoirs, the presence of the calcium carbonate ring produces an effect regardless of its height. Therefore, while there are numeric differences in the projected height of the rings, the overall difference in visual impact among the alternatives is not considered significant.

At the inflow areas to both Lake Powell and Lake Mead, sediment deltas will continue to build up over time and be visible under all alternatives. Their relative exposure and visibility are directly related to reservoir elevations. The differences among all alternatives are negligible for both Lake Powell and Lake Mead.

ES.2.7 Biological Resources

ES.2.7.1 Vegetation and Wildlife

Lake Powell and Lake Mead. Under the Water Supply Alternative, there may be a minor negative impact on obligate phreatophytes, and marsh and the wildlife that use such habitats because lake elevations tend to be lower than under the No Action Alternative. Under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, there may be a minor positive impact on obligate phreatophytes, and marsh and associated wildlife because lake elevations tend to be higher than under the No Action Alternative.

Glen Canyon Dam to Lake Mead. All five action alternatives tend to have lower 10th percentile releases from Glen Canyon Dam than the No Action Alternative. These lowered releases may negatively impact obligate phreatophytes, and marsh and associated wildlife downstream of Lake Powell. The impacts are expected to be minor because though lower, they are within the range of historical flows.

Hoover Dam to Davis Dam and Lake Havasu and Parker Dam. There would be no impacts to vegetation or wildlife in these river reaches under all five action alternatives because there may be only small differences in Lake Mead releases and these reaches are dominated by Lake Mohave and its backwater, and Lake Havasu. Vegetated habitats potentially affected by flow changes between Hoover Dam and Lake Mohave are limited. Lake Mohave and Lake Havasu are operated on monthly rule curves so vegetation and wildlife effects at the lakes under the action alternatives are identical to those under the No Action Alternative.

Davis Dam to Parker Dam. There may be higher 10th and 50th percentile monthly releases and a higher annual median release from Davis Dam under the Water Supply Alternative and this may cause a minor positive impact to obligate phreatophytes, and marsh and associated wildlife as compared to the No Action Alternative. Under the Reservoir Storage Alternative, there may be lower 10th and 50th percentile monthly releases and a lower annual median release from Davis Dam; this may cause a minor negative impact to obligate phreatophytes, and marsh and associated wildlife as compared to the No Action Alternative. These differences remain within the range of historical flows. The other action alternatives, including the Preferred Alternative would have little to no effect compared to the No Action Alternative.

Parker Dam to Imperial Dam. Under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, there are lower 10th and 50th percentile monthly releases and a lower annual median release from Parker Dam; these lower releases may have a minor negative impact on obligate phreatophytes, and marsh and associated wildlife. Under the Water Supply Alternative there is a higher annual median release from Parker Dam, which may provide a minor benefit to obligate phreatophytes, and marsh and associated wildlife.

Imperial Dam to NIB. There are no impacts to vegetation or wildlife under any of the action alternatives in this reach.

NIB to SIB. Mexico diverts its water at Morelos Diversion Dam (at the NIB) and flows downstream of this dam are rare. There is a higher probability of excess flows passing Morelos Diversion Dam under the Conservation Before Shortage and Reservoir Storage alternatives than under the No Action Alternative, which is expected to cause a moderate positive benefit to river flows, obligate phreatophytes, and marsh and associated wildlife downstream of Morelos Diversion Dam[1]. The other action alternatives, including the Preferred Alternative, would provide similar flows as the No Action Alternative.

ES.2.7.2 Special Status Species

In addition to the assessment of effects on general vegetation and wildlife, the analysis also considered potential effects on special status fish, bird, and plant species. These effects were evaluated for species occurring at Lake Powell and Lake Mead, the reaches of the Colorado River between Glen Canyon Dam and Lake Mead, and downstream of Lake Mead.

Lake Powell. Lower Lake Powell elevations under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, at the 10th and 50th percentile of reservoir elevations may increase the amount of riverine habitat available at the inflow areas to Lake Powell. This may provide a minor positive impact to razorback sucker, bonytail, Colorado pikeminnow, and flannelmouth sucker found in the riverine areas at the inflows. The higher lake elevations under the Reservoir Storage Alternative may decrease the amount of riverine habitat at the inflow areas, which may result in a minor negative impact.

Clark's grebe that may inhabit Lake Powell could be impacted by elevation changes in Lake Powell that affect marsh habitat at the inflow areas. Under the Reservoir Storage and Water Supply alternatives, there may be higher and lower lake elevations, respectively, which would mean a minor positive and a minor negative impact, respectively, to Clark's grebe.

Glen Canyon Dam to Lake Mead. The action alternatives, except for the Reservoir Storage Alternative, may result in higher river temperatures downstream of Glen Canyon Dam at the 10th percentile elevations and higher to lower temperatures at the 50th percentile elevations relative to the No Action Alternative. The Reservoir Storage Alternative may result in higher to lower river temperatures at the 10th and 50th percentiles elevations, respectively. Higher temperatures may provide a minor positive impact to humpback

[1] These flows were modeled as part of the storage and delivery mechanism under the Conservation Before Shortage and Reservoir Storage alternatives. These modeling assumptions were utilized in the Final EIS in order to analyze the potential impacts to environmental resources of the storage and delivery mechanism, particularly with regard to reservoir elevations and river flow impacts. The use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, these releases could be made under current management of the Colorado River.

chub, bluehead sucker and flannelmouth sucker spawning and growth. However, these warmer temperatures also benefit non-native fish species which compete with native fish, and parasites that affect native fish, resulting in a minor negative impact. The lower average temperatures in the summer and winter at the 10th percentile of elevations under the Reservoir Storage Alternative could reduce the growing season for humpback chub, bluehead sucker, and flannelmouth sucker but would not affect spawning, resulting in a minor negative impact. The short duration of warmer average temperatures in the spring followed by cooler temperatures are unlikely to provide any benefit to non-native fish and native fish parasites. Lower annual releases in some years could reduce sediment loss from the Colorado River while higher releases in some years could increase sediment losses. How these changes in sediment transport could affect native fish habitat is unknown. The range in hourly flows could be reduced during lower annual releases and increased during higher annual releases. Lower temperatures may provide a minor negative impact to these native fish species. Under the Reservoir Storage Alternative, average water temperatures above 15ºC (59°F) may occur one month later than under the No Action Alternative and may have a minor negative impact on leopard frogs due to increased potential for thermal shock in July. Under the other action alternatives impacts to the leopard frog are not expected relative to the No Action Alternative.

Higher 90th percentile releases under the Reservoir Storage Alternative have a potential for increased impact to beach habitat in the lower Grand Canyon, which could adversely impact vegetation and Grand Canyon evening primrose on those beaches. Under the five action alternatives, flows may exceed those under the No Action Alternative and 17,000 cfs in some months, which may cause additional impact to Kanab ambersnail habitat at Vasey's Paradise. Under the Reservoir Storage Alternative, flows in June could exceed those under the No Action Alternative and exceed 20,000 cfs, thus causing greater impact to Niobrara ambersnail habitat. Under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative at the 90th percentile there may be flows that when above 20,000 cfs are equal to or less than those under No Action Alternative, which would provide a minor positive benefit to the Niobrara ambersnail. Under the five action alternatives there may be a minor negative impact on the southwestern willow flycatcher because of the 10th percentile release flows trend lower than those under the No Action Alternative. These lower potential flows could adversely impact southwestern willow flycatcher habitat in the Grand Canyon.

Lake Mead. The lower and higher Lake Mead elevations that may occur under the Water Supply and Reservoir Storage alternatives, respectively, could cause minor negative and minor positive impacts, respectively, to special status bird species. Impacts on bird species may be caused by increased or decreased potential for dewatering of riparian habitats and headcutting at the Lake Mead inflow areas. Higher lake elevations under the Reservoir Storage Alternative may inundate additional shoreline habitat for the sticky buckwheat, Geyer's milkvetch and Las Vegas Bearpoppy and be a minor negative impact. Lower Lake Mead elevations under the Water Supply Alternative may expose additional shoreline habitat for these plants and be a minor positive impact. These impacts were deemed minor because all habitats below the full pool elevation of Lake Mead are subject to periodic inundation and exposure as the lake elevation fluctuates in the future. Under the Preferred Alternative, there could be minor positive impacts to special status fish when elevations are above the current razorback spawning areas at the 50th percentile of elevations and when lower elevations would extend riverine habitat in the inflow area for special status fish. Elevations higher than under the No Action Alternative at the 10th percentile would have no impacts on razorback sucker spawning. Lake elevations under both the Basin States and Conservation Before Shortage alternatives could be both above and below those under the No Action Alternative and would have no impact to razorback suckers. The increased amount of riverine habitat at the 10th percentile of elevations could provide a minor positive impact to special status fish in the Colorado River inflow. Under the Water Supply Alternative there may be both minor positive and negative impacts to special status fish species due to providing more riverine habitat and lower elevations relative to razorback spawning areas, respectively, at the 50th percentile. Under the Reservoir Storage Alternative, elevations could be above current razorback sucker spawning areas over 50 percent of the time in about half the modeled years, a moderate positive impact. Higher reservoir elevations would provide less riverine habitat for special status fish in the Colorado River inflow at the10th and 50th percentile elevations for a minor negative impact.

Hoover Dam to Davis Dam and Lake Havasu to Parker Dam. There is no substantial difference between the No Action Alternative and any of the action alternatives in this reach.

Davis Dam to Lake Havasu. Lower monthly and annual median releases from Davis Dam under the Reservoir Storage Alternative may have a minor negative impact on obligate phreatophytes, and marsh and associated special status bird species, and Colorado River cotton rat. Impacts to these species may occur through adverse effects to their habitats from reduced dam releases. Razorback sucker, flannelmouth sucker, and bonytail may experience a minor negative impact because lower potential releases could have adverse impacts to riverine spawning habitat and backwater rearing habitats that these species utilize. Higher monthly and annual median releases from Davis Dam under the Water Supply Alternative may have a minor positive impact on obligate phreatophytes, and marsh and associated special status bird species, and Colorado river cotton rat. Razorback sucker, flannelmouth sucker, and bonytail may also benefit from these higher flows because they could maintain more of the spawning and rearing habitats present in this reach.

Parker Dam to Imperial Dam. Lower monthly and annual median flows under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, may have minor negative impacts to the habitats of the special status bird species and Colorado River cotton rat. Obligate phreatophytes, and marsh and associated special status species would be negatively impacted by lower releases. Razorback sucker and bonytail chub may be negatively impacted by lower flows under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative. Lower flows may negatively impact spawning and rearing habitats for these species. Higher annual median flows under the Water Supply Alternative would benefit the habitats of special status birds, mammals and fish and may have a minor positive impact.

Imperial Dam to NIB. Under the No Action Alternative and the action alternatives there would be no impact to special status species in this reach.

NIB to SIB. Flows past Morelos Diversion Dam[2] are more probable under the Reservoir Storage and Conservation Before Shortage alternatives. The increased probability of flows may have a moderate positive impact on the special status bird species through positive impacts to riparian and marsh habitats these species utilize. These higher probabilities of flows may also positively impact the special status bat species listed in this section, Yuma hispid cotton rat, and Colorado river cotton rat through positive impacts to their riparian and marsh habitats. Though these flows are an overall benefit to the riparian corridor downstream of the NIB, the increased probability of high flows could increase the likelihood of scouring *Atriplex* vegetation in this reach, which would be a minor negative impact to MacNeill's sooty-winged skipper.

ES.2.8 Cultural Resources

For Lake Powell, under the Water Supply Alternative at the 10th percentile, there are at least 227 unexcavated sites subject to effect, as compared to about 193 sites under the other alternatives. Consultation is underway regarding eligibility and effect.

For the reach from Glen Canyon to Lake Mead, the alternatives pose no additional threat to cultural resources because of the programs already underway.

For Lake Mead, there are at least 32 cultural resources located below elevation 1,080 feet msl. The probability of exposing sites below this elevation vary by alternative, with the Reservoir Storage Alternative having the lowest probability (up to 13 percent lower compared to the No Action Alternative) and the Water Supply Alternative having the highest probability (up to nine percent higher compared to the No Action Alternative). The Basin States and Conservation Before Shortage alternatives and the Preferred Alternative have probabilities similar to those of the No Action Alternative.

For reaches downstream of Lake Mead, no adverse effects are anticipated from any of the alternatives. However, consultation regarding eligibility and effect is under way.

For Indian sacred sites and other issues of Tribal concern (not including ITAs), none of the alternatives are expected to restrict access or result in loss of physical integrity to sacred sites. Consultations with Indian tribes are ongoing with respect to these issues and other issues and concerns.

[2] These flows were modeled as part of the storage and delivery mechanism under the Conservation Before Shortage and Reservoir Storage Alternatives. These modeling assumptions were utilized in the Final EIS in order to analyze the potential impacts to environmental resources of the storage and delivery mechanism, particularly with regard to reservoir elevations and river flow impacts. The use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, these releases could be made under current administration of the Colorado River.

ES.2.9 Indian Trust Assets

After analyzing each resource, it is concluded that Tribal trust assets identified in the study area would not be adversely affected by any of the anticipated environmental impacts stemming from the proposed federal action.

ES.2.10 Electrical Power Resources

The Basin States, Conservation Before Shortage, and Water Supply alternatives could potentially have minor impacts in generation, capacity, and economic value of electrical power at Glen Canyon and Hoover Powerplants due to slightly lower average reservoir elevations that could occur under these alternatives. The Water Supply Alternative could potentially have the highest effect on electrical power production and value because this alternative provides the lowest average reservoir elevations of the action alternatives. The Preferred Alternative and the Reservoir Storage Alternative could potentially provide a benefit to electrical power production and value at Glen Canyon and Hoover Powerplants because these alternatives would provide higher average reservoir elevations than the No Action Alternative. However, most of these changes are less than one percent and as such, these impacts are considered minor.

For the Parker-Davis Project and Headgate Rock powerplants, the Preferred Alternative and the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives could potentially decrease electrical power production at these facilities as compared to the No Action Alternative because of the lower release volumes from the associated dams/powerplants. The Reservoir Storage Alternative generally provides lower water releases compared to the No Action Alternative and other action alternatives and therefore this alternative could have the greatest effect on power production at these facilities. The Water Supply Alternative results in greater release volumes downstream and therefore slight increases in electrical power production and value as compared to the No Action Alternative. Again, these changes are relatively minor (most less than one percent) compared to overall electrical power production at these facilities.

All of the action alternatives, with the exception of the Reservoir Storage Alternative, could potentially increase pumping costs for entities that pump water from Lake Powell due to the lower reservoir elevations, as compared to the No Action Alternative. At Lake Mead, all of the action alternatives, with the exception of the Water Supply Alternative, provide higher reservoir elevations as compared to the No Action Alternative and therefore could potentially result in lower pumping costs for the entities that pump water from Lake Mead.

Reductions in power revenues could reduce the amount of money available to meet the intended uses of the basin power funds, possibly leading to reductions in allocations to power contractors or power rate adjustments. The action alternatives generally have a minor impact on the economic value of electrical power generation at the Glen Canyon and Hoover Powerplants. However, total loss of electrical power generation capabilities would have a substantial effect on the basin power funds. At the Glen Canyon Powerplant, the probability of this type of loss in electrical power generation capability is very small (less than five percent) except under the Water Supply Alternative, which would result in as much as a nine percent probability. At Hoover Powerplant, the probability of total loss of generation is higher, increasing from zero in 2008 to about 30 percent in 2026. However, the Reservoir Storage Alternative is the exception to this, while the remaining alternatives are very similar to the No Action Alternative.

ES.2.11 Recreation

ES.2.11.1 Shoreline Facilities

The Reservoir Storage Alternative would result in higher reservoir elevations and a lower probability of closure of shoreline facilities than the other action alternatives and the No Action Alternative. Conversely, the Water Supply Alternative would result in the highest probability of such closures. The Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative are similar to the No Action Alternative.

At Lake Mead, all of the alternatives have similar probabilities of facility closures except for the Reservoir Storage Alternative, which has a slightly to moderately lower probability. At Lake Mead, under all of the alternatives there is a 74 to 78 percent probability that the Pearce Bay launch ramp would be closed to boaters, except under the Reservoir Storage Alternative this probability is 66 percent. Similarly, there is a 21 to 30 percent probability of closure of the Echo Bay public launch ramp (in the north end of the reservoir) under all of the alternatives, except under the Reservoir Storage Alternative this probability is nine percent.

ES.2.11.2 Boating and Navigation

For safe boating at Lake Powell, probabilities range from 24 to 28 percent that NPS would have to prohibit boating around Castle Rock and Gregory Butte under the No Action Alternative and the Reservoir Storage Alternative. Under the Basin States Alternative there is a 36 percent probability and under the Conservation Before Shortage Alternative there is a 35 percent probability that boating prohibitions would need to be put in place. Under the Water Supply Alternative, the probability of this occurrence is 52 percent. Under the Preferred Alternative there is a 32 percent probability that prohibitions would be put in place.

For Lake Mead, all the alternatives except the Reservoir Storage Alternative in July 2026 provide a 72 to 76 percent probability that boaters may encounter navigational hazards at the upstream end of Lake Mead due to reservoir elevations being drawn down to below 1,170 feet msl. Under the Reservoir Storage Alternative there is a 69 percent probability of a similar recreational impacts. Similar effects would occur in the Overton Arm of Lake Mead.

For whitewater boating through Grand Canyon, the Glen Canyon Dam ROD flows will be maintained. Even in a 7.0 maf Glen Canyon Dam release year, the minimum daily flow will remain at or above 5,000 cfs, a safe boating threshold.

ES.2.11.3 Sport Fish Populations

Sport fish populations would not be adversely affected at Lake Powell under any of the alternatives. Although surface water temperatures may approach lethal levels in the upper 10 feet of the reservoir under any alternative, lethal levels for striped bass and threadfin shad are not expected to be exceeded by any alternative. Moreover, cooler temperatures below the lake surface would serve as a refuge for the fish. The situation for striped bass and threadfin shad in Lake Mead is similar to Lake Powell. Higher water temperatures could impair the Lake Mead Fish Hatchery, particularly under the Water Supply Alternative.

Under the No Action Alternative, 10^{th} percentile temperatures are suitable for growth, spawning and incubation in most months. Higher water temperatures under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, could affect various life history stages of rainbow trout downstream of Glen Canyon Dam. Under the action alternatives, 10^{th} percentile modeling results indicate that there could be minor impacts to rainbow trout due to warmer temperatures. The Water Supply Alternative shows the most warming and potential to negatively impact trout. The Reservoir Storage Alternative shows the least warming and will often result in colder temperatures than the No Action Alternative. Conditions for trout under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, will be similar to slightly worse than under the No Action Alternative.

ES.2.12 Transportation

For the Lake Powell ferry, the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative would have minor effects on ferry service; the Water Supply Alternative could result in potential moderate adverse effects; and the Reservoir Storage Alternative could have beneficial effects. The probability varies from year to year, but there is up to a 17 percent probability that the Lake Powell ferry may become inoperable under the Water Supply Alternative for some period of time. Conversely, the ferry would remain operable with the highest probabilities and greatest durations of time under the Reservoir Storage Alternative.

For the Colorado River ferry service downstream of Davis Dam, only under the Reservoir Storage Alternative are there any measurable effects and these potential effects would be minor. The other action alternatives show no difference from the No Action Alternative.

The Lake Havasu ferry service would be unaffected under all of the action alternatives.

ES.2.13 Socioeconomics

ES.2.13.1 Employment, Income, and Tax Revenue

Although a loss in employment and income could potentially occur under any of the action alternatives, the probability of any shortage occurring would be greater under the No Action Alternative. This suggests that the potential loss in employment, income, and tax revenues estimated for the No Action Alternative would be reduced under each of the action alternatives. The probabilities of any shortage amount occurring would be similar under all the action alternatives during the interim period with the exception of the Water Supply Alternative. When compared to the other action alternatives, the probabilities of any shortage amount occurring would be lower under the Water Supply Alternative. This indicates that, with the exception of the Water Supply Alternative, the potential losses in employment, income, and tax revenues would be similar among the action alternatives during the interim period. However, none of the changes in employment and income are considered substantial when compared to total employment and income generated within the study area.

For the period 2027 through 2060, the change in employment and income would be similar between the No Action Alternative and the action alternatives. The greatest difference would be in 2027 in which the probabilities would be slightly higher when compared to those under the No Action Alternative. However, by 2040, the probabilities of shortages occurring under all of the alternatives are very similar.

ES.2.13.2 Municipal and Industrial Water Uses

Adverse effects on employment and income in Arizona and Nevada during shortages would be minimized as a result of drought plans being in place. No adverse effects are expected in California because of priority of apportionment and the availability of alternative water supplies.

ES.2.13.3 Recreation Economics

Recreation opportunities and associated economic activity at Lake Powell are not expected to be substantially different under the No Action Alternative, the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative. Recreation opportunities and associated economic activity could potentially be adversely affected under the Water Supply Alternative due to the potentially lower Lake Powell elevations that may occur under this alternative. Conversely, recreation opportunities and associated economic activity would benefit under the Reservoir Storage Alternative as a result of potentially higher Lake Powell elevations under this alternative.

Recreation opportunities and associated economic activity at Lake Mead are not expected to be substantially different under the No Action Alternative, the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative. Recreation opportunities and associated economic activity could potentially benefit under the Reservoir Storage Alternative due to the potentially higher Lake Mead elevations that may occur under this alternative.

Because daily and hourly flows in the Lake Powell to Lake Mead reach and in the Colorado River reaches downstream of Lake Mead would likely remain within ranges suitable for boating, there would be no change in river-related economic activity.

ES.2.14 Environmental Justice

After evaluating each resource, it is concluded that the environmental justice communities identified in the study area would not be disproportionately affected by any of the anticipated environmental impacts stemming from the proposed federal action. Nor would the proposed federal action result in adverse disproportionate impacts on human health within these environmental justice communities.

ES.2.15 Indirect Effects of ICS Mechanism

SNWA proposes three ICS projects which were specifically formulated to utilize the ICS mechanism: Virgin River and Muddy River Tributary Conservation, Coyote Spring Well and Moapa Transmission System Project, and lower Colorado River Drop 2 Storage Reservoir Project. It is anticipated that creation of ICS and subsequent delivery of water from Lake Mead for the proposed SNWA projects will be approved as part of the ROD for the proposed federal action. While the proposed SNWA water conservation projects are not federal projects, they will rely on Reclamation's approval for creation and delivery of ICS from Lake Mead. The effects of these projects within the geographic scope of the proposed federal action have been included in the modeling assumptions and are therefore included in the various resource analyses in this Final EIS. The localized impacts of these water conservation projects (outside the geographic scope of the proposed federal action) are described as indirect effects of Reclamation's establishment of the ICS mechanism.

The Coyote Spring Well and Moapa Transmission System Project would increase flow in the Muddy River, although the effect on flows would be minor and may provide minor positive impacts.

The Drop 2 Storage Reservoir Project would result in a reduction in non-storable flows that are delivered to Mexico. The Environmental Assessment for the Drop 2 Storage Reservoir Project included a specific analysis of the hydrologic impacts of the project on smaller (non-flood release) flows in the limitrophe division of the Colorado River and concluded decreases in surface water flows passing Morelos Diversion Dam would not conflict with 1944 Treaty delivery obligations, or substantially alter the existing drainage pattern or flows of the limitrophe reach. The Final EA did not identify significant impacts from the project.

No significant impacts on water quality, visual resources, cultural resources, ITAs, electrical power, recreation, transportation, or environmental justice are anticipated from the SNWA Tributary Conservation projects. The changes in river flow would be minimal and may provide minor positive impacts.

ES.2.16 Climate Change Considerations

Based on the current inability to precisely project future impacts of climate change to runoff throughout the Colorado River Basin at the spatial scale needed for CRSS, Reclamation based its hydrologic analysis for this EIS primarily on the resampled historical record. However, in order to understand the potential effects of future inflow sequences outside the range of historical flows (i.e., future sequences with increased variability including the severity, frequency, and duration of droughts), particularly during the 19-year period of the application of the proposed federal action, Reclamation analyzed the sensitivity of the hydrologic resources (including reservoir storage, reservoir releases, and river flows) to hydrologic scenarios derived from alternative methodologies (including stochastic hydrology methods and paleo-reconstruction methods) in the Draft EIS. An additional analysis has been added to Appendix N in the Final EIS that incorporates a newly published tree-ring reconstruction of hydrologic inflows at Lees Ferry (Meko et al. 2007) that extends the estimate of annual flow at Lees Ferry back to the year 762, a record length of 1,244 years.

Although precise estimates of the future impacts of climate change to runoff throughout the Colorado River Basin at appropriate spatial scales are not currently available, these impacts may include decreased mean annual flow and increased variability, including more frequent and more severe droughts. Furthermore, even without precise knowledge of the effects on runoff, increasing temperatures alone would likely increase losses (e.g., evapotranspiration and sublimation), resulting in reduced runoff.

Acknowledging the potential for impacts due to climate change and increased hydrologic variability, the Secretary proposes that these guidelines be interim in duration and extend through 2026, providing the opportunity to gain valuable operating experience for the management of Lake Powell and Lake Mead, particularly for low reservoir conditions, and improve the basis for making additional future operational decisions, whether during the interim period or thereafter. In addition, the Preferred Alternative has been crafted to include operational elements that would respond if potential impacts of climate change and increased hydrologic variability are realized. In particular, the Preferred Alternative includes a coordinated operation element that allows for the adjustment of Lake Powell's release to respond to low reservoir storage conditions in Lake Powell or Lake Mead as described in Section 2.7 and Section 2.3. In addition, the Preferred Alternative will enhance conservation opportunities in the Lower Basin and the retention of water in Lake Mead through adoption of the ICS mechanism. Finally, the Preferred Alternative includes a shortage strategy at Lake Mead that would result in additional shortages being considered, after appropriate consultation, if Lake Mead elevations drop below 1,025 feet msl.

ES.3 Summary

A summary of potential effects of the No Action Alternative and the action alternatives is provided in Table ES-2.

ES.4 Cumulative Impacts

The proposed federal action would not result in any significant cumulative impacts.

ES-2
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives					
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
4.3	Hydrologic Resources						
	Probability of Glen Canyon annual release volumes ≥ 7.5 maf, 2009 to 2060	99.96%	96.66%	96.66%	97.9%	100%	96.39%
	Probability of Glen Canyon annual release volumes ≥ 8.23 maf, 2009 to 2060	99%	96.32%	96.38%	96.33%	93.79%	96.64%
	Lake Powell March elevation, probability of water levels ≤ 3,490 feet msl 2026	1.0%	0%	0%	9.0%	0%	0%
	Lake Mead July elevation, probability of water levels ≤ 1,050 feet msl 2026	30%	23%	23%	29%	9%	21%
	Hoover Dam annual release, 2026 50th percentile values	9.04 maf	9.17 maf	9.11 maf	9.39 maf	8.68 maf	9.16 maf
4.4	Water Deliveries						
	Probability of involuntary shortage, 2026	49%	35%	7%	12%	37%	41%
	Probability of voluntary and involuntary shortage, 2026	49%	35%	36%	12%	37%	41%
	Probability of normal deliveries, 2026	34%	26%	25%	47%	45%	19%
	Probability of surplus, 2026	17%	39%	39%	41%	18%	40%
4.5	Water Quality						
	Temperature at Little Colorado River, July 2026, 50th percentile	12 °C	12 °C	12 °C	13 °C	12 °C	12 °C
	Salinity downstream of Parker Dam, 2026,	621 mg/L	625 mg/L	625 mg/L	633 mg/L	615 mg/L	625 mg/L
	Salinity at Imperial Dam, 2026	740 mg/L	747 mg/L	751 mg/L	760 mg/L	735 mg/L	747 mg/L
4.6	Air Quality						
	Lake Powell 2025, 10th percentile exposed shoreline	17,000 acres	17,000 acres	17,000 acres	22,000 acres	14,000 acres	17,000 acres
	Lake Mead 2025, 10th percentile exposed shoreline	89,000 acres	82,000 acres	83,000 acres	90,000 acres	73,000 acres	82,000 acres

Table ES-2
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives					
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
4.7	Visual Resources						
	Lake Powell maximum height of calcium carbonate ring, 10th percentile, 2025	148 feet	148 feet	148 feet	192 feet	128 feet	148 feet
	Lake Mead maximum height of calcium carbonate ring, 10th percentile, 2025	218 feet	197 feet	199 feet	221 feet	170 feet	195 feet
4.8	Biological Resources[1]						
	Effects on Vegetation and Wildlife						
	Lake Powell and Lake Mead	--	None to minor positive	None to minor positive	Minor negative	Minor positive	Minor positive
	Glen Canyon Dam to Lake Mead	--	Minor negative	Minor negative	Minor negative	Minor negative	Minor negative
	Hoover Dam to NIB	--	None to minor negative	None to minor negative	None to minor positive	None to minor negative	None to minor negative
	NIB to SIB	--	None	Moderate positive	None	Moderate positive	None
	Effects on Special Status Species						
	Glen Canyon Dam to Lake Mead humpback chub	--	Minor positive to minor negative	Minor positive to minor negative	Minor positive to minor negative	Minor negative	Minor positive to minor negative
	Parker Dam to Imperial Dam Yuma clapper rail	--	Minor negative	Minor negative	Minor positive	Minor negative	Minor negative
	NIB to SIB Southwestern willow flycatcher	--	None	Moderate positive	None	Moderate positive	None
4.9	Cultural Resources						
	Number of Lake Powell sites potentially exposed, 10th percentile	194 sites	190 sites	190 sites	227 sites	193 sites	190 sites
	Probability of exposing 32 Lake Mead sites ≤ elevation 1,080 feet msl, 2026	45%	45%	46%	48%	23%	47%
4.10	Indian Trust Assets[1]						
	Water rights affected	-	None	None	None	None	None
	Trust land affected	-	None	None	None	None	None

Table ES-2
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives					
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
4.11	Electrical Power Resources						
	Glen Canyon Powerplant						
	Average annual generation and percent change from No Action Alternative value	4,247,880 MWh	(0.08)%	(0.07)%	(2.57)%	0.78%	0.08%
	Average monthly capacity and percent change from No Action Alternative value	606 MW	(0.15)%	(0.13)%	(2.72)%	0.79%	0.03%
	Average total economic value and percent change from No Action Alternative value	$7,350,000,000	0.02%	0.04%	(2.25)%	0.88%	0.19%
	Hoover Powerplant						
	Average annual generation and percent change from No Action Alternative value	3,127,523 MWh	(0.22)%	(0.05)%	(2.39)%	9.07%	1.4%
	Average monthly capacity and percent change from No Action Alternative value	1,191 MW	0.31%	0.58%	(2.56)%	11.52%	2.31%
	Average total economic value and percent change from No Action Alternative value	$7,223,000,000	0.08%	0.34%	(2.51)%	10.63%	2.38%
	Davis and Parker Powerplants						
	Average annual generation and percent change from No Action Alternative value	1,639,687 MWh	(0.56)%	(0.69)%	0.11%	(1.07)%	(0.68)%
	Average monthly capacity and percent change from No Action Alternative value	331 MW	0%	0%	0%	0%	0%
	Average total economic and percent change from No Action Alternative value	$2,268,000,000	(0.53)%	(0.73)%	0.31%	(1.54)%	(0.81)%
	Headgate Rock Powerplant						
	Average annual generation and percent change from No Action Alternative value	77,482 MWh	(1.21)%	(1.71)%	(0.28)%	(1.7)%	(1.5)%
	Average monthly capacity and percent change from No Action Alternative value	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable
	Average total economic value and percent change from No Action Alternative value	$103,000,000	(1.29)%	(2.02)%	(0.17)%	(2.31)%	(1.83)%

Table ES-2
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives					
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
4.12	Recreation						
	Lake Powell						
	Probability of closure, Wahweap and lower Bullfrog launch ramps, 2026	7%	9%	9%	23%	3%	8%
	Probability of navigation closures, Castle Rock, Gregory Butte, 2026	28%	36%	36%	52%	24%	32%
	Effects on sport fish	--	None	None	None	None	None
	Lake Mead						
	Probability of closure, Pearce Bay launch ramp, 2026	74%	76%	75%	78%	66%	74%
	Probability of closure, Echo Bay launch ramp, 2026	30%	23%	23%	29%	9%	21%
	Probability of navigation difficulties, upper Lake Mead, 2026	73%	73%	73%	76%	64%	72%
4.13	Transportation						
	Probability of Lake Powell ferry closure, end of September 2026	5%	7%	7%	17%	3%	7%
	Effects on Laughlin River taxis and tour boats	--	None	None	Minor positive	Minor negative	None
	Effects on Lake Havasu ferry service	--	None	None	None	None	None

Table ES-2
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives					
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
4.14	Socioeconomics and Land Use						
	Probability of 500,000 af shortage with loss of 561 jobs and $18,000,000 in income, and $5,900,000 in tax revenues in agricultural sector in Arizona, 2026	34%	15%	1%	--	--	24%
	Probability of 500,000 af shortage with loss of 397 jobs and $12,300,000 in income, and $4,200,000 in tax revenues in agricultural sector in Arizona, 2060	54%	54%	50%	51%	53%	52%
	Agricultural production and resulting effects on employment, income, and tax revenues in California and Nevada	--	None	None	None	None	None
	Recreation spending at Lake Powell	--	Same	Same	Decrease	Increase	Increase
	Recreation spending at Lake Mead (LMNRA)	--	Same	Same	Same	Increase	Increase
	Change in river recreation economic activity						
	Lake Powell to Lake Mead	--	None	None	None	None	None
	Downstream of Lake Mead	--	None	None	None	None	None
	Change in economic activity in Municipal & Industrial sector						
	Arizona	--	None	None	None	None	None
	California	--	None	None	None	None	None
	Nevada	--	None	None	None	None	None
4.15	Environmental Justice	--	None	None	None	None	None

Note: (1) "None" after a hyphen in the No Action Alternative column means no difference between the action alternative and the No Action Alternative.

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Chapter One

1.1 Introduction

During the period from 2000 to 2007, the Colorado River has experienced the worst drought conditions in approximately one hundred years of recorded history. During this period, storage in Colorado River reservoirs has dropped from nearly full to less than 55 percent of capacity as of September 30, 2007. Currently, the Department of the Interior (Department) does not have specific operational guidelines in place to address the operations of Lake Powell and Lake Mead during drought and low reservoir conditions.

Accordingly, the Secretary of the Department of the Interior (Secretary), acting through the Bureau of Reclamation (Reclamation), proposes adoption of specific Colorado River Lower Basin (Lower Basin) shortage guidelines and coordinated reservoir management strategies to address operations of Lake Powell and Lake Mead, particularly under drought and low reservoir conditions. This action is proposed in order to provide a greater degree of certainty to United States Colorado River water users and managers of the Colorado River Basin by providing detailed, and objective guidelines for the operations of Lake Powell and Lake Mead, thereby allowing water users in the Lower Basin to know when, and by how much, water deliveries will be reduced in drought and other low reservoir conditions. The environmental impact statement (EIS) process provides the opportunity to develop the information needed to analyze and consider trade-offs between the frequency and magnitude of shortages, and to describe potential effects on water storage in Lake Powell and Lake Mead, and on water supplies, power production, recreation, and other environmental resources.

The Secretary proposes that these guidelines be interim in duration and extend through 2026. Adoption of these new guidelines, along with modification of existing operational guidelines for a consistent interim period through 2026, will provide the opportunity to gain valuable operating experience for the management of Lake Powell and Lake Mead under modified operations and improve the basis for making additional future operational decisions, whether during the interim period or thereafter.

The Secretary intends to consider, adopt and implement the proposed federal action[1] consistent with applicable federal law and judicial decisions, and, further, in a manner that will not require any additional statutory authorization. In addition, the proposed federal action would be implemented consistent with the Colorado River Compact of 1922 (Compact), the Consolidated Decree entered by the United States Supreme Court in the case of *Arizona v. California*, 547 U.S. 150 (2006) (Consolidated Decree), and other provisions of applicable federal law. The proposed federal action will be implemented through the adoption of interim guidelines that would be used each year by the Department in implementing the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Long-Range Operating Criteria or LROC) through issuance of the Annual Operating Plan for Colorado River Reservoirs (AOP).

[1] The phrase "proposed federal action" is used herein to refer to the action that the Secretary may take to meet the purpose and need. A range of alternatives, including the Preferred Alternative, are considered and analyzed in this Final EIS.

This Final Environmental Impact Statement (Final EIS) has been prepared pursuant to the National Environmental Policy Act of 1969 (NEPA), as amended, and the Council on Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations (C.F.R.) part (pt.) 1500 through 1508). This Final EIS has been prepared to address the formulation and evaluation of the proposed federal action and to identify the potential environmental effects of implementing the proposed federal action.

This Final EIS identifies the potentially relevant environmental issues associated with, and analyzes the environmental consequences of, alternatives for implementing the proposed federal action. The alternatives addressed in this Final EIS are those Reclamation has determined would meet the purpose and need for the proposed federal action and represent a broad range of reasonable alternatives.

1.2 Proposed Federal Action

The proposed federal action includes the adoption of specific interim guidelines for Lower Basin shortages and coordinated operations of Lake Powell and Lake Mead. These interim guidelines would remain in effect for determinations to be made through 2025 regarding water supply and reservoir operating decisions through 2026 and would provide guidance each year in development of the AOP. This proposed federal action considers four operational elements that collectively are designed to address the purpose and need for the proposed federal action; these elements are addressed in each of the alternatives described in Chapter 2.

The interim guidelines would be used by the Secretary to:

1) determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) below 7.5 million acre-feet (maf) (a ''Shortage'') pursuant to Article II(B)(3) of the Consolidated Decree;

2) define the coordinated operations of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;

3) allow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions; and

4) determine those conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing Interim Surplus Guidelines (ISG), published in the *Federal Register* (Fed. Reg.) on January 25, 2001 (66 Fed. Reg. 7772), and the term of the ISG from 2016 through 2026.

1.3 Purpose of and Need for Action

The purpose of the proposed federal action is to: 1) improve Reclamation's management of the Colorado River by considering the trade-offs between the frequency and magnitude of reductions of water deliveries, and considering the effects on water storage in Lake Powell and Lake Mead, water supply, power production, recreation, and other environmental resources; 2) provide mainstream United States users of Colorado River water, particularly those in the Lower Division states, a greater degree of predictability with respect to the amount of annual water deliveries in future years, particularly under drought and low reservoir conditions; and, 3) provide additional mechanisms for the storage and delivery of water supplies in Lake Mead.

The proposed federal action is needed for the following reasons:

- the Colorado River is of unique and strategic importance in the southwestern United States for water supply, hydropower production, flood control, recreation, fish and wildlife habitat, and other benefits. In addition, the United States has a delivery obligation to the United Mexican States (Mexico) for certain waters of the Colorado River pursuant to the February 3, 1944 Treaty between the United States and Mexico Relating to the Utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande (1944 Treaty);

- the eight-year period from 2000 through 2007 was the driest eight-year period in the 100-year historical record of the Colorado River; this drought in the Colorado River Basin has reduced Colorado River system storage, while demands for Colorado River water supplies have continued to increase. From October 1, 1999 through September 30, 2007, storage in Colorado River reservoirs fell from 55.8 maf (approximately 94 percent of capacity) to 32.1 maf (approximately 54 percent of capacity), and was as low as 29.7 maf (approximately 52 percent of capacity) in 2004. This drought was the first sustained drought experienced in the Colorado River Basin at a time when all major storage facilities were in place, and when use by the Lower Division states met or exceeded the annual "normal" apportionment of 7.5 maf pursuant to Article II(B)(1) of the Consolidated Decree. These conditions, among other factors, led the Department to conclude that additional management guidelines are necessary and desirable for the efficient management of the major mainstream Colorado River reservoirs;

- in the future, low reservoir conditions may occur more frequently due to drought periods and anticipated future demands on Colorado River water supplies;

- as a result of actual operating experience and through reviews of the LROC and preparation of AOPs, particularly during recent drought years, the Secretary has determined a need for more specific guidelines, consistent with the Consolidated Decree and other applicable provisions of federal law to assist in the Secretary's determination of annual water supply conditions in the Lower Basin under low reservoir conditions. This increased level of predictability is needed by water managers and the entities that receive Colorado River water to better plan for and manage available water supplies, and to better integrate the use of Colorado River water with other water supplies that they rely on;

- to date, storage of water and flows in the Colorado River has been sufficient so that it has not been necessary to reduce Lake Mead annual releases below 7.5 maf; that is, the Secretary has never reduced deliveries by declaring a "shortage" on the lower Colorado River. Without operational guidelines in place, water users in the Lower Division states who rely on Colorado River water are not currently able to identify particular reservoir conditions under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Lower Division states below 7.5 maf. Nor are these water users able to identify the frequency or magnitude of any potential future annual reductions in their water deliveries;

- subsequent to the public consultation meetings held in the summer of 2005, the Secretary has also determined the desirability of developing additional operational guidelines that will provide for releases greater than or less than 8.23 maf from Lake Powell; and

- to further enhance this coordinated reservoir approach, the Secretary has also determined a need for guidelines that provide water users in the Lower Division states the opportunity to conserve, store, and take delivery of water in and from Lake Mead for the purposes of enhancing existing water supplies, particularly under low reservoir conditions. The Secretary has determined the need to modify and extend the ISG to coincide with the duration of the proposed new guidelines. This will provide an integrated approach for reservoir management and more predictability for future Lower Division water supplies.

1.4 Lead and Cooperating Agencies

The Secretary is responsible for the operation of Glen Canyon Dam and Hoover Dam pursuant to applicable federal law. The Secretary is also vested with the responsibility of managing the mainstream waters of the lower Colorado River pursuant to federal law. This responsibility is carried out consistent with the Law of the River.[2] Reclamation, as the agency that is designated to act on the Secretary's behalf with respect to these matters, is the lead federal agency for the purposes of NEPA compliance for the development and implementation of the proposed interim guidelines.

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[2] The treaties, compacts, decrees, statutes, regulations, contracts and other legal documents and agreements applicable to the allocation, appropriation, development, exportation and management of the waters of the Colorado River Basin are often referred to as the Law of the River. There is no single, universally agreed upon definition of the Law of the River, but it is useful as a shorthand reference to describe this longstanding and complex body of legal agreements governing the Colorado River.

Five federal agencies are cooperating for purposes of assisting with environmental analysis and preparation of this Final EIS. These cooperating agencies are the Bureau of Indian Affairs (BIA), the United States Fish and Wildlife Service (FWS), the National Park Service (NPS), Western Area Power Administration (Western), and the United States Section of the International Boundary and Water Commission (USIBWC).

The BIA has responsibility for the administration and management of lands held in trust by the United States for American Indians (Indian) and Indian tribes located within the Colorado River Basin (a list of these Indian tribes is provided in Chapter 6). Developing forestlands, leasing assets on these lands, directing agricultural programs, protecting water and land rights, developing and maintaining infrastructure and economic development are all part of the BIA's responsibility.

The FWS is involved in the conservation, protection and enhancement of fish, wildlife, and plants and their habitats for the continuing benefit of the American people. FWS manages four national wildlife refuges along the Colorado River. Among its many other key functions, the FWS administers and implements federal wildlife laws, protects endangered species, manages migratory birds, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and assists foreign governments with international conservation efforts. It also oversees the federal aid program that distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies.

The NPS administers areas of national significance along the Colorado River, including Glen Canyon National Recreation Area (GCNRA), Grand Canyon National Park, and Lake Mead National Recreation Area (LMNRA). The NPS administers visitor use (including recreation) of cultural and natural resources in these areas from offices located at Page, Arizona; Grand Canyon National Park, Arizona; and Boulder City, Nevada, respectively. The NPS also grants and administers concessions for the operation of marinas and other recreation facilities at Lake Powell and Lake Mead, as well as concessions' operations along the Colorado River between Glen Canyon Dam and Lake Mead.

Western markets and distributes hydroelectric power and related services within a 15-state region of the central and western United States and it is one of four power marketing administrations within the Department of Energy. Its role is to market and transmit electricity from multi-use water projects. Western markets and transmits power generated from the various hydropower plants located within the Colorado River Basin and operated by Reclamation. Western customers include municipalities, cooperatives, public utility and irrigation districts, federal and state agencies, investor-owned utilities (only one of which purchases firm power from Western), and Indian tribes located throughout the Colorado River Basin. The wholesale customers, in turn, provide retail electric service to millions of consumers within the seven Colorado River Basin States (Basin States).

The USIBWC is the United States component of a bi-national organization responsible for administration of the provisions of the 1944 Treaty, which includes the Colorado River waters allotted to Mexico, protection of lands along the Colorado River from floods by levee and floodway construction projects, resolution of international boundary water sanitation and other water quality problems, and preservation of the Colorado River as the international boundary.

The International Boundary and Water Commission (IBWC) consists of the United States Section and the Mexican Section, which have their headquarters in the adjoining cities of El Paso, Texas and Ciudad Juarez, Chihuahua, respectively.

1.5 Scope of the EIS

In a May 2, 2005 letter to the Governors of the Basin States, issued to complete the 2005 AOP mid-year review, the Secretary directed Reclamation to develop additional strategies for improving coordinated management of the reservoirs of the Colorado River system. Pursuant to that direction, Reclamation conducted a public consultation workshop on May 26, 2005, in Henderson, Nevada; issued a *Federal Register* notice on June 15, 2005 soliciting public comments; and conducted public meetings on July 26 and July 28, 2005, in Henderson, Nevada, and Salt Lake City, Utah, respectively. Reclamation received a broad range of public comments and suggestions from these discussions. Based in part on comments received from the public, Reclamation determined that the appropriate level of NEPA documentation for the development of Lower Basin shortage guidelines and coordinated management strategies for the operations of Lake Powell and Lake Mead under low reservoir conditions would be in the form of an EIS.

Consequently, on September 30, 2005, Reclamation published a Notice of Intent (NOI) (70 Fed. Reg. 57322) to prepare an EIS. The NOI described the proposed federal action as having two major elements: 1) adoption of specific Lower Basin shortage guidelines; and 2) developing coordinated reservoir management strategies to address operations of Lake Powell and Lake Mead under low reservoir conditions. The NOI also initiated a public process for determining the scope of specific shortage guidelines and coordinated reservoir management strategies and the issues and alternatives to be considered and analyzed in the preparation of the EIS.

Reclamation conducted public scoping meetings on November 1, 2, 3, and 8, 2005, in Salt Lake City, Utah; Denver, Colorado; Phoenix, Arizona; and Henderson, Nevada, respectively. Reclamation also consulted with representatives from the Basin States, Indian tribes, non-governmental organizations (NGO), and other interested parties. Reclamation provided a 62-day comment period consistent with the Public Notice issued on September 30, 2005. The public comment period ended on November 30, 2005.

On March 31, 2006, Reclamation published a Scoping Summary Report on the development of Lower Basin shortage guidelines and coordinated management strategies for the operations of Lake Powell and Lake Mead and issued a Notice of Availability (NOA) (71 Fed. Reg. 16341). The report summarized the comments received and the issues raised through the scoping process and provided an assessment of the proposed scope of the environmental analysis to be included in the EIS.

A total of 1,153 written comment letters were received during the scoping process. The comment letters were submitted by a wide range of interested parties that included federal, state, and local agencies; Indian tribes; businesses; special interest groups; and individuals.

On February 28, 2007, Reclamation published a NOA (72 Fed. Reg. 9026) for the Draft EIS which commenced a 61-day public review period that ended on April 30, 2007. As part of this review process, Reclamation conducted three public hearings on April 3, 4, and 5, 2007. The hearings took place in Henderson, Nevada; Phoenix, Arizona; and Salt Lake City, Utah, respectively, to invite public input on the Draft EIS. Additionally, a Modeling Workshop was held on March 6, 2007 in Henderson, Nevada to provide the public with information on the modeling performed and used in the Draft EIS to analyze the potential impacts of hydrologic resources and water deliveries. A total of 78 written comment letters were received during the scoping process and two individuals provided oral comments during the public hearings. The comment letters were submitted by a wide-range of interested parties that included businesses; federal, state and local agencies; Indian tribes; special interest groups; and individuals. Volume IV contains reproductions of letters received from the public and transcripts of the three public hearings held in connection with the public review of the Draft EIS and Reclamation's responses to the comments received.

1.5.1 Affected Region and Interests

The geographic region that would be affected by the proposed federal action begins with Lake Powell and extends downstream along the Colorado River floodplain to the Southerly International Boundary (SIB) with Mexico. This proposed federal action would also potentially affect interests of organizations and individuals, whose geographic distribution extends beyond the Colorado River floodplain into the service areas of certain water agencies in the Lower Basin states.

1.5.2 Relevant Issues

The results of the scoping process resulted in Reclamation considering the issues listed in Table 1.5-1. Those issues considered to be potentially significant are addressed in this Final EIS. Those that were not considered potentially significant are not analyzed in this Final EIS.

1.6 Summary of Contents of this Final EIS

Following is a brief description of the topics presented in the four volumes that comprise this Final EIS.

Volume I of this Final EIS (this volume) describes the proposed federal action, the alternatives considered, the analysis of the potential effects of these alternatives on Colorado River operations and associated resources, and environmental commitments associated with the alternatives. The contents of the chapters in this volume are as follows:

- **Chapter 1, Purpose and Need,** includes the following: identification of the purpose of and need for Lower Basin shortage guidelines and coordinated reservoir management strategies of Lake Powell and Lake Mead being considered in the proposed federal action; background information concerning the apportionment of Colorado River waters and the physical facilities associated with the Colorado River Basin; and, discussion of the institutional framework within which the Colorado River Basin is managed. Chapter 1 also discusses previous and ongoing actions that have a relationship to the proposed federal action.

Table 1.5-1
Relevant Issues

Resource	Potentially Significant	Issue Areas
Physical		
Geology and soils	No	No potential for effect
Climate	No	No potential for effect
Minerals	No	No potential for effect
Visual	Yes	Calcium carbonate ring in reservoirs, attraction features, sediment deltas
Unique characteristics	Yes	Wilderness, wild and scenic rivers, park units
Water resources	Yes	Hydrology, water deliveries, groundwater, operations, water quality
Air quality	Yes	Fugitive dust and exposure of reservoir shoreline
Noise	No	No potential for effect
Biological Resource		
Aquatic resources	Yes	Foodbase, fish
Vegetation	Yes	Riparian, wetlands, weeds
Wildlife	Yes	Amphibians, reptiles, raptors, mammals, waterfowl
Special-status species	Yes	Threatened and endangered species, state and tribal sensitive
Socioeconomic		
Environmental justice	Yes	Disproportionate effects on minority and low income populations
Land use	Yes	Relationship to local and state planning documents; agriculture, fallowing, prime farmland
Cultural resources	Yes	Historic properties
Indian Trust Assets	Yes	Water rights and trust lands
Energy and hydropower	Yes	Economic analysis and capacity
Population and housing	No	No potential for effect
Recreation	Yes	Marinas, boating, fishing, camping
Transportation, traffic	Yes	Ferries in Lake Powell, Lake Mohave
Water rights	No	The proposed federal action does not affect water rights. The EIS evaluates potential reductions in water deliveries pursuant to the existing framework of water rights and statutes.

- **Chapter 2, Description of Alternatives,** describes the process of formulating alternatives and presents a range of reservoir operation strategies and guidelines considered under each alternative. A summary table of potential environmental consequences of these alternatives is provided at the end of Chapter 2.

- **Chapter 3, Affected Environment,** describes the affected environment for the proposed federal action.

- **Chapter 4, Environmental Consequences,** presents evaluations of potential impacts that could result from implementation of the alternatives under consideration. The discussion also addresses environmental consequences, i.e., potential effects of the action alternatives that could occur as compared to the No Action Alternative.

- **Chapter 5, Other Considerations and Cumulative Impacts,** discusses cumulative impacts, the relationship between short-term uses and long-term productivity, and irreversible and irretrievable commitments of resources affected by the reservoir operation strategies and guidelines under consideration.

- **Chapter 6, Consultation and Coordination,** describes the public involvement process, including public notices, scoping meetings, and hearings. This chapter also describes the coordination with federal and state agencies, Indian tribes, and Mexico (through the IBWC) during the preparation of this document and any permitting or approvals that may be necessary for implementation of the proposed federal action.

In addition to the above, Volume I includes a list of acronyms used throughout this document, a glossary of commonly used terms, a list of references cited in the Final EIS, a list of persons contributing to the preparation of the Final EIS, a distribution list of agencies, organizations and persons receiving copies of the document, and an index.

Volumes II and III contain appendices which are comprised of documents and other supporting material that provide detailed historical background and/or technical information concerning the proposed federal action.

Volume IV contains reproductions of letters received from the public review of the Draft EIS and Reclamation's responses to the comments received. Volume IV also contains copies of the transcripts of three public hearings.

1.7 Water Supply Management and Allocation

This section summarizes the water supply available in the Colorado River Basin from natural runoff, distribution of this water under the Law of the River, and the reservoirs and diversion facilities through which the water supply is administered from mainstream Colorado River reservoirs and associated facilities.

1.7.1 Colorado River System Water Supply

The Colorado River Basin is located in the southwestern United States, as shown on Figure 1.7-1, and occupies an area of approximately 250,000 square miles. The Colorado River is approximately 1,400 miles in length and originates along the Continental Divide in Rocky Mountain National Park in Colorado. Elevations in the Colorado River Basin range from sea level to over 14,000 feet above mean sea level (msl) in the mountainous headwaters.

Climate varies significantly throughout the Colorado River Basin. Most of the Colorado River Basin is arid and semi-arid, and generally receives less than ten inches of precipitation per year. In contrast, many of the mountainous areas that rim the northern portion of the Colorado River Basin receive, on average, over 40 inches of precipitation per year.

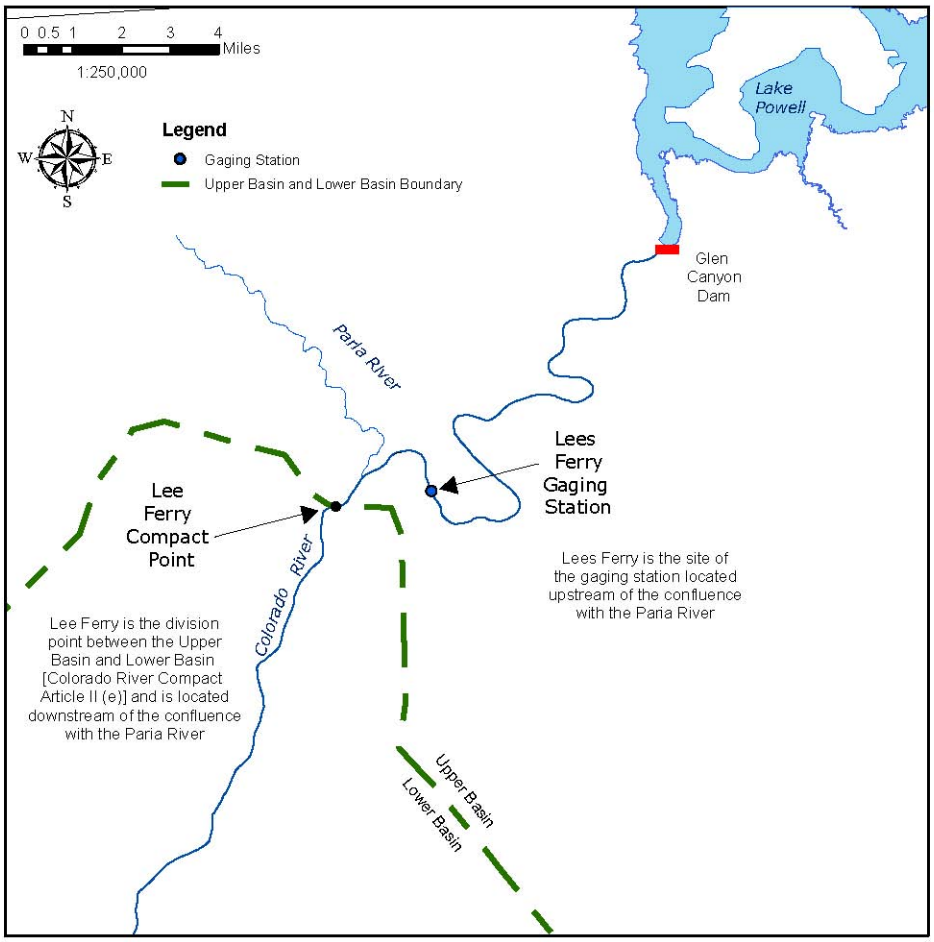
Most of the total annual flow in the Colorado River Basin is a result of natural runoff from mountain snowmelt. Because of this, natural flow is very high in the late spring and early summer, diminishing rapidly by mid-summer. While flows in late summer through autumn sometimes increase following rain events, natural flow in the late summer through winter is generally low. Major tributaries to the Colorado River include the Green River, San Juan River, Yampa River, Gunnison River, and Gila River.

Figure 1.7-1
The Colorado River Basin

The annual flow of the Colorado River and its tributaries varies considerably from year to year. The natural flow at the Lees Ferry Gaging Station in Arizona (Figure 1.7-2) located 15.9 river miles (RMs) downstream of Glen Canyon Dam, has varied annually from 5 maf to 23 maf. Natural flow represents an estimate of flows that would exist without human intervention.

The average annual natural flow at Lees Ferry Gaging Station is approximately 15.1 maf. In the Lower Basin, the average annual natural flow from the Little Colorado River, Virgin River, and Bill Williams River is approximately 1.4 maf.

Figure 1.7-2
Lees Ferry Gaging Station and Lee Ferry Compact Point



1.7.2 Apportionment of Water Supply

This section summarizes the Law of the River, Colorado River apportionments of the Basin States, and the allotment to Mexico pursuant to the 1944 Treaty.

1.7.2.1 The Law of the River

The Secretary is vested with the responsibility to manage the mainstream waters of the Lower Basin pursuant to applicable federal law. This responsibility is carried out consistent with a body of documents referred to as the Law of the River. The Law of the River comprises numerous operating criteria, regulations, and administrative decisions included in federal and state statutes, interstate compacts, court decisions and decrees, an international treaty, and contracts with the Secretary.

Particularly notable among these documents are:

1) the Colorado River Compact of 1922, which apportioned beneficial consumptive use of water between the Colorado River Upper Basin and Lower Basin;

2) the Boulder Canyon Project Act of 1928 (BCPA), which authorized construction of Hoover Dam and the All-American Canal (AAC), required that water users in the Lower Basin have a contract with the Secretary, and established the responsibilities of the Secretary to direct, manage, and coordinate the operation of Colorado River dams and related works in the Lower Basin;

3) the California Seven Party Agreement of 1931, which, through regulations adopted by the Secretary, established the relative priorities of rights among major users of Colorado River water in California;

4) the 1944 Treaty (and subsequent minutes of the IBWC) related to the quantity and quality of Colorado River water delivered to Mexico;

5) the Upper Colorado River Basin Compact of 1948, which apportioned the Upper Basin water supply among the Upper Basin states;

6) the Colorado River Storage Project Act of 1956 (CRSPA), which authorized a comprehensive water development plan for the Upper Basin that included the construction of Glen Canyon Dam and other facilities;

7) the 1963 United States Supreme Court Decision in *Arizona v. California* which confirmed that the apportionment of the Lower Basin tributaries was reserved for the exclusive use of the states in which the tributaries are located; confirmed the Lower Basin mainstream apportionments of 2.8 maf for use in Arizona, 4.4 maf for use in California, and 0.3 maf for use in Nevada; provided water for Indian reservations and other federal reservations in Arizona, California, and Nevada; and confirmed the significant role of the Secretary in managing the mainstream Colorado River within the Lower Basin;

8) the 1964 United States Supreme Court Decree (Decree) in *Arizona v. California* which implemented the Supreme Court's 1963 decision; the Decree was supplemented over time after its adoption and the Supreme Court entered a Consolidated Decree in 2006 which incorporates all applicable provisions of the earlier-issued Decrees;

9) the Colorado River Basin Project Act of 1968 (CRBPA), which authorized construction of a number of water development projects including the Central

Arizona Project (CAP) and required the Secretary to develop the LROC and issue an AOP for mainstream reservoirs;

10) the Colorado River Basin Salinity Control Act of 1974, which authorized a number of salinity control projects and provided a framework to improve and meet salinity standards for the Colorado River in the United States and Mexico; and

11) the Grand Canyon Protection Act of 1992, which addressed the protection of resources in Grand Canyon National Park and in GCNRA, consistent with applicable federal law.

Documents which are generally considered as part of the Law of the River include, but are not limited to, those listed in Table 1.7-1. Among other provisions of applicable federal law, NEPA and the Endangered Species Act of 1973 (ESA), as amended, provide a statutory overlay on certain actions taken by the Secretary. For example, as noted in Section 1.1, preparation of this Final EIS has been undertaken pursuant to NEPA.

1.7.2.2 Apportionment to the Basin States

The initial apportionment of water from the Colorado River was determined as part of the Compact, which divided the Colorado River system into two sub-basins, the Upper Basin and the Lower Basin (Figure 1.7-1). The Upper Basin includes those parts of the states of Arizona, Colorado, New Mexico, Utah, and Wyoming within and from which waters drain naturally into the Colorado River above the Lee Ferry Compact Point in Arizona. The Lower Basin includes those parts of the states of Arizona, California, Nevada, New Mexico, and Utah within and from which waters drain naturally into the Colorado River below the Lee Ferry Compact Point. The Compact also divided the seven Basin States into the Upper Division and the Lower Division states (Figure 1.7-3). The Upper Division states are Colorado, New Mexico, Utah and Wyoming. The Lower Division states are Arizona, California, and Nevada.

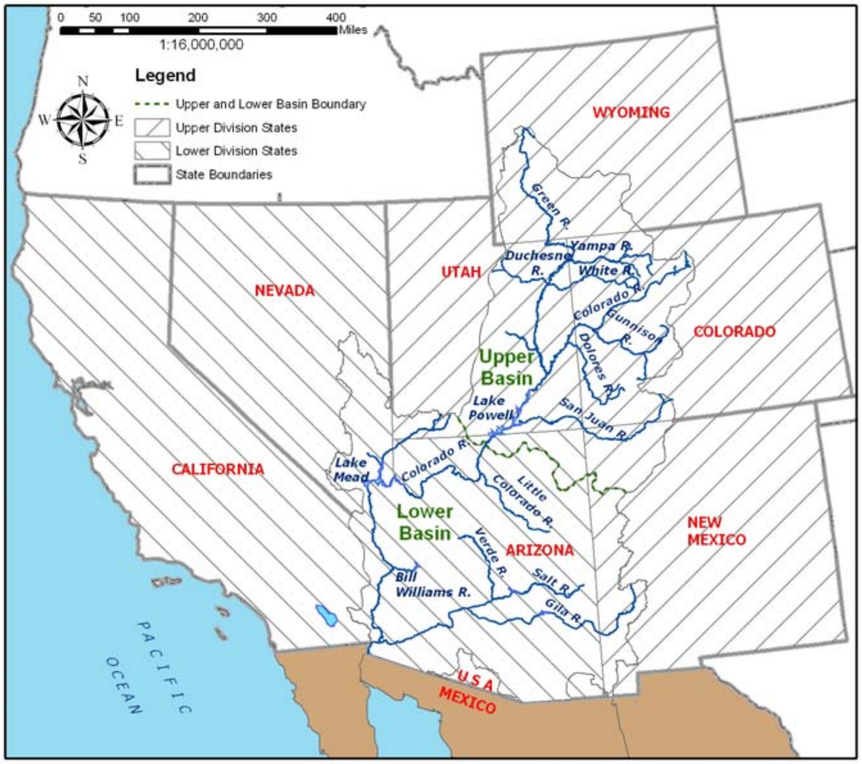
The Compact apportioned to the Lower Basin states and the Upper Basin states, in perpetuity, the exclusive beneficial consumptive use of 7.5 maf of water per year (mafy). In addition to this apportionment, Article III(b) of the Compact gives the Lower Basin states the right to increase their beneficial consumptive use by 1.0 mafy. The Compact also stipulates in Article III(d) that the Upper Division states will not cause the flow of the river at the Lee Ferry Compact Point to be depleted below an aggregate of 75 maf for any period of ten consecutive years.

The Compact, in Article VII, states that nothing in the Compact shall be construed as affecting the obligations of the United States to Indian tribes. While the rights of most Indian tribes to Colorado River water were subsequently adjudicated, some Tribal rights remain unadjudicated. To the extent that Indian tribes consumptively use water from the Colorado River, such uses are included in the apportionment of the appropriate Basin State.

Table 1.7-1
Selected Documents Included in the Law of the River

- The River and Harbor Act of March 3, 1899
- The Reclamation Act of June 17, 1902
- Reclamation of Indian Lands in Yuma, Colorado River and Pyramid Lake Indian Reservations Act of April 21, 1904
- Yuma Project authorized by the Secretary of the Interior on May 10, 1904, pursuant to Section 4 of the Reclamation Act of June 17, 1902
- Warren Act of February 21, 1910
- Protection of Property Along the Colorado River Act of June 25, 1910
- Patents and Water-Right Certificates Acts of August 9, 1912 and August 26, 1912
- Yuma Auxiliary Project Act of January 25, 1917
- Availability of Money for Yuma Auxiliary Project Act of February 11, 1918
- Sale of Water for Miscellaneous Purposes Act of February 25, 1920
- Federal Power Act of June 10, 1920
- The Colorado River Compact of November 24, 1922
- The Colorado River Front Work and Levee System Acts of March 3, 1925 and January 21,1927-June 28, 1946
- The Boulder Canyon Project Act of December 21, 1928
- The California Limitation Act of March 4, 1929
- The California Seven Party Agreement of August 18, 1931
- The Parker and Grand Coulee Dams Authorization of August 30, 1935
- The Parker Dam Power Project Appropriation Act of May 2, 1939
- The Reclamation Project Act of August 4, 1939
- The Boulder Canyon Project Adjustment Act of July 19, 1940
- The Flood Control Act of December 22, 1944
- Treaty between the United States and Mexico Relating to the Utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande of February 3, 1944
- Gila Project Act of July 30, 1947
- The Upper Colorado River Basin Compact of October 11, 1948
- Consolidated Parker Dam Power Project and Davis Dam Project Act of May 28, 1954
- Palo Verde Diversion Dam Act of August 31, 1954
- Change Boundaries, Yuma Auxiliary Project Act of February 15, 1956
- The Colorado River Storage Project Act of April 11, 1956
- Water Supply Act of July 3, 1958
- Boulder City Act of September 2, 1958
- Report of the Special Master, Simon H. Rifkind, *Arizona v. California*, et al., December 5, 1960
- The Consolidated Decree entered by the United States Supreme Court in the case of *Arizona v. California*, 547 U.S. 150 (2006) (Consolidated Decree)
- International Flood Control Measures, Lower Colorado River Act of August 10, 1964
- Southern Nevada (Robert B. Griffith) Water Project Act of October 22, 1965
- The Colorado River Basin Project Act of September 30, 1968
- Criteria for the Coordinated Long Range Operation of Colorado River Reservoirs, June 8, 1970, Amended March 21, 2005
- Supplemental Irrigation Facilities, Yuma Division Act of September 25, 1970
- 43 C.F.R. pt. 417 Lower Basin Water Conservation Measures, September 7, 1972
- Minute 218, March 22, 1965; Minute 241, July 14, 1972, (replaced 218); and Minute 242, August 30, 1973, (replaced 241); Minute 306, December 12, 2000 of the IBWC
- The Colorado River Basin Salinity Control Act of June 24, 1974
- Hoover Power Plant Act of August 17, 1984
- The Numerous Colorado River Water Delivery and Project Repayment Contracts with the States of Arizona and Nevada, cities, water districts and individuals
- Hoover and Parker-Davis Power Marketing Contracts
- Reclamation States Emergency Drought Relief Act of 1991
- Grand Canyon Protection Act of October 30, 1992
- Operation of Glen Canyon Dam, Record of Decision (1996)
- Interim Surplus Guidelines Record of Decision, January 17, 2001 (66 Fed. Reg. 7772).
- Interim 602(a) Storage Guideline, May 19, 2004 (69 Fed. Reg. 28945)
- Colorado River Water Delivery Agreement of October 10, 2003 (69 Fed. Reg. 12202)

Figure 1.7-3
Upper and Lower Division States of the Colorado River



Upper Division State Apportionments. Upper Division state apportionments were established by the Upper Colorado River Basin Compact of 1948. These apportionments allocate the Upper Basin states consumptive use after deduction of up to 50,000 acre-feet per year (afy) for Arizona as follows: Colorado, 51.75 percent; New Mexico, 11.25 percent; Utah, 23.00 percent; and Wyoming, 14.00 percent. The Upper Basin state apportionments have not yet been fully developed.

Lower Division State Apportionments. Lower Division state apportionments were established by Congress in the BCPA and by the Secretary's water delivery contracts under the BCPA. These apportionments are: Arizona, 2.8 maf; California, 4.4 maf; and Nevada, 0.3 maf; totaling 7.5 maf, subject to annual increases or reductions pursuant to Secretarial determinations of a Surplus or a Shortage condition. Under Article II(B)(2) of the Consolidated Decree, when the Secretary determines that there is a Surplus Condition, 46 percent of the available water supply in excess of 7.5 maf may be apportioned for use in Arizona; 50 percent for use in California; and four percent for use in Nevada.

Figure 1.7-4 presents a schematic of the operation of the Colorado River, primarily in the Lower Basin. The Consolidated Decree confirms the apportionments to the Lower Division states established by the BCPA and guides the Secretary's operation of facilities, including Hoover Dam, on the lower Colorado River. If water apportioned for use in a Lower Division state is not consumed by that state in any year, the Secretary may release the unused water for use in another Lower Division state. Water that is stored off-stream by a Lower Division state (for future use by that state or by another Lower Division state) is accounted as consumptive use to the state that stored the water in the year it was stored.

All mainstream Colorado River waters apportioned to the Lower Basin, except for a few thousand acre-feet (af) apportioned for use in Arizona, have been fully allocated to specific entities and, except for certain federal establishments, placed under permanent water delivery contracts with the Secretary for irrigation or domestic use. These entities include irrigation districts, water districts, municipalities, Indian tribes, public institutions, private water companies, and individuals. Federal establishments with federal reserved rights established pursuant to Article II(D) of the Consolidated Decree are not required to have a contract with the Secretary, but the water allocated to a federal establishment is included within the apportionment of the Lower Division state in which the federal establishment is located; e.g., Fort Mojave Indian Reservation in California and the Havasu National Wildlife Refuge in Arizona.

The highest priority lower Colorado River water rights are present perfected rights (PPRs), which the Consolidated Decree defines as those perfected rights existing on June 25, 1929, the effective date of the BCPA. The Consolidated Decree also recognizes federal Indian reserved rights for the quantity of water necessary to irrigate all the practicably irrigable acreage (lands considered suitable for irrigation) on five Indian reservations along the lower Colorado River. The Consolidated Decree defines the rights of Indian and other federal reservations to be federal establishment PPRs. PPRs are important because in any year in which less than 7.5 maf of Colorado River water is available for consumptive use in the Lower Division states, PPRs will be satisfied first, in the order of their priority without regard to state lines.

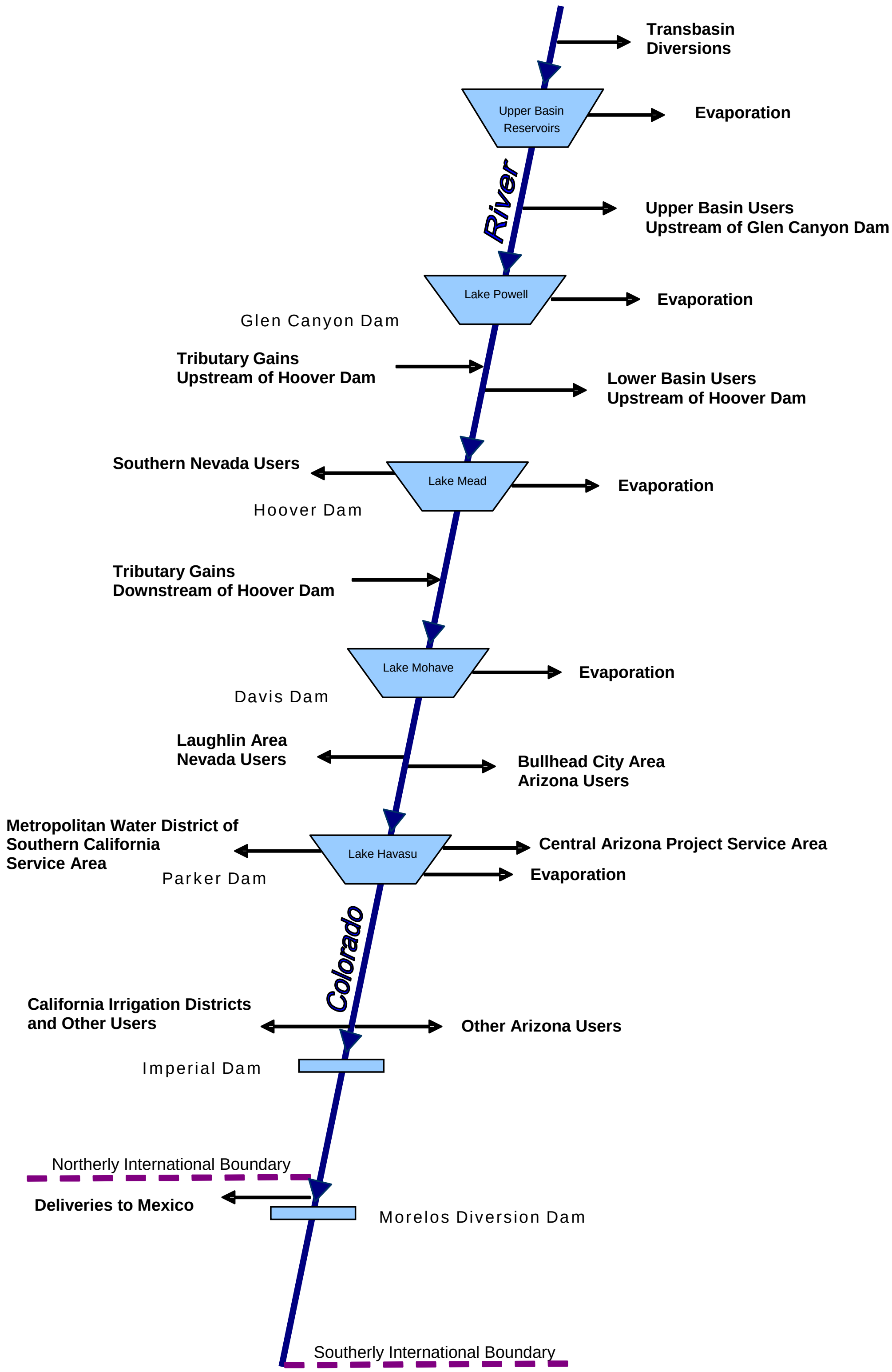
Waters available to a Lower Division state within its apportionment, but having a priority date later than June 25, 1929, have been allocated by the Secretary through execution of water delivery contracts to water users within that state as required by Section 5 of the BCPA.

1.7.2.3 Allotment to Mexico (Pursuant to the 1944 Treaty)

Allocation of Colorado River water to Mexico is governed by the 1944 Treaty. Article 10(a) of the 1944 Treaty states:

> "(a) A guaranteed annual quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) to be delivered in accordance with the provisions of Article 15 of this Treaty"

Figure 1.7-4
Colorado River Reservoirs and Diversions



Further, Article 10(b) of the 1944 Treaty provides:

> "(b) Any other quantities arriving at the Mexican points of diversion, with the understanding that in any year in which, as determined by the United States Section, there exists a surplus of waters of the Colorado River in excess of the amount necessary to supply uses in the United States and the guaranteed quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) annually to Mexico, the United States undertakes to deliver to Mexico, in the manner set out in Article 15 of this Treaty, additional waters of the Colorado River system to provide a total quantity not to exceed 1,700,000 acre-feet (2,096,931,000 cubic meters) a year. Mexico shall acquire no right beyond that provided by this subparagraph by the use of waters of the Colorado River system, for any purpose whatsoever, in excess of 1,500,000 acre-feet (1,850,234,000 cubic meters) annually."

Additionally, Article 10 of the 1944 Treaty provides:

> "In the event of extraordinary drought or serious accident to the irrigation system in the United States, thereby making it difficult for the United States to deliver the guaranteed quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) a year, the water allotted to Mexico under subparagraph (a) of this Article will be reduced in the same proportion as consumptive uses in the United States are reduced."

The proposed federal action is for the purpose of adopting additional operational guidelines to improve the Department's annual management and operation of key Colorado River reservoirs for an interim period through 2026. However, in order to assess the potential effects of the proposed federal action in this Final EIS, certain modeling assumptions (discussed in Chapter 2) are used that display projected water deliveries to Mexico. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico.

The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

1.7.3 System Reservoirs and Diversion Facilities

The Colorado River system contains numerous reservoirs that provide an aggregate of approximately 60 maf of storage (or roughly the same amount of four years' of average flow of the Colorado River). Of these reservoirs, Lake Powell and Lake Mead provide approximately 85 percent of this storage. Lake Powell provides 24.3 maf of this storage.

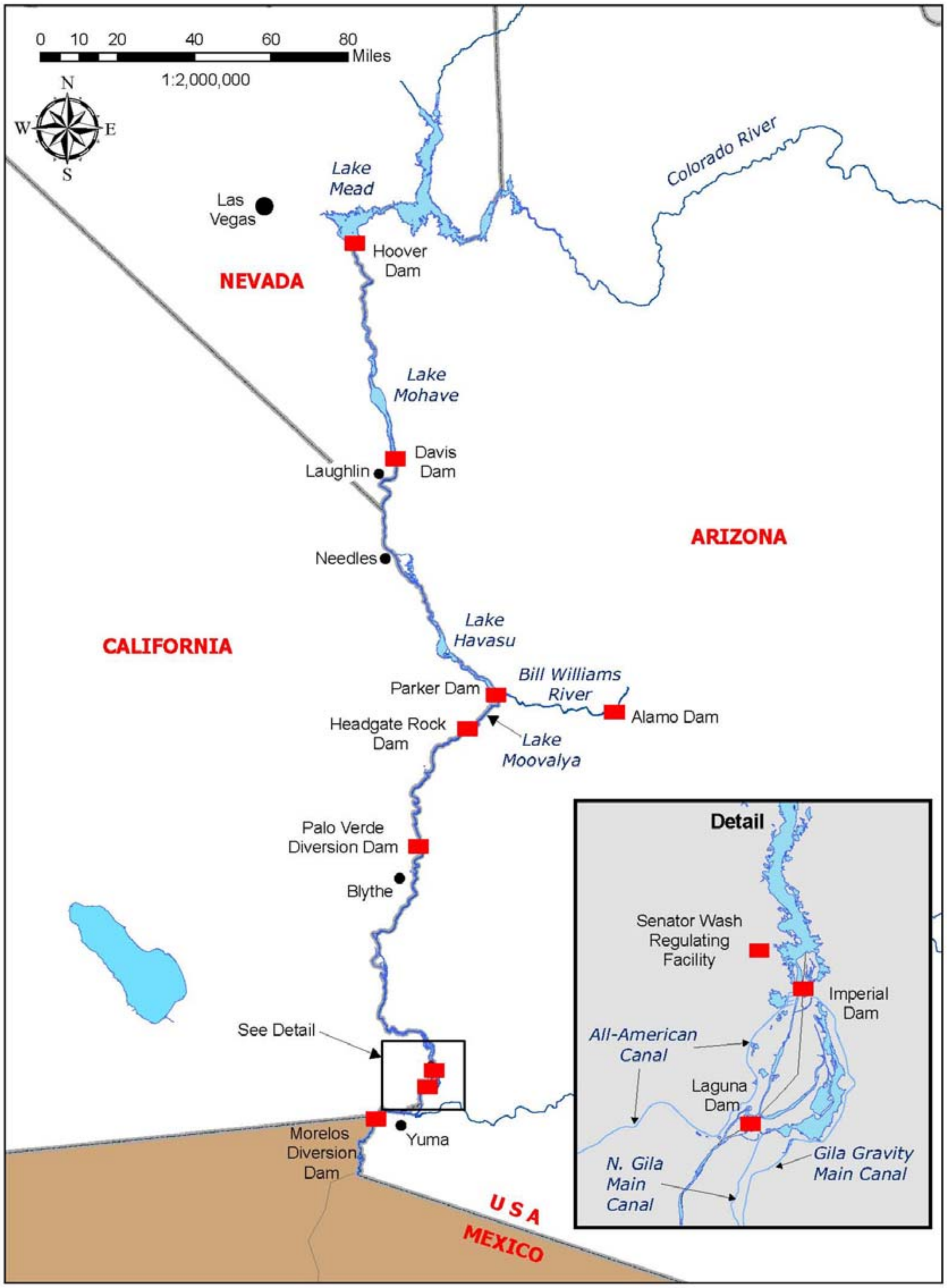
The Lower Basin dams and reservoirs include Hoover Dam, Davis Dam, and Parker Dam (Figure 1.7-5). Hoover Dam created Lake Mead and can store up to 26.2 maf. Davis Dam was constructed by Reclamation to re-regulate Hoover Dam's releases and to aid in the annual delivery of 1.5 maf to Mexico. Davis Dam created Lake Mohave and provides 1.8 maf of storage. Parker Dam forms Lake Havasu (0.65 maf of storage) from which water is pumped by both Metropolitan Water District of Southern California (MWD) and the CAP. Parker Dam re-regulates releases from Davis Dam and from the United States Army Corps of Engineers' (USACE) Alamo Dam on the Bill Williams River, and in turn releases water for downstream use in the United States and Mexico. Other Lower Basin mainstream reservoirs, shown on Figure 1.7-5, are operated primarily for the purpose of river flow regulation to facilitate diversion of water to Arizona, California and Mexico. Diversion facilities of the Lower Division states typically serve multiple entities.

There are several points of diversion in Arizona. Arizona can use up to 50,000 afy of water under its Upper Basin apportionment. In the Lower Basin, the largest diversion for Arizona is the CAP pumping plant on Lake Havasu downstream of the confluence of the Bill Williams River. Irrigation water for the Fort Mojave Indian Reservation, near Needles, California, is pumped from wells. There are also several other municipal, industrial and agricultural water users located along the Colorado River that pump their water from wells. Irrigation water for the Colorado River Indian Reservation near Parker, Arizona, is diverted at Headgate Rock Dam, which was constructed for that purpose. A river pumping plant in the Cibola area provides water to irrigate lands adjacent to the Colorado River. The last major diversion for Arizona occurs at Imperial Dam, where water is diverted into the Gila Gravity Main Canal for irrigation for the Gila and Wellton-Mohawk projects and into the AAC for subsequent release into the Yuma Main Canal for the Yuma Project and the City of Yuma.

California receives most of its Colorado River water at three diversion points: MWD's pumping plant on Lake Havasu; the Palo Verde Irrigation District's diversion at the Palo Verde Diversion Dam near Blythe, California; and the AAC diversion at Imperial Dam (Figure 1.7-5).

In Nevada, the state's consumptive use apportionment of Colorado River water is used almost exclusively for municipal and industrial (M&I) purposes. About 90 percent of this water is diverted from Lake Mead at a point approximately five miles northwest of Hoover Dam at Saddle Island by the Southern Nevada Water Authority (SNWA) facilities. The remainder of Nevada's diversion occurs downstream of Davis Dam in the Laughlin, Nevada area and on the Fort Mojave Indian Reservation.

Figure 1.7-5
Lower Basin Dams and Reservoirs



1.7.4 Flood Control Operation

Under the BCPA, flood control is specified as the project purpose having first priority for the operation of Hoover Dam. Subsequently, Section 7 of the Flood Control Act of 1944 established that the Secretary of War (now the United States Army Corps of Engineers) will prescribe regulations for flood control for projects authorized wholly or partially for such purposes.

The Los Angeles District of the USACE published the current flood control regulations in its Water Control Manual for Flood Control, Hoover Dam and Lake Mead, Colorado River, Nevada and Arizona (Water Control Manual) dated December 1982. The Field Working Agreement between the USACE and Reclamation for the flood control operation of Hoover Dam and Lake Mead, as prescribed by the Water Control Manual, was signed on February 8, 1984. The flood control plan is the result of a coordinated effort between the USACE and Reclamation; however, the USACE is responsible for providing the flood control regulations and has authority for final approval. The Secretary is responsible for operating Hoover Dam in accordance with these regulations. Deviation from the flood control operating criteria must be authorized by the USACE.

1.7.5 Hydropower Generation

Reclamation is authorized by legislation to produce electric power at Glen Canyon Dam, Hoover Dam, Davis Dam, Parker Dam, and other smaller facilities. While Reclamation is the federal agency authorized to produce power at the major Colorado River system dams, Western is the federal agency authorized to market and deliver this power. Western enters into electric service contracts on behalf of the United States with public and private utility systems for distribution of hydroelectric power produced at Reclamation facilities in excess of project demand.

1.7.6 Annual Operating Plan and Long Range Operating Criteria

The CRBPA required the Secretary to adopt operating criteria for the Colorado River by January 1, 1970. The LROC, adopted in 1970 address operation of the Colorado River reservoirs in compliance with requirements set forth in the Compact, the CRSPA, the BCPA, the 1944 Treaty, and other applicable federal laws. Section 602 of the CRBPA, as amended, provides that the LROC can only be modified after correspondence with the governors of the Basin States and appropriate consultation with such state representatives as each governor may designate. The LROC calls for formal reviews at least every five years. The reviews are conducted as a public involvement process and are attended by representatives of federal agencies, the seven Basin States, Indian tribes, the general public including representatives of the academic and scientific communities, environmental organizations, the recreation industry, and contractors for the purchase of federal power produced at federal hydropower plants in the Colorado River Basin.

Under the applicable provisions of the CRBPA, the Secretary makes annual determinations in the AOP regarding the availability of Colorado River water for deliveries to the Lower Division states. A requirement to equalize storage between Lake Powell and Lake Mead when there is sufficient storage in the Upper Basin is also included in the LROC, as required by the CRBPA. Equalization releases are made if: 1) the end of the water year storage forecast for Lake Powell is greater than that of Lake Mead; and 2) the storage forecast for the end of the water year in the Upper Basin reservoirs is greater than the quantity of storage required by Section 602(a) of the CRBPA (602(a) storage) for that same date.

The 602(a) storage quantity is the storage in the Upper Basin necessary to assure Lower Basin delivery obligations without impairing consumptive use requirements in the Upper Basin. The LROC offers factors to be considered to determine 602(a) storage, but does not present a set formula. The factors to be considered include the historic stream flows, the most critical period of record, probability of available waters, and estimated future depletions in the Upper Basin.

In 2004, Reclamation adopted an interim 602(a) storage guideline, in effect through 2016, which establishes that Lake Powell’s elevation must be above 3,630 feet msl (which corresponds to storage of approximately 14.85 maf) for equalization releases to occur (Reclamation 2004f). In the event that the elevation of Lake Powell is below the 602(a) storage guideline, and equalization is not required, the LROC provide that “the objective shall be to maintain a minimum release of water from Lake Powell of 8.23 million acre-feet for that year.”

In the AOP, the Secretary is required to determine when Normal, Surplus, or Shortage conditions occur in the lower Colorado River, based on various factors including storage and hydrologic conditions in the Colorado River Basin.

1.7.6.1 Normal Water Supply Condition

A Normal Condition exists when the Secretary determines that sufficient mainstream water is available to satisfy 7.5 maf of annual consumptive use in the Lower Division states. If a state will not use all of its apportioned water for the year, the Secretary may allow other states of the Lower Division to use the unused apportionment, provided that the use is authorized by a water delivery contract with the Secretary.

1.7.6.2 Surplus Water Supply Condition

A Surplus Condition exists when the Secretary determines that sufficient mainstream water is available for release to satisfy consumptive use in the Lower Division states in excess of 7.5 maf annually. This excess consumptive use is surplus and is distributed for use in Arizona, California, and Nevada pursuant to the terms and conditions provided in the ISG, adopted in 2001. The current provisions of the ISG are scheduled to terminate in 2016.

In general terms, the ISG link the availability of surplus water to the elevation of Lake Mead. When Lake Mead is full and Reclamation is making flood control releases, surplus supplies are unlimited. As Lake Mead’s elevation drops, surplus water amounts are reduced, and ultimately eliminated. The ISG also link surplus availability to continued progress by California in reducing its agricultural use of water to benchmarks established in the ISG.

If a state does not use all of its apportioned water for the year, the Secretary may allow other Lower Division states to use the unused apportionment, provided that the use is authorized by a water delivery contract with the Secretary.

1.7.6.3 Shortage Water Supply Condition

A Shortage Condition exists when the Secretary determines that insufficient mainstream water is available to satisfy 7.5 maf of annual consumptive use in the Lower Division states. To date, the Secretary has never made such a determination. When making a shortage determination, the Secretary must consult with various parties as set forth in the Consolidated Decree and consider all relevant factors as specified in the LROC, including 1944 Treaty obligations, the priorities set forth in the Consolidated Decree, and the reasonable consumptive use requirements of mainstream water users in the Lower Division states.

Pursuant to the Consolidated Decree, the Secretary is required to first provide for the satisfaction of the PPRs in the order of their priorities without regard to state lines. Pursuant to the CRBPA, water contract holders in Arizona with contracts dated September 30, 1968 (when the CAP was authorized) or later, have a lower priority than California's 4.4 maf apportionment. Beyond these two requirements, the Department does not have detailed guidelines in place that define the circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead, i.e., when water supplies would be reduced, by how much, or who would experience specified reductions.

In the absence of specific shortage criteria, a shortage determination would most likely be made on an annual basis through the AOP process. This is a process by which the interests of the different stakeholders are addressed through consultation. Water users who rely on the Colorado River in the Lower Division states are not currently able to identify particular reservoir conditions under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead, nor are these water users able to identify the frequency or magnitude of any potential future annual reductions in their water deliveries.

1.8 Related Actions

The alternatives considered in this Final EIS address operation and storage of water in Lake Powell and Lake Mead. While there are many actions related to the operation of the Colorado River with respect to the proposed federal action analyzed in this Final EIS, Reclamation has identified five primary documents that are related to, or would assist the reader in understanding the issues analyzed in this process:

- Operation of Glen Canyon Dam - Final EIS (1995) and Record of Decision (ROD) (1996) (Reclamation 1995, 1996a);
- Off-stream Storage of Colorado River Water and Development and Release of Intentionally Created Unused Apportionment in the Lower Division States - 43 C.F.R. pt. 414 (1999);
- Interim Surplus Criteria - Final EIS (2000) and ROD - Colorado River Interim Surplus Guidelines (2001) (Reclamation 2000, 2001);

- ♦ Implementation Agreement, Inadvertent Overrun and Payback Policy, and Related Federal Actions - Final EIS (2002) and ROD - Colorado River Water Delivery Agreement (2003) (Reclamation 2002a, 2003); and

- ♦ Lower Colorado River Multi-Species Conservation Program (LCR MSCP) - Final Programmatic EIS/Environmental Impact Report (EIR) and ROD - Lower Colorado River Multi-Species Conservation Plan (2005) (Reclamation 2005b).

Chapter 5 of this Final EIS provides an extensive review of these and other related actions that may have a cumulative impact on the resources affected by the alternatives presented herein.

The efforts documented in the references listed above are summarized below.

1.8.1 Operation of Glen Canyon Dam - Final EIS and ROD

The 1995 Operation of Glen Canyon Dam Final EIS was prepared in response to the 1992 Grand Canyon Protection Act, and analyzed alternative operation scenarios that met statutory responsibilities for protecting downstream resources and achieving other authorized purposes. The 1996 Glen Canyon Dam ROD describes detailed criteria and operating plans for dam operations and includes other management actions to accomplish this objective; among these are the Glen Canyon Dam Adaptive Management Program (AMP) of scientific monitoring and experimentation, beach/habitat-building flows (BHBF), and further study of temperature control.

The AMP provides a process for assessing the effects of Glen Canyon Dam operations on downstream resources and project benefits. The results of that assessment are used to develop recommendations for modifying Glen Canyon Dam operations and other resource management actions. This is accomplished through the Adaptive Management Work Group (AMWG), a federal advisory committee. The AMWG consists of stakeholders that include federal and state agencies, representatives of the seven Basin States, Indian tribes, hydroelectric power customers, environmental and conservation organizations, and recreational and other interest groups.

The BHBF releases are scheduled high releases of short duration that are in excess of power plant capacity in accordance with hydrologic triggering criteria. These BHBFs are designed to rebuild high elevation sandbars, deposit nutrients, restore backwater channels, and provide some of the dynamics of a natural system. The first test of a BHBF was conducted in spring of 1996, and a subsequent test of a BHBF was conducted in November 2004.

Evaluating the feasibility of increasing the temperature of water released from Glen Canyon Dam was a common element in the Glen Canyon Dam EIS and one of the elements of the reasonable and prudent alternative in the Biological Opinion (BO) of that document. In 1999, Reclamation issued an environmental assessment regarding potential modification of Glen Canyon Dam to construct a selective withdrawal structure, and has subsequently continued to investigate various structural designs. Reclamation has initiated a NEPA process that, among other elements, will consider construction of a selective withdrawal structure as part of a long-term experimental plan.

1.8.2 Off-stream Storage of Colorado River Water and Development and Release of Intentionally Created Unused Apportionment in the Lower Division States

In 1999, the Department adopted a rule to facilitate off-stream storage of Colorado River water and development and release of “Intentionally Created Unused Apportionment” (ICUA) for the Lower Division states. Reclamation prepared an Environmental Assessment (EA) to assess the environmental impacts of the rule, and a Finding of No Significant Impact (FONSI) was issued on October 1, 1999. The final rule was published in the Federal Register on November 1, 1999 and is codified at 43 C.F.R. pt. 414.

This rule establishes a procedural framework within the Lower Basin states for an authorized entity in one state to enter into storage agreements with authorized entities in another state for the off-stream storage (and future recovery) of Colorado River water. Under the agreements, the storing state will use water it stores under an interstate agreement and, in return, at a future date, decrease its consumptive use of Colorado River water, thereby developing the ICUA that the Secretary will release for consumptive use in the consuming state. Under this rule, two Storage and Interstate Release Agreements (SIRA) have been executed to date.

1.8.3 Interim Surplus Criteria - Final EIS and ROD - Colorado River Interim Surplus Guidelines

On January 17, 2001, the Secretary, through a ROD, adopted specific ISG that identify the conditions under which the Secretary will authorize the release of water from Lake Mead, for use in the Lower Basin, in excess of 7.5 maf. As adopted, the term of the ISG is through 2016. The ISG are applied by the Secretary each year through the AOP.

The ISG provide mainstream users of Colorado River water, particularly those in California, a greater degree of predictability with respect to the likely existence, or lack thereof, of a surplus determination in a given year for the interim period (i.e., through 2016). Prior to adoption of the ISG, availability of surplus was limited to periods when Lake Mead was nearly full and expected to make additional releases to avoid future spills. Conversely, under the ISG, as Lake Mead’s elevation drops, surplus water amounts are reduced, and ultimately eliminated. Surplus determinations under the AOP are further discussed in Section 1.7 of this Final EIS.

The ISG, as adopted in the 2001 ROD, provide for certain benchmarks for reduction of California’s agricultural use of Colorado River water and other actions; as long as the benchmarks are met, the more permissive determinations of surplus under the ISG are permitted. In the event that the benchmarks are not met, surplus determinations revert to a more conservative water management approach (i.e., surplus water is only made available when reservoirs are nearly full).

1.8.4 Implementation Agreement, Inadvertent Overrun and Payback Policy, and Related Federal Actions - Final EIS and ROD - Colorado River Water Delivery Agreement

California’s Colorado River Water Use Plan (CA Plan) calls for conservation measures to be put in place that will reduce California’s historic dependency on Colorado River water in excess of the state's 4.4 maf apportionment. The Colorado River Water Delivery Agreement, signed by the Secretary on October 10, 2003, provides for implementation of major components of the CA Plan and incorporates contractual agreements that facilitate California's sharing and distribution of Colorado River water within its 4.4 mafy entitlement.

The Colorado River Water Delivery Agreement is the Secretary's agreement to make those Colorado River water deliveries specified in the agreements with the relevant California entities. These agreements provide for the conservation and transfer of about 400 kaf of water annually among the Imperial Irrigation District, Coachella Valley Water District, MWD, and San Diego County Water Authority.

1.8.5 Lower Colorado River Multi-Species Conservation Program - Final Programmatic EIS/EIR and ROD - Lower Colorado River Multi-Species Conservation Plan

The LCR MSCP is a 50-year cooperative effort between federal and non-federal entities, approved by the Secretary in April 2005, that:

- conserves habitat and works towards the recovery of threatened and endangered species, as well as reducing the likelihood of additional species being listed;
- accommodates present water diversions and power production and optimizing opportunities for future water and power development, to the extent consistent with the law; and
- provides the basis for incidental take authorizations.

The LCR MSCP provides ESA compliance for specific covered federal actions and non-federal activities under ESA Sections 7 and 10. The LCR MSCP provides ESA coverage for non-federal actions that are related to the use and management of the lower Colorado River (from Lake Mead to the SIB).

In addition to the covered activities of the non-federal LCR MSCP entities, specific present and potential future actions of six federal agencies on the lower Colorado River are also included in the LCR MSCP. Those federal agencies are Reclamation, BIA, NPS, Bureau of Land Management (BLM), Western, and the FWS. These federal agencies and non-federal entities are collectively referred to as the LCR MSCP participants. The covered actions and activities for the LCR MSCP participants occur along the lower Colorado River in Imperial, Riverside, and San Bernardino counties, California; La Paz, Mohave, and Yuma counties, Arizona; and Clark County, Nevada. The duration of the Section 10 permit and the associated formal ESA Section 7 consultation for the federal agencies is 50 years (2005 to 2055).

The Conservation Plan was designed to fully mitigate adverse effects to species included within the LCR MSCP resulting from federal covered actions and non-federal covered activities, and to meet the ESA Section 10 standard to minimize and mitigate the impacts of the covered activities on covered species to the maximum extent practicable. While the LCR MSCP is geared toward special status species, it is important to understand that all species that use the habitats impacted by LCR MSCP-covered activities benefit from the conservation actions currently being carried out under the LCR MSCP.

Federal covered actions included in the LCR MSCP and covered under the LCR MSCP BO (FWS 2005) include the adoption and application of specific surplus and shortage guidelines that would allow for the release of water (excluding 1944 Treaty water) in excess of the 7.5 maf of entitlement waters in surplus years or less than the 7.5 maf in shortage years and approval and implementation of various administrative actions that could result in changes in the storage and delivery of Lower Division state entitlement waters at different points on the Colorado River. The LCR MSCP BO covered the effects of covered actions for a reduction of Lake Mead reservoir elevations to 950 feet msl and Colorado River flow reductions of up to 0.845 maf from Hoover Dam to Davis Dam, 0.860 maf from Davis Dam to Parker Dam, and 1.574 maf from Parker Dam to Imperial Dam. The LCR MSCP identified, and is mitigating impacts to, the covered species and their habitats from the river flow reductions described above.

Reclamation has reviewed the effects of the Preferred Alternative in this Final EIS and has determined that all potential effects to listed species and their habitats along the Colorado River from the full pool elevation of Lake Mead to the SIB are covered by the LCR MSCP. The LCR MSCP coverage also includes the conveyance of conserved Virgin River and Muddy River (tributary) flows through Lake Mead and the Overton Arm. This determination is documented in the Biological Assessment (BA) for the proposed federal action which is the subject of this EIS (Appendix R). Accordingly, the BA for the proposed federal action analyzes potential effects to listed species for areas outside the geographic coverage of the LCR MSCP – from Lake Powell to the inflow to Lake Mead, and for the interrelated/interdependent effects of the Lake Mead storage and delivery mechanism on the Virgin River and the Muddy River.

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Chapter Two

2.1 Development of Alternatives

This chapter discusses the processes used to define, develop, and analyze the No Action Alternative, as well as a range of reasonable action alternatives and the Preferred Alternative, for implementing the proposed federal action. Based on the information and comments received during the scoping process, the proposed federal action has been designed to reflect, among others, three important considerations:

1) **Encouraging Conservation of Water:** Many comments submitted to Reclamation focused on the importance of encouraging and utilizing water conservation as an important tool to better manage limited water supplies and therefore minimize the likelihood and severity of potential future shortages. Water conservation could occur through a number of approaches such as fallowing of land, lining of canals, financial incentives to maximize conservation, dry-year options, and associated storage and recovery methodologies and procedures to address conservation actions by particular parties.

2) **Consideration of Reservoir Operations at all Operational Levels:** Many comments submitted to Reclamation urged Reclamation to consider and analyze management and operational guidelines for the full range of operational elevations of Lake Powell and Lake Mead. It was suggested that this approach is integral to the prudent development of new operational guidelines for low reservoir conditions, as the approach and management of these reservoirs at higher elevations has a direct impact on available storage, thereby affecting the likelihood and severity of potential future shortages.

3) **Term of Operational Guidelines:** Many comments urged Reclamation to consider interim, rather than permanent, additional operational guidelines. In this manner, Reclamation would have the ability to use actual operating experience for a period of years, thereby facilitating a better understanding of the operational effects of the new guidelines. Modifications could then be made, if necessary, based on this operating experience.

As a result of the analyses of the comments and input received by Reclamation, the following four operational elements of the proposed federal action were developed:

1) **Shortage Guidelines:** Adoption of guidelines that would identify those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Lower Division states to below 7.5 maf, pursuant to the Consolidated Decree.

   The primary purpose of this element is the distribution of water supplies during drought and low reservoir conditions. While Lake Powell and Lake Mead have large storage capacities, water supply demands are increasing and careful management of existing water supplies will help ensure sufficient supplies are available to meet these demands. The proposed shortage guidelines in the alternatives analyzed in the Final EIS range from aggressive shortages to no reduction of water supplies until the reservoirs are empty. Most of the alternatives have discrete levels of shortage associated with specific Lake Mead reservoir elevations.

2) **Coordinated Reservoir Operations:** Adoption of guidelines for the coordinated operations of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions.

   Lake Powell and Lake Mead operations are currently coordinated only under high reservoir elevations through storage equalization. The action alternatives consider various options designed to better utilize existing reservoir storage throughout the full range of reservoir operations to enhance both water supply and other benefits of the reservoir system for both the Upper Basin and Lower Basin.

3) **Storage and Delivery of Conserved Water:** Adoption of guidelines for the storage and delivery of conserved Colorado River system and non-system water in Lake Mead, pursuant to applicable federal law, to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions.

   One way to increase water deliveries during drought is through the augmentation and conservation of existing water supplies. The alternatives consider options for the creation of a system of storage credits in Lake Mead whereby system and non-system water may be conserved and stored in Lake Mead, with various limits on the maximum size, storage and delivery of the credit water. The alternatives range from an operational scenario that considers no new mechanism (status quo) to a maximum Lake Mead storage credit volume of 4.2 maf.

4) **Interim Surplus Guidelines:** Adoption of guidelines that would identify the conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing ISG and extend the term of the ISG from 2016 to 2026.

   The ISG are due to expire in 2016. The alternatives range from termination of the permissive provisions of the existing ISG in 2007 to extension of the current provisions of the ISG through 2026. This element of the proposed federal action helps establish an operational strategy for the full range of reservoir operations through 2026.

Reclamation developed five action alternatives for analysis in this EIS. These alternatives include some formulation of each of these four operational elements and reflect input from Reclamation staff, the cooperating agencies, stakeholders, and other interested parties. Reclamation received two written proposals for alternatives that met the purpose and need of the proposed federal action; one proposal was received from the Basin States as revised on April 30, 2007 and another proposal was received from a consortium of environmental NGOs. These proposals were used by Reclamation to formulate two of the alternatives considered and analyzed in this EIS (Basin States Alternative and Conservation Before Storage Alternative, respectively). A third alternative (Water Supply Alternative) was developed by Reclamation and a fourth alternative (Reservoir Storage Alternative) was developed in coordination with NPS and Western. The No Action Alternative and these four action alternatives, analyzed in the Draft EIS (February 2007), were posted on Reclamation's website (http://www.usbr.gov/lc/region/programs/strategies.html) on June 30, 2006.

A fifth action alternative (Preferred Alternative) was developed after consideration of the comments received on the Draft EIS and further analysis. The Preferred Alternative was posted on Reclamation's website (same as above) on June 15, 2007. The preferred alternative is composed of operational elements identified and analyzed in the Draft EIS.

A description of each of the alternatives follows.

2.2 No Action Alternative

The No Action Alternative represents a projection of current conditions to the most reasonable future responses or conditions that could occur during the life of the proposed federal action without any action alternative being implemented. Thus, the No Action Alternative provides a baseline against which action alternatives can be compared.

Pursuant to the LROC, the Secretary makes a number of determinations at the beginning of each operating year through the development and execution of the AOP, including the water supply available to users in the Lower Basin and the annual release from Lake Powell. The LROC do not include specific guidelines for such determinations. Furthermore, there is no actual operating experience under very low reservoir conditions, e.g., there has never been a shortage determination in the Lower Basin. Therefore, in the absence of specific guidelines, the outcome of the annual determination in any particular year in the future cannot be precisely known. However, a reasonable representation of future conditions under the No Action Alternative is needed for comparison to each action alternative. The modeling assumptions used for this representation are consistent with assumptions used in previous environmental compliance documents for the ISG, the Colorado River Water Delivery Agreement, and the LCR MSCP (Section 1.8). The assumptions used in the No Action Alternative are not intended to limit or predetermine the decision in any future AOP determination.

The formulation of the four operational elements of the proposed federal action for the No Action Alternative follows.

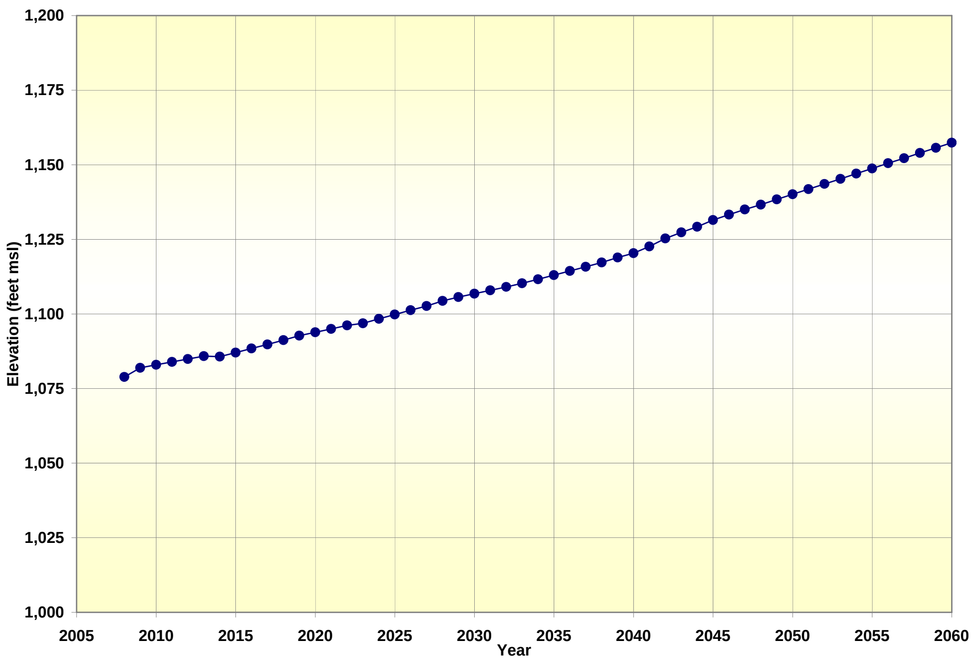
2.2.1 Shortage Guidelines

Each year, the Secretary makes a determination as to whether the consumptive use requirements of mainstream users in the Lower Division states will be met under a Normal, Surplus, or Shortage Condition, in accordance with the Consolidated Decree and the LROC as implemented through the AOP process. The LROC specify that the Secretary will consider all relevant factors in making a shortage determination and list some of the factors to be considered. However, there is no specific guidance as to exactly when, how, or to whom reductions in deliveries would be made. Therefore, it is impossible to know exactly how the Secretary might make a shortage determination in the future. Furthermore, conditions in the Colorado River Basin have been such that there has not been a need to declare a Shortage Condition and there is no actual operating experience with regard to shortage determinations.

To obtain a reasonable representation of future conditions under the No Action Alternative (while not representing official policy of the Department with regard to future determinations), the following assumptions were made:

- as in the modeling assumptions for previous Colorado River Basin environmental compliance documents, shortage trigger elevations (Figure 2.2-1) were used to prevent Lake Mead's elevation from declining below 1,050 feet msl with approximately an 80 percent probability (known as a "Level 1 Shortage", Appendix A). In a given year, a shortage (or reduction in deliveries) that ranges from approximately 350 to 500 thousand acre-feet (kaf) would be imposed when the projected January 1 Lake Mead elevation is below the shortage trigger elevation for that year; and
- if Lake Mead's elevation continues to decline, additional reductions would be imposed to keep Lake Mead elevation above 1,000 feet msl. This approach essentially provides absolute protection of SNWA's lower intake (elevation 1,000 feet msl) at Lake Mead and would reduce deliveries to water users (including SNWA) by amounts required to maintain Lake Mead elevation at or above 1,000 feet msl.

Figure 2.2-1
Lake Mead Level 1 Shortage Trigger Lake Mead Elevations Under the No Action Alternative



In accordance with the Consolidated Decree, the CRBPA, and other key provisions of the Law of the River, the Secretary has the authority to determine and allocate shortages to the Lower Division states. Although some guidance exists with regard to how shortages would be allocated (e.g., PPR deliveries must be met without regard to state lines, California does not incur shortages until Arizona post-1968 contracts are reduced completely), there are no specific guidelines in place to further inform the Secretary's decision with respect to how shortages might be shared by the water users in Arizona, California and Nevada.

Furthermore, the determination of deliveries to Mexico is not a part of the proposed federal action. Any such determination would be made in accordance with the 1944 Treaty (Section 1.7.3).

Nevertheless, modeling assumptions with respect to the distribution of shortages to Lower Division states and water delivery reductions to Mexico are necessary in order to analyze the potential impacts to hydrologic and other environmental resources.[1] These modeling assumptions were applied to the No Action Alternative as well as the action alternatives, i.e., the modeling assumptions with regard to the distribution of shortages are identical under all alternatives.

It was assumed that shortages would be allocated to each Lower Division state and Mexico based on percentages of the total shortage being applied. The modeling assumptions for distribution of shortages used in this Final EIS are presented in Table 2.2-1. More detailed descriptions of these modeling assumptions are provided in Appendix A.

Table 2.2-1
Modeling Assumptions for Distribution of Shortages[1]

Entity	Percentage of Total Shortage, Stage 1	Percentage of Additional Shortage, Stage 2[2]
Arizona	80.00	15 to 20
California	0.00	60 to 65
Nevada	3.33	3.33
Mexico	16.67	16.67
Total	100.00	100.00

1. *These modeling assumptions do not reflect policy decisions and are not intended to constitute an interpretation or application of the 1944 Treaty.*
2. *Shortage amounts presented in the Stage 2 column are incremental over the amount of shortages that would have already been allocated under Stage 1.*

[1] Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

Shortages are first imposed under Stage 1 and would be applied to the most junior users within Arizona (those with post-1968 water rights, i.e., 4th and 5th priority rights within Arizona) and Nevada (primarily the SNWA). Stage 1 shortages would continue until deliveries to the post-1968 water rights holders in Arizona (including the CAP) are reduced to zero. The maximum amount of Stage 1 shortages during the period of analysis is dependent on the scheduled depletions for the post-1968 water rights holders and decreases over time from approximately 1.8 maf in 2008 to 1.7 maf in 2060.

After deliveries to the 4th and 5th priority rights within Arizona are reduced to zero, additional reductions are applied to Arizona, California, and Nevada. These shortages, referred to as Stage 2 shortages, continue to the maximum necessary to keep Lake Mead elevation above 1,000 feet msl.

2.2.2 Coordinated Reservoir Operations

The No Action Alternative assumes Lake Powell's operation would follow the current operating criteria as specified by the LROC and as implemented through the AOP process. Three factors affecting the annual releases from Lake Powell are: 1) the minimum objective release; 2) storage equalization; and 3) spill avoidance.

Pursuant to the LROC, the objective under current operational conditions is to maintain a minimum release of water from Lake Powell of 8.23 maf for the water year. Under the No Action Alternative, a minimum release of 8.23 maf is assumed to be made each water year unless storage equalization or spill avoidance are in effect.

Annual releases from Lake Powell greater than the minimum objective release occur when Upper Basin storage is greater than that required by 602(a) storage, and the storage in Lake Powell is forecast to be greater than the storage in Lake Mead at the end of that water year. Under these conditions, additional releases are made from Lake Powell to equalize the storage in Lake Mead with the storage in Lake Powell by the end of the water year.

The 602(a) storage requirement specifies the amount of storage in Upper Basin reservoirs necessary to assure deliveries to the Lower Basin in compliance with the Compact without impairment to the annual consumptive use in the Upper Basin. If the 602(a) storage requirement is not met, equalization does not occur. The LROC specifies that all relevant factors including historic stream flows, the most critical period of record, the probabilities of water supply, and estimated future depletions be considered when determining the 602(a) storage amount.

In 2004, an Interim 602(a) Storage Guideline was adopted that specifies that through 2016, the 602(a) storage requirement shall utilize a storage amount of not less than 14.85 maf which corresponds to an elevation of 3,630 feet msl for Lake Powell. Under the No Action Alternative, the determination of 602(a) storage is consistent with the storage criterion and the provisions of the Interim 602(a) Storage Guideline. The algorithm used to calculate the 602(a) storage requirement is presented in Appendix A.

Annual release volumes from Lake Powell greater than the minimum objective of 8.23 maf may also be made to avoid anticipated spills. An objective in the operation of Glen Canyon Dam is to attempt to safely fill Lake Powell each summer. When carryover storage from the previous year in combination with the current inflow forecast is projected to exceed Lake Powell's storage capacity, Reclamation schedules the release of the volumes of water needed to avoid spills. Subject to actual inflows, Lake Powell is operated to reach storage of about 23.8 maf in July (0.5 maf from full pool). In years when Lake Powell fills or nearly fills during the summer, additional releases in late summer and early winter are made to draw the reservoir down, so that there is at least 2.4 maf of vacant space in Lake Powell on September 30 for flood protection. Under the No Action Alternative, it is assumed that spill avoidance releases are made when necessary.

2.2.3 Storage and Delivery of Conserved Water

There is currently no mechanism in place for the storage and delivery of conserved system and non-system water in Lake Mead; therefore, the No Action Alternative assumes that none will exist during the interim period.

2.2.4 Interim Surplus Guidelines

The ISG specify ranges of Lake Mead elevations and operational conditions that are used to determine the availability of surplus water for each year during their effective term (through 2016). The elevation ranges are coupled with specific uses of surplus water so that if Lake Mead's elevation declines, the amount of surplus water is reduced. The Surplus, Normal, and Shortage conditions are described below:

2.2.4.1 Flood Control Surplus

If flood control releases are anticipated to be required given the current inflow forecast, the Secretary declares a Flood Control Surplus Condition for that year. The estimated annual amount of surplus water available for pumping and release from Lake Mead (in addition to 7.5 maf) varies over time (2002 to 2016) and ranges between 1.20 to 1.58 mafy. Under current practice, Mexico is allowed to schedule up to an additional 200 kaf pursuant to the 1944 Treaty during flood control years when water supplies exceed those required for use in the United States.

2.2.4.2 Quantified Surplus (70R Strategy)

If flood control releases are anticipated to be required assuming the 70th percentile inflow (the inflow value from the historical record that has not been exceeded more than 30 percent of the time), the Secretary declares a Quantified Surplus Condition for that year. The estimated annual amount of surplus water available for pumping and release from Lake Mead (in addition to 7.5 maf) varies over time (2002 to 2016) and ranges between 1.02 to 1.45 mafy.

2.2.4.3 Full Domestic Surplus (Lake Mead at or above Elevation 1,145 feet msl)

If the projected January 1 Lake Mead elevation is at or above 1,145 feet msl but below the elevation calculated by the 70R Strategy, the Secretary declares a Full Domestic Surplus Condition for that year. The projected annual amount of surplus water available for pumping and release from Lake Mead (in addition to 7.5 maf) varies over time (2002 to 2016) and ranges between 340 to 535 thousand acre-feet per year (kafy).

2.2.4.4 Partial Domestic Surplus (Lake Mead at or above Elevation 1,125 feet msl)

If the projected January 1 Lake Mead elevation is at or above 1,125 feet msl and below 1,145 feet msl, the Secretary declares a Partial Domestic Surplus Condition for that year. The estimated annual amount of surplus water available for pumping and release from Lake Mead (in addition to 7.5 maf) varies over time (2002 to 2016) and ranges between 90 to 375 kafy.

2.2.4.5 Normal and Shortage Conditions (Lake Mead below Elevation 1,125 feet msl)

If the projected January 1 Lake Mead elevation is at or below 1,125 feet msl, the Secretary declares a Normal Condition or a Shortage Condition for that year.

Under the No Action Alternative, surplus determinations through 2016 would be as described above. After 2016, it is assumed that surplus determinations would only be based on the more conservative Quantified Surplus (70R Strategy) and Flood Control Surplus conditions. Further details of these modeling assumptions to represent the ISG are presented in Appendix A.

2.3 Basin States Alternative

The Basin States Alternative proposes a coordinated operation of Lake Powell and Lake Mead that would minimize shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin. This alternative also provides a mechanism for promoting water conservation in the Lower Basin. The formulation of the four operational elements of the proposed federal action for the Basin States Alternative follows.

2.3.1 Shortage Guidelines

The Basin States Alternative provides discrete levels of shortage associated with specific Lake Mead elevations as presented below. This alternative provides criteria for shortages up to a maximum of 500 kaf at Lake Mead elevation of 1,025 feet msl.

The shortages modeled under the Basin States Alternative are as follows:

- when Lake Mead is projected to be below elevation 1,075 feet msl and at or above elevation 1,050 feet msl on January 1, a shortage of 333 kaf shall be imposed for that year;

- when Lake Mead is projected to be below elevation 1,050 feet msl and at or above elevation 1,025 feet msl on January 1, a shortage of 417 kaf shall be imposed for that year;

- when Lake Mead is projected to be below elevation 1,025 feet msl on January 1, a shortage of 500 kaf shall be imposed for that year; and

- when Lake Mead is below elevation 1,025 feet msl, the Secretary shall consult with the Basin States to discuss further measures that may be undertaken consistent with the Law of the River.[2]

The shortage amounts are expressed as reductions to water users in the Lower Division states. However, modeling of this and the other alternatives includes the assumption that deliveries to Mexico are also reduced.[3] As such, the total shortage amounts modeled under this alternative are 400; 500; and 600 kaf, at elevations 1,075; 1,050; and 1,000 feet msl, respectively.

2.3.2 Coordinated Reservoir Operations

Under the Basin States Alternative, the annual Lake Powell release is based the volume of water in storage or corresponding elevation of Lake Powell and Lake Mead as described below.

2.3.2.1 Equalization

The Basin States Alternative provides an elevation schedule (Table 2.3-1) that would be used in determining when equalization releases would be made from Lake Powell.

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[2] This alternative proposes that consultations between the Basin States and Reclamation be undertaken to define additional shortages needed when Lake Mead falls below elevation 1,025 feet msl and is projected to fall below 1,000 feet msl. The possible outcomes of such a consultation process are unknown; therefore, for modeling purposes it was assumed that shortages of 500 kaf would continue to be applied at Lake Mead elevations below 1,025 feet msl.

[3] Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

Table 2.3-1
Basin States Alternative
Lake Powell Equalization Elevations

Year	Reservoir Elevation (feet msl)
2008	3,636
2009	3,639
2010	3,642
2011	3,643
2012	3,645
2013	3,646
2014	3,648
2015	3,649
2016	3,651
2017	3,652
2018	3,654
2019	3,655
2020	3,657
2021	3,659
2022	3,660
2023	3,662
2024	3,663
2025	3,664
2026	3,666

When Lake Powell is at or above these specified elevations and when the volume of Lake Powell is projected to be greater than the volume of Lake Mead at the end of the water year, Lake Powell would release greater than 8.23 mafy to equalize its volume with Lake Mead. Otherwise, 8.23 maf is released from Lake Powell.

2.3.2.2 Upper Elevation Balancing

When Lake Powell is below the elevations stated in Table 2.3-1 and is projected to be at or above 3,575 feet msl at the end of the water year, a release in the amount of 8.23 maf from Lake Powell would be made if the projected elevation of Lake Mead is at or above 1,075 feet msl at the end of the water year. If the projected end of water year elevation of Lake Mead is below 1,075 feet msl, the volumes of Lake Mead and Lake Powell would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.0 maf and no less than 7.0 maf.

2.3.2.3 Mid-Elevation Releases
When Lake Powell elevation is projected to be below 3,575 feet msl and at or above 3,525 feet msl at the end of the water year, a release in the amount of 7.48 maf would be made if the projected end of water year elevation of Lake Mead is at or above 1,025 feet msl. If the projected end of water year elevation of Lake Mead is below 1,025 feet msl, a release of 8.23 maf from Lake Powell would be made.

2.3.2.4 Lower Elevation Balancing
When the projected end of water year elevation of Lake Powell is below 3,525 feet msl, Lake Mead and Lake Powell would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.5 maf and no less than 7.0 maf.

2.3.3 Creation and Delivery of Intentionally Created Surplus
The Basin States Alternative includes the adoption of a mechanism to encourage and account for augmentation and conservation of water supplies, e.g., fallowing of land, lining of canals and other system efficiency improvements, and introduction of tributary and non-system water in the Lower Basin. The mechanism provides for the creation, accounting, and delivery of Intentionally Created Surplus (ICS). At the time the ICS is created, five percent of the ICS would be dedicated to the Colorado River system on a one-time basis. Additionally, ICS accounted for in Lake Mead longer than one year would be subject to annual evaporation losses of three percent per year. If flood control releases occur, ICS would be reduced on a pro-rata basis until no ICS remains, i.e., ICS would be released first.

The maximum amount of ICS that can be created during any year, the maximum cumulative amount of ICS that can be available at any one time, and the maximum amount of ICS that may be delivered in any one year under this alternative are presented in Table 2.3-2.

Table 2.3-2
Basin States Alternative
Volume Limitations of ICS

Entity	Maximum Annual ICS Creation (kaf)	Maximum Cumulative ICS (kaf)	Maximum Annual ICS Delivery (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Total	625	2,100	1,000

2.3.4 Interim Surplus Guidelines
The Basin States Alternative includes both a modification and an extension of the ISG. The ISG would be extended through 2026 and be modified by eliminating the Partial Domestic Surplus Condition, beginning in 2008, and limiting the amount of water available under the

Full Domestic Surplus Condition during the period 2017 through 2026.[4] The elimination of the Partial Domestic Surplus Condition reduces the amount of surplus water that could be made available and leaves more water in storage to reduce the severity of future shortages.

2.4 Conservation Before Shortage Alternative

The Conservation Before Shortage Alternative was developed by a consortium of environmental NGOs, including Defenders of Wildlife, Environmental Defense, National Wildlife Federation, Pacific Institute, Sierra Club, Sonoran Institute, The Nature Conservancy, and the Rivers Foundation of the Americas. The Conservation Before Shortage Alternative includes voluntary, compensated reductions in water use to minimize involuntary shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin. This alternative also provides a mechanism for promoting water conservation in the Lower Basin by expanding the ICS mechanism.

The formulation of the four operational elements of the proposed federal action for the Conservation Before Shortage Alternative follows.

2.4.1 Shortage Guidelines

Although the Conservation Before Shortage Alternative does not include stepped, involuntary shortages, it does include voluntary conservation levels similar to the Basin States Alternative shortage levels described in Section 2.3. These voluntary conservation levels are described below.

This alternative provides a shortage strategy that would absolutely protect Lake Mead elevation of 1,000 feet msl whereby water deliveries would be reduced by the amount required to maintain Lake Mead elevations at or above 1,000 feet msl.

2.4.2 Coordinated Reservoir Operations

The Conservation Before Shortage Alternative assumes the same coordinated reservoir operations as the Basin States Alternative described in Section 2.3.

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[4] During 2017 through 2026, the distribution of Domestic Surplus water would be limited as follows: 1) for use by MWD, 250 kafy in addition to the amount of California's basic apportionment available to MWD; 2) for use by SNWA, 100 kafy in addition to the amount of Nevada's basic apportionment available to SNWA; and 3) for use in Arizona, 100 kafy in addition to the amount of Arizona's basic apportionment available to Arizona contractors.

2.4.3 Storage and Delivery of Conserved Water

The conservation triggers proposed under this alternative are as follows:

- when Lake Mead is projected to be below elevation 1,075 feet msl and at or above elevation 1,050 feet msl on January 1, the Secretary will seek the conservation of 400 kaf of water;

- when Lake Mead is projected to be below elevation 1,050 feet msl and at or above elevation 1,025 feet msl on January 1, the Secretary will seek the conservation of 500 kaf of water; and

- when Lake Mead is projected to be below elevation 1,025 feet msl on January 1, the Secretary will seek the conservation of 600 kaf of water.

Under the Conservation Before Shortage Alternative, ICS would be generated by activities similar to those described for the Basin States Alternative (Section 2.3). In addition, participation in the ICS mechanism would be expanded to include other entities.

The maximum amount of ICS that can be created during any year, the maximum cumulative amount of ICS that can be available at any one time, and the maximum amount of ICS that may be delivered in any one year under this alternative are presented in Table 2.4-1. ICS that is assumed to be created by other entities is shown in Table 2.4-1 as “Unassigned.”

Table 2.4-1
Conservation Before Shortage Alternative
Volume Limitations of ICS

Entity	Maximum Annual ICS Creation (kaf)	Maximum Cumulative ICS (kaf)	Maximum Annual ICS Delivery (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Unassigned	825	2,100	600
Total	1,450	4,200	1,600

2.4.4 Interim Surplus Guidelines

The Conservation Before Shortage Alternative assumes the same modifications to and extension of the term of the ISG as described under the Basin States Alternative (Section 2.3).

2.4.5 Funding Mechanisms

There are two other aspects of the Conservation Before Shortage proposal that are unique to the Conservation Before Shortage Alternative: a funding mechanism for the voluntary conservation program, and a recommendation that a portion of the conserved water be used to benefit the environment. The details of the modeling assumptions used to simulate the ICS mechanism, including water for environmental purposes, are presented in Appendix M.

The Conservation Before Shortage proposal describes potential funding sources that include a Federal government contribution for the cost of all conservation agreements up to the volume of the bypass flow that the Secretary has not otherwise replaced in the year that a conservation trigger becomes effective, and responsibility for half of the cost of any additional agreements required to generate the proposed voluntary, conserved water. A second component of the funding mechanism would be a "Power Pool Protection Fund" which proposes that a percentage of the funding for the proposed voluntary conservation program be derived from a conditional surcharge on power rates under existing or renewed contracts for hydropower produced at Hoover Dam, depending upon the storage in Lake Mead. A third component of the funding mechanism would be "Temporary Cost Recovery/Delivery Surcharges", requiring that the cost of some portion of the conservation agreements, including those with Colorado River users in Mexico, be funded through a conservation surcharge imposed on a per-acre-foot basis on water deliveries to all Lower Basin contractors.

The viability of the Conservation Before Shortage program funding proposal is not known at this time. The Department currently does not have the authority to implement all facets of this proposal and additional legislation would be necessary to gain such authority.

2.5 Water Supply Alternative

The Water Supply Alternative is intended to maximize water deliveries at the expense of retaining water in storage in the reservoirs for future use. This alternative would implement shortages only when sufficient water to meet entitlements is not available in Lake Mead.

The formulation of the four operational elements of the proposed federal action for the Water Supply Alternative follows.

2.5.1 Shortage Guidelines

Under the Water Supply Alternative, shortages would not be imposed until Lake Mead nears elevation 895 feet msl (top of the dead pool). Near that elevation, releases would be limited to the amount of water available. However, when Lake Mead elevation drops below 1,000 feet msl, SNWA would be unable to take water through its lower intake.

2.5.2 Coordinated Reservoir Operations

When Lake Powell is projected to be above elevation 3,575 feet msl at the end of the water year, the operation of Lake Powell would be the same as under the No Action Alternative unless Lake Mead elevation is below 1,075 feet msl. When Lake Powell elevation is projected to be below elevation 3,575 feet msl at the end of the water year or Lake Mead elevation is projected to be below elevation 1,075 feet msl at the end of the water year, the volumes of Lake Powell and Lake Mead would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.5 maf and no less than 7.0 maf.

2.5.3 Storage and Delivery of Conserved Water

The Water Supply Alternative does not include a mechanism for the storage and delivery of conserved system and non-system water in Lake Mead.

2.5.4 Interim Surplus Guidelines

Under this alternative, the existing ISG would be extended through 2026.

2.6 Reservoir Storage Alternative

The Reservoir Storage Alternative was developed in coordination with the cooperating agencies and other stakeholders, primarily Western and NPS. This alternative would keep more water in storage in Lake Powell and Lake Mead to benefit power and recreation interests by reducing water deliveries and by increasing shortages. This alternative also provides a mechanism for promoting water conservation in the Lower Basin.

The formulation of the four operational elements of the proposed federal action for the Reservoir Storage Alternative follows.

2.6.1 Shortage Guidelines

The Reservoir Storage Alternative is similar to the Basin States Alternative in that it provides discrete levels of shortage associated with specific Lake Mead reservoir elevations (Section 2.3). However, shortages in this alternative begin at a higher Lake Mead elevation and the shortages amounts are larger so that more water would be retained in storage and higher Lake Powell and Lake Mead elevations would be maintained. The Reservoir Storage Alternative does not contain provisions that would protect the Lake Mead elevation of 1,000 feet msl.

The shortages modeled under this alternative are as follows:

- when Lake Mead is projected to be below elevation 1,100 feet msl and at or above elevation 1,075 feet msl on January 1, a shortage of 500 kaf shall be imposed for that year;
- when Lake Mead is projected to be below elevation 1,075 feet msl and at or above elevation 1,050 feet msl on January 1, a shortage of 667 kaf shall be imposed for that year;
- when Lake Mead is projected to be below elevation 1,050 feet msl and at or above elevation 1,025 feet msl on January 1, a shortage of 883 kaf shall be imposed for that year; and
- when Lake Mead is projected to be below elevation 1,025 feet msl on January 1, a shortage of 1,000 kaf would be imposed for that year.

The volumes of shortages are expressed as reductions to water users in the Lower Division states. However, modeling of the Reservoir Storage Alternative and the other alternatives includes the assumption that deliveries to Mexico are also reduced.[5] As such, the total shortage amounts modeled under this alternative are 600; 800; 1,000; and 1,200 kaf at elevations 1,100; 1,075; 1,050; and 1,025 feet msl, respectively.

2.6.2 Coordinated Reservoir Operations

When Lake Powell is projected to be above elevation 3,595 feet msl at the end of the water year, the operation of Lake Powell would be the same as under the No Action Alternative. Elevations of Lake Powell that trigger releases that are less than the minimum objective release of 8.23 maf are tied to critical recreation elevations at Lake Powell as follows:

- when Lake Powell is projected to be below elevation 3,595 feet msl and above elevation 3,560 feet msl at the end of the water year, a release in the amount of 7.80 maf from Lake Powell would be made; and
- when Lake Powell is projected to be below elevation 3,560 feet msl at the end of the water year, the volumes of Lake Powell and Lake Mead would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.5 maf and no less than 7.8 maf.

[5] Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico.

2.6.3 Storage and Delivery of Conserved Water

Under the Reservoir Storage Alternative, storage credits would be generated by activities similar to those described under the Basin States Alternative (Section 2.3). In addition, participation in the storage and delivery mechanism would be expanded to include other entities. At the time the storage credits are created, ten percent of the conserved water would be dedicated to the Colorado River system on a one-time basis.

The maximum amount of storage credits that can be created during any year, the maximum cumulative amount of storage credits that can be available at any one time, and the maximum amount of storage credits that may be delivered by each entity in any one year under this alternative are presented in Table 2.6-1. Storage credits that are assumed to be generated by other entities are shown in Table 2.6-1 as "Unassigned."

Table 2.6-1
Reservoir Storage Alternative
Volume Limitations of Storage and Delivery Mechanism

Entity	Maximum Annual Storage of Conserved System or Non-system Water (kaf)	Maximum Total Storage of Conserved System or Non-system Water (kaf)	Maximum Annual Delivery of Conserved System or Non-system Water (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Unassigned	475	950	950
Total	1,100	3,050	1,950

2.6.4 Interim Surplus Guidelines

Under the Reservoir Storage Alternative, the permissive provisions of the existing ISG are terminated in 2007 and surplus determinations revert to the Quantified Surplus and Flood Control Surplus conditions from 2008 through 2026.

2.7 Preferred Alternative

The Preferred Alternative incorporates operational elements identified in the Basin States and Conservation Before Shortage alternatives. It proposes a coordinated operation of Lake Powell and Lake Mead that would minimize shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin and adopts the ICS mechanism for promoting water conservation in the Lower Basin.

The formulation of the four operational elements of the proposed federal action for the Preferred Alternative follows.

2.7.1 Shortage Guidelines

The Preferred Alternative, similar to the Basin States Alternative, assumes discrete levels of shortage associated with specific Lake Mead elevations as described below. This alternative provides criteria for shortages up to a maximum of 500 kaf at Lake Mead elevation of 1,025 feet msl.

The shortages modeled under the Preferred Alternative are as follows:

- ♦ when Lake Mead is projected to be below elevation 1,075 feet msl and at or above elevation 1,050 feet msl on January 1, a shortage of 333 kaf shall be imposed for that year;
- ♦ when Lake Mead is projected to be below elevation 1,050 feet msl and at or above elevation 1,025 feet msl on January 1, a shortage of 417 kaf shall be imposed for that year;
- ♦ when Lake Mead is projected to be below elevation 1,025 feet msl on January 1, a shortage of 500 kaf shall be imposed for that year; and
- ♦ when Lake Mead is below elevation 1,025 feet msl, the Secretary shall undertake appropriate consultation, including with the Basin States, to discuss further measures that may be undertaken consistent with the Law of the River.[6]

The volumes of shortages are expressed as reductions to water users in the Lower Division states. However, modeling of this and the other alternatives includes the assumption that deliveries to Mexico are also reduced.[7] As such, the total shortage amounts modeled under this alternative are 400; 500; and 600 kaf at elevations 1,075; 1,050; and 1,025 feet msl, respectively.

2.7.2 Coordinated Reservoir Operations

The Preferred Alternative assumes the same coordinated reservoir operations as the Basin States and Conservation Before Shortage alternatives described in Sections 2.3 and 2.4, respectively.

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[6] This alternative proposes that appropriate consultations be undertaken to define additional shortages needed when Lake Mead falls below elevation 1,025 feet msl. The possible outcomes of such a consultation process are unknown; therefore, for modeling purposes it was assumed that shortages of 500 kaf would continue to be applied at Lake Mead elevations below 1,025 feet msl.

[7] Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

2.7.3 Creation and Delivery of ICS

The Preferred Alternative is similar to the Basin States and Conservation Before Shortage alternatives. It includes the adoption of a mechanism to encourage and account for augmentation and conservation of water supplies. The mechanism provides for the creation, accounting, and delivery of ICS. At the time the ICS is created, five percent of the ICS would be dedicated to the Colorado River system on a one-time basis. Additionally, ICS accounted for in Lake Mead longer than one year would be subject to annual evaporation losses of three percent per year. If flood control releases occur, ICS would be reduced on a pro-rata basis until no ICS remains, i.e., ICS would be released first.

The maximum amount of ICS that can be created during any year, the maximum cumulative amount of ICS that can be available at any one time, and the maximum amount of ICS that may be delivered in any one year under the Preferred Alternative are presented in Table 2.7-1. ICS that is assumed to be created by other entities is shown in Table 2.7-1 as "Additional Amounts."

Table 2.7-1
Preferred Alternative
Volume Limitations of ICS

Entity	Maximum Annual ICS Creation (kaf)	Maximum Cumulative ICS (kaf)	Maximum Annual ICS Delivery (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Total[1]	625	2,100	1,000
Additional Amounts	625	2,100	1,000
Total[2]	1,250	4,200	2,000

1 *It is anticipated that the ICS mechanism will be implemented to allow a maximum cumulative amount of ICS that would be available at any one time of up to 2.1 maf.*

2 *The analysis of potential effects in this Final EIS includes a maximum cumulative amount of ICS that would be available at any one time of up to 4.2 maf.*

2.7.4 Interim Surplus Guidelines

The Preferred Alternative assumes the same modifications to and extension of the term of the ISG as described under the Basin States and Conservation Before Shortage alternatives (Sections 2.3 and 2.4, respectively).

2.7.5 Preferred Alternative Summary and Conclusions

The Preferred Alternative is the most reasonable and feasible alternative among those considered and analyzed in the Final EIS. The potential environmental effects of this action alternative, as well as the No Action Alternative and the four other action alternatives have been fully analyzed in the Final EIS. The environmental effects of the Preferred Alternative are well within the range of anticipated effects of the alternatives presented in the Draft EIS and do not affect the environment in a manner not already considered in the Draft EIS.

Reclamation has determined that the four key operational elements described and evaluated in the Draft EIS and selected to formulate the Preferred Alternative best meet all aspects of the purpose and need for the proposed federal action as discussed below. Additionally, Reclamation has developed draft operational guidelines (Appendix S) for how the Preferred Alternative may be implemented during the interim period. These guidelines may be revised and refined prior to adoption in the ROD.

1) **Shortage Guidelines:** The Preferred Alternative defines discrete levels of shortage volumes associated with Lake Mead reservoir elevations. This will provide water users and managers in the Lower Basin with greater certainty with regard to when, and by how much, water deliveries will be reduced in drought and other low reservoir conditions.

2) **Coordinated Reservoir Operations:** The Preferred Alternative proposes coordinated operations of Lake Powell and Lake Mead throughout the full range of operational elevations. Better management of these reservoirs at higher elevations has a direct impact on available storage, thereby affecting the likelihood and severity of potential future shortages.

3) **Creation and Delivery of ICS:** The Preferred Alternative proposes a mechanism to encourage and account for augmentation and conservation of water supplies and thereby minimize the likelihood and severity of potential future shortages. This mechanism provides for the creation, accounting, and delivery of ICS.

   Under the Preferred Alternative, the maximum cumulative amount of ICS that could be available at any one time is 2.1 maf. This amount could be increased up to 4.2 maf in future years. Depending on the severity of drought and low reservoir conditions, it may be desirable to facilitate greater conservation. As appropriate, the Secretary will enter into agreements to deliver ICS.

   At the time the ICS is created, five percent of the ICS would be dedicated to the Colorado River system on a one-time basis. This system assessment will benefit the system and enhance the water in storage in Lake Mead and would be available to meet future needs.

   The draft interim operational guidelines (Appendix S) set forth Reclamation’s concepts for the creation of ICS, verification, water accounting procedures, and any necessary forbearance agreements required to deliver ICS as contemplated under the Preferred Alternative. Although the guidelines for this element are interim and will expire in 2026, some of the conservation projects established under the guidelines could be permanent in duration.

4) **Interim Surplus Guidelines:** The draft interim operational guidelines (Appendix S) would extend the ISG, providing for an operational strategy for the full range of reservoir operations through 2026. The ISG would also be modified by eliminating the Partial Domestic Surplus Condition, beginning in 2008, and by limiting the amount of water available under the Full Domestic Surplus Condition during the

period 2017 through 2026. The elimination of the Partial Domestic Surplus Condition reduces the amount of surplus water that could be made available and leaves more water in storage to reduce the severity of future shortages.

2.8 Summary Comparison of Alternatives

Summary comparisons of the alternatives identified and analyzed in the Final EIS are provided in Table 2.8-1 as a matrix of alternatives and their formulation for each of the four operational elements of the proposed federal action. Table 2.8-2 provides a comparison of the alternatives under the Coordinated Reservoir Operations element of the proposed federal action for Lake Powell. Table 2.8-3 provides a comparison of the alternatives under the Shortage Guidelines element of the proposed federal action for Lake Mead.

Table 2.8-1
Matrix of Alternatives

Alternatives	Shortage Guidelines to Reduce Deliveries from Lake Mead (elevation in feet msl)	Coordinated Reservoir Operations (Lake Mead & Lake Powell) (elevation in feet msl)	Lake Mead Storage and Delivery of Conserved System and Non-system Water	Interim Surplus Guidelines (ISG) for Deliveries/Releases from Lake Mead
No Action	▪ Determination made through the AOP process, absent shortage guidelines ▪ Reasonably represented by a two-level shortage strategy - probabilistic protection of Lake Mead elevation 1,050 and absolute protection of Lake Mead elevation 1,000	▪ Minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required ▪ Operation at low reservoir levels reasonably represented by a 8.23 maf release from Lake Powell down to Lake Powell dead pool	▪ No water management mechanism for storage and delivery of conserved system and non-system water	▪ No modification or extension of the ISG which end in 2016 ▪ After 2016, determination made through the AOP process, absent surplus guidelines; reasonably represented by the spill avoidance (referred to as the 70R) strategy
Basin States	▪ Shortages (i.e., reduced deliveries in the United States) of 333, 417, and 500 kaf from Lake Mead at elevations 1,075, 1,050, and 1,025 respectively [1] ▪ Initiate efforts to develop additional guidelines for shortages if Lake Mead falls below elevation 1,025 (Note: includes consultation with Basin States)	▪ Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required ▪ Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevations at Lake Powell and Lake Mead	▪ Creation, accounting, and delivery of ICS ▪ Maximum total ICS of 2.1 maf ▪ System assessment of 5% when ICS is created	▪ Modification of ISG to eliminate Partial Domestic Surplus condition ▪ Extension of the modified guidelines through 2026
Conservation Before Shortage	▪ Shortages are implemented in any given year when necessary to keep Lake Mead above SNWA's lower intake at elevation of 1,000 (absolute protection of elevation 1,000)	▪ Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required ▪ Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevations at Lake Powell and Lake Mead	▪ Prior to shortage, conservation of different volumes of water tied to Lake Mead elevation ▪ Creation, accounting, and delivery of ICS ▪ Water for environmental uses ▪ Maximum total ICS of up to 4.2 maf ▪ System assessment of 5% when ICS is created	▪ Modification of ISG to eliminate Partial Domestic Surplus condition ▪ Extension of the modified guidelines through 2026
Water Supply	▪ Release full annual entitlement amounts until Lake Mead is drawn down to dead pool (elevation 895)	▪ Minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required ▪ Balancing if Lake Powell is below elevation 3,575 or Lake Mead is below elevation 1,075	▪ No water management mechanism for storage and delivery of conserved system and non-system water	▪ Extension of the existing ISG through 2026
Reservoir Storage	▪ Shortages (i.e., reduced deliveries in the United States) of 500, 667, 833, and 1,000 kaf from Lake Mead at elevations 1,100, 1,075, 1,050, and 1,025 respectively[1]	▪ Minimum objective release of 8.23 maf from Lake Powell if Lake Powell is above elevation 3,595 unless storage equalization releases are required ▪ 7.8 maf release from Lake Powell between Lake Powell elevations of 3,560 and 3,595 ▪ Balancing below Lake Powell elevation 3,560	▪ Storage and delivery of conserved system and non-system water ▪ Maximum total storage of conserved system and non-system water of 3.05 maf ▪ System assessment of 10% of stored conserved system and non-system water	▪ Provisions of existing ISG terminate after 2007, and during period from 2008-2026, surplus determinations are limited to 70R and Flood Control conditions
Preferred Alternative	▪ Shortages (i.e., reduced deliveries in the United States) of 333, 417, and 500 kaf from Lake Mead at elevations 1,075, 1,050, and 1,025 respectively[1] ▪ Initiate efforts to develop additional guidelines for shortages if Lake Mead falls below elevation 1,025 (Note: Includes consultation)	▪ Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required ▪ Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevations at Lake Powell and Lake Mead	▪ Creation, accounting, and delivery of ICS ▪ Maximum total ICS in Lake Mead of up to 4.2 maf ▪ System assessment of 5% when ICS is created	▪ Modification of ISG to eliminate Partial Domestic Surplus condition ▪ Extension of the modified guidelines through 2026

[1] These are amounts of shortage (i.e., reduced deliveries in the United States). As in the Draft EIS, the Final EIS includes modeling assumptions that identify water deliveries to Mexico pursuant to the 1944 Treaty.

Table 2.8-2
Lake Powell
Comparison of Alternatives
Coordinated Reservoir Operations Element of the Proposed Federal Action

Lake Powell Elevation (feet msl)	No Action Alternative	Basin States Alternative	Conservation Before Shortage Alternative	Water Supply Alternative	Reservoir Storage Alternative	Preferred Alternative	Lake Powell Storage (maf)
3,700	Equalize, avoid spills or release 8.23 maf	Equalize, avoid spills or release 8.23 maf	Equalize, avoid spills or release 8.23 maf	Equalize, avoid spills or release 8.23 maf	Equalize, avoid spills or release 8.23 maf	Equalize, avoid spills or release 8.23 maf	**24.3**
Equalization	**602(a)**	**Upper Equalization Line**	**Upper Equalization Line**	**602(a)**	**602(a)**	**Upper Equalization Line**	**Equalization**
	Release 8.23 maf	Release 8.23 maf; if Lake Mead < 1,075 feet msl, balance contents with a min/max release of 7.0 and 9.0 maf	Release 8.23 maf; if Lake Mead < 1,075 feet msl, balance contents with a min/max release of 7.0 and 9.0 maf	Release 8.23 maf; if Lake Mead < 1,075 feet msl, balance contents with a min/max release of 7.0 and 9.5 maf	Release 8.23 maf	Release 8.23 maf; if Lake Mead < 1,075 feet msl, balance contents with a min/max release of 7.0 and 9.0 maf	
3,595					Release 7.8 maf		**11.3**
3,575		Release 7.48 maf; if Lake Mead < 1,025 feet msl, release 8.23 maf	Release 7.48 maf; if Lake Mead < 1,025 feet msl, release 8.23 maf	Balance contents with a min/max release of 7.0 and 9.5 maf		Release 7.48 maf; if Lake Mead < 1,025 feet msl, release 8.23 maf	**9.5**
3,560					Balance contents with a min/max release of 7.8 and 9.5 maf		**8.3**
3,525		Balance contents with a min/max release of 7.0 and 9.5 maf	Balance contents with a min/max release of 7.0 and 9.5 maf			Balance contents with a min/max release of 7.0 and 9.5 maf	**5.9**
3,490							**4.0**
3,370							**0**

Table 2.8-3
Lake Mead
Comparison of Alternatives
Coordinated Reservoir Operations Element of the Proposed Federal Action

Lake Mead Elevation (feet msl)	No Action Alternative	Basin States Alternative	Conservation Before Shortage Alternative	Water Supply Alternative	Reservoir Storage Alternative	Preferred Alternative	Lake Mead Storage (maf)
1,220	Flood Control or 70R Surplus	Flood Control or 70R Surplus	Flood Control or 70R Surplus	Flood Control or 70R Surplus	Flood Control or 70R Surplus	Flood Control or 70R Surplus	25.9
1,200	Full Domestic Surplus (through 2016)	Domestic Surplus	Domestic Surplus	Full Domestic Surplus	Normal Operations	Domestic Surplus	22.9
1,145	Partial Domestic Surplus (through 2016)	Normal Operations	Normal Operations	Partial Domestic Surplus		Normal Operations	15.9
1,125	Normal Operations			Normal Operations			13.9
1,100					Shortage 500[1] kaf		11.5
1,075	Shortage 80 percent Protection of elevation 1,050 feet msl	Shortage 333 kaf[1]	Voluntary Conservation		Shortage 667[1] kaf	Shortage 333 kaf[1]	9.4
1,050		Shortage 417 kaf[1]			Shortage 833[1] kaf	Shortage 417 kaf[1]	7.5
1,025		Shortage 500 kaf[1] and Consultation[2]			Shortage 1,000[1] kaf	Shortage 500 kaf[1] and Consultation[2]	5.8
1,000	Shortage Absolute Protection of elevation 1,000 feet msl		Shortage Absolute Protection of elevation 1,000 feet msl				4.3
895							0

[1] These are amounts of shortage (i.e., reduced deliveries in the United States). As in the Draft EIS, the Final EIS includes modeling assumptions that identify water deliveries to Mexico pursuant to the 1944 Treaty.
[2] If Lake Mead falls below elevation 1,025, the Department will initiate efforts to develop additional guidelines for shortages at lower Lake Mead elevations.

2.9 Summary of Potential Effects

Table 2.9-1 presents a summary of the potential effects of the alternatives. Chapter 4 contains detailed descriptions of these effects.

Table 2.9-1
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives					
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
4.3	Hydrologic Resources						
	Probability of Glen Canyon annual release volumes ≥ 7.5 maf, 2009 to 2060	99.96%	96.66%	96.66%	97.9%	100%	96.39%
	Probability of Glen Canyon annual release volumes ≥ 8.23 maf, 2009 to 2060	99%	96.32%	96.38%	96.33%	93.79%	96.64%
	Lake Powell March elevation, probability of water levels ≤ 3,490 feet msl 2026	1.0%	0%	0%	9.0%	0%	0%
	Lake Mead July elevation, probability of water levels ≤ 1,050 feet msl 2026	30%	23%	23%	29%	9%	21%
	Hoover Dam annual release, 2026 50th percentile values	9.04 maf	9.17 maf	9.11 maf	9.39 maf	8.68 maf	9.16 maf
4.4	Water Deliveries						
	Probability of involuntary shortage, 2026	49%	35%	7%	12%	37%	41%
	Probability of voluntary and involuntary shortage, 2026	49%	35%	36%	12%	37%	41%
	Probability of normal deliveries, 2026	34%	26%	25%	47%	45%	19%
	Probability of surplus, 2026	17%	39%	39%	41%	18%	40%
4.5	Water Quality						
	Temperature at Little Colorado River, July 2026, 50th percentile	12 °C	12 °C	12 °C	13 °C	12 °C	12 °C
	Salinity downstream of Parker Dam, 2026,	621 mg/L	625 mg/L	625 mg/L	633 mg/L	615 mg/L	625 mg/L
	Salinity at Imperial Dam, 2026	740 mg/L	747 mg/L	751 mg/L	760 mg/L	735 mg/L	747 mg/L
4.6	Air Quality						
	Lake Powell 2025, 10th percentile exposed shoreline	17,000 acres	17,000 acres	17,000 acres	22,000 acres	14,000 acres	17,000 acres
	Lake Mead 2025, 10th percentile exposed shoreline	89,000 acres	82,000 acres	83,000 acres	90,000 acres	73,000 acres	82,000 acres

Table 2.9-1
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives					
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
4.7	Visual Resources						
	Lake Powell maximum height of calcium carbonate ring, 10th percentile, 2025	148 feet	148 feet	148 feet	192 feet	128 feet	148 feet
	Lake Mead maximum height of calcium carbonate ring, 10th percentile, 2025	218 feet	197 feet	199 feet	221 feet	170 feet	195 feet
4.8	Biological Resources[1]						
	Effects on Vegetation and Wildlife						
	Lake Powell and Lake Mead	--	None to minor positive	None to minor positive	Minor negative	Minor positive	Minor positive
	Glen Canyon Dam to Lake Mead	--	Minor negative	Minor negative	Minor negative	Minor negative	Minor negative
	Hoover Dam to NIB	--	None to minor negative	None to minor negative	None to minor positive	None to minor negative	None to minor negative
	NIB to SIB	--	None	Moderate positive	None	Moderate positive	None
	Effects on Special Status Species						
	Glen Canyon Dam to Lake Mead humpback chub	--	Minor positive to minor negative	Minor positive to minor negative	Minor positive to minor negative	Minor negative	Minor positive to minor negative
	Parker Dam to Imperial Dam Yuma clapper rail	--	Minor negative	Minor negative	Minor positive	Minor negative	Minor negative
	NIB to SIB Southwestern willow flycatcher	--	None	Moderate positive	None	Moderate positive	None
4.9	Cultural Resources						
	Number of Lake Powell sites potentially exposed, 10th percentile	194 sites	190 sites	190 sites	227 sites	193 sites	190 sites
	Probability of exposing 32 Lake Mead sites ≤ elevation 1,080 feet msl, 2026	45%	45%	46%	48%	23%	47%
4.10	Indian Trust Assets[1]						
	Water rights affected	-	None	None	None	None	None
	Trust land affected	-	None	None	None	None	None

Table 2.9-1
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives					
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
4.11	Electrical Power Resources						
	Glen Canyon Powerplant						
	Average annual generation and percent change from No Action Alternative value	4,247,880 MWh	(0.08)%	(0.07)%	(2.57)%	0.78%	0.08%
	Average monthly capacity and percent change from No Action Alternative value	606 MW	(0.15)%	(0.13)%	(2.72)%	0.79%	0.03%
	Average total economic value and percent change from No Action Alternative value	$7,350,000,000	0.02%	0.04%	(2.25)%	0.88%	0.19%
	Hoover Powerplant						
	Average annual generation and percent change from No Action Alternative value	3,127,523 MWh	(0.22)%	(0.05)%	(2.39)%	9.07%	1.4%
	Average monthly capacity and percent change from No Action Alternative value	1,191 MW	0.31%	0.58%	(2.56)%	11.52%	2.31%
	Average total economic value and percent change from No Action Alternative value	$7,223,000,000	0.08%	0.34%	(2.51)%	10.63%	2.38%
	Davis and Parker Powerplants						
	Average annual generation and percent change from No Action Alternative value	1,639,687 MWh	(0.56)%	(0.69)%	0.11%	(1.07)%	(0.68)%
	Average monthly capacity and percent change from No Action Alternative value	331 MW	0%	0%	0%	0%	0%
	Average total economic and percent change from No Action Alternative value	$2,268,000,000	(0.53)%	(0.73)%	0.31%	(1.54)%	(0.81)%
	Headgate Rock Powerplant						
	Average annual generation and percent change from No Action Alternative value	77,482 MWh	(1.21)%	(1.71)%	(0.28)%	(1.7)%	(1.5)%
	Average monthly capacity and percent change from No Action Alternative value	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable
	Average total economic value and percent change from No Action Alternative value	$103,000,000	(1.29)%	(2.02)%	(0.17)%	(2.31)%	(1.83)%

Table 2.9-1
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives					
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
4.12	Recreation						
	Lake Powell						
	Probability of closure, Wahweap and lower Bullfrog launch ramps, 2026	7%	9%	9%	23%	3%	8%
	Probability of navigation closures, Castle Rock, Gregory Butte, 2026	28%	36%	36%	52%	24%	32%
	Effects on sport fish	--	None	None	None	None	None
	Lake Mead						
	Probability of closure, Pearce Bay launch ramp, 2026	74%	76%	75%	78%	66%	74%
	Probability of closure, Echo Bay launch ramp, 2026	30%	23%	23%	29%	9%	21%
	Probability of navigation difficulties, upper Lake Mead, 2026	73%	73%	73%	76%	64%	72%
4.13	Transportation						
	Probability of Lake Powell ferry closure, end of September 2026	5%	7%	7%	17%	3%	7%
	Effects on Laughlin River taxis and tour boats	--	None	None	Minor positive	Minor negative	None
	Effects on Lake Havasu ferry service	--	None	None	None	None	None

Table 2.9-1
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives					
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
4.14	Socioeconomics and Land Use						
	Probability of 500,000 af shortage with loss of 561 jobs and $18,000,000 in income, and $5,900,000 in tax revenues in agricultural sector in Arizona, 2026	34%	15%	1%	--	--	24%
	Probability of 500,000 af shortage with loss of 397 jobs and $12,300,000 in income, and $4,200,000 in tax revenues in agricultural sector in Arizona, 2060	54%	54%	50%	51%	53%	52%
	Agricultural production and resulting effects on employment, income, and tax revenues in California and Nevada	--	None	None	None	None	None
	Recreation spending at Lake Powell	--	Same	Same	Decrease	Increase	Increase
	Recreation spending at Lake Mead (LMNRA)	--	Same	Same	Same	Increase	Increase
	Change in river recreation economic activity						
	Lake Powell to Lake Mead	--	None	None	None	None	None
	Downstream of Lake Mead	--	None	None	None	None	None
	Change in economic activity in Municipal & Industrial sector						
	Arizona	--	None	None	None	None	None
	California	--	None	None	None	None	None
	Nevada	--	None	None	None	None	None
4.15	Environmental Justice	--	None	None	None	None	None

Note: (1) "None" after a hyphen in the No Action Alternative column means no difference between the action alternative and the No Action Alternative.

Chapter Three

3.1 Introduction

Chapter 3 describes environmental resources (e.g., hydrologic, biologic, and socioeconomic) of the Colorado River Basin that could be affected by the proposed federal action and the range of alternatives for implementing the proposed federal action described in Chapter 1 and Chapter 2, respectively. The extent to which each specific resource may be impacted is discussed in Chapter 4.

Section 3.2 presents a general discussion of the geographic scope within which potential effects of the alternatives are analyzed, and describes each of the potentially affected Colorado River reaches and water service areas. Subsequent sections in this chapter describe specific resources that may be potentially affected, such as water deliveries, recreation and biologic resources. Each resource section contains a discussion of one or more specific issues identified for consideration through scoping, public review and comment, and internal review (Chapter 1, Table 1.5-1).

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3.2 Geographic Scope

The proposed federal action considers modified operations of Lake Powell and Lake Mead over a wide range of reservoir elevations as addressed by the four operational elements discussed in Section 1.2, i.e., shortage conditions, coordinated operations of Lake Powell and Lake Mead, storage and delivery of Colorado River system and non-system water, and the modified ISG. Such operational changes may affect reservoir storage levels of, and releases from, Lake Powell and Lake Mead, which in turn may subsequently affect river flows, available water supplies, and other resources.

This section describes the geographic scope of specific issues and potential effects associated with changes in the operations of Lake Powell and Lake Mead, as discussed and analyzed under the alternatives considered in this Final EIS (Chapter 2). Reservoirs located upstream of Lake Powell and operated independently of Lake Powell would not be affected by the proposed federal action. However, the releases from Lake Powell and Lake Mead and downstream river flows could be affected by these changes. As such, the upstream limit of the potentially affected environment for the purposes of this Final EIS is the full pool elevation of Lake Powell, and the downstream limit is the SIB (Figure 3.2-1).

In addition to the potential impacts that may occur within the Colorado river corridor, the alternatives may also affect the water supply that is available to specific Colorado River water users in the Lower Basin due to the shortage guidelines element of the proposed federal action. The following water agency service areas are included in the affected environment discussions:

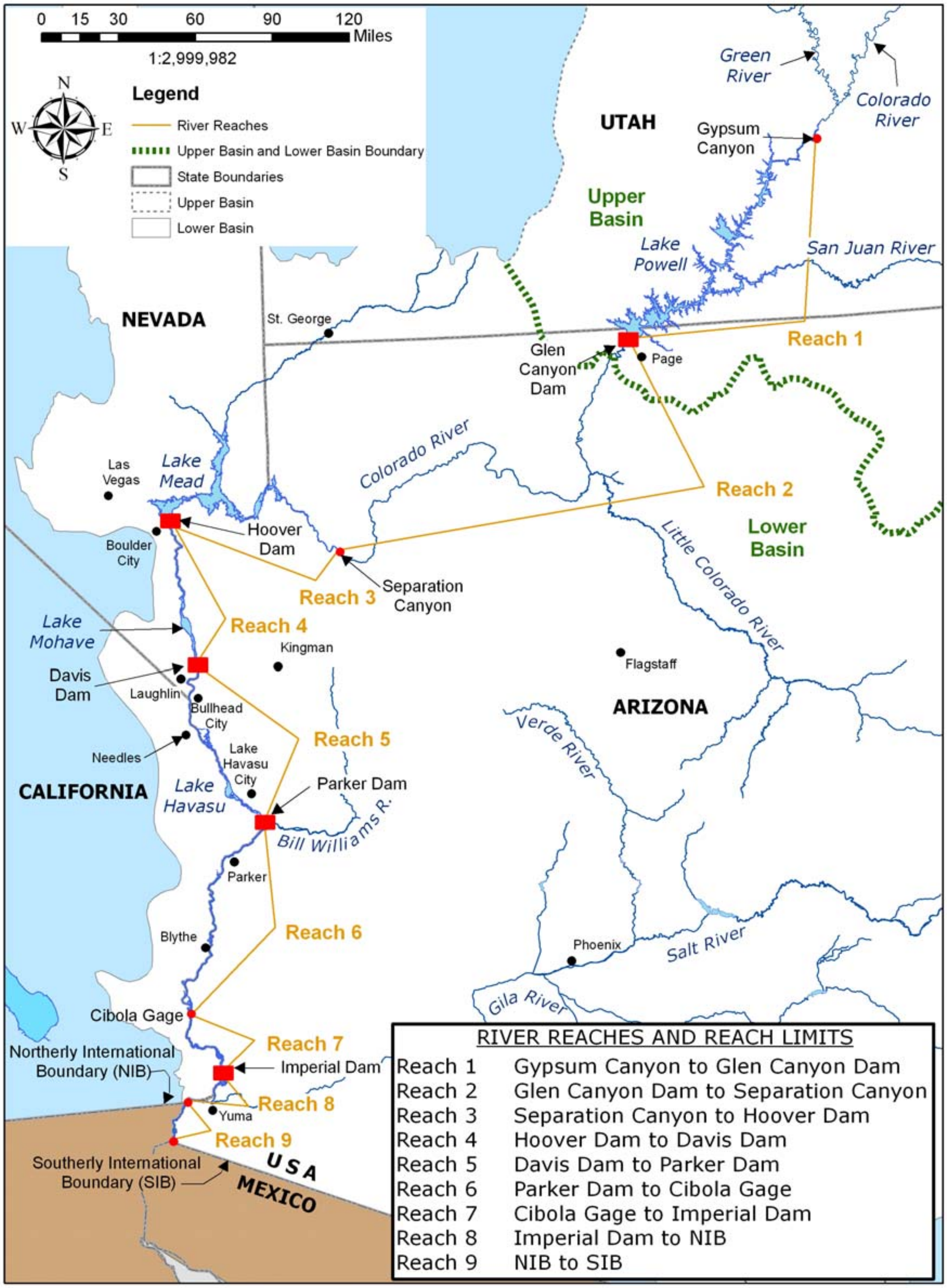
- Arizona water users, particularly the lower priority water users located in the CAP service area;
- The SNWA service area; and
- The MWD service area.

3.2.1 Definition of Colorado River Reaches

The section of the Colorado River extending from Lake Powell to the SIB consists of river reaches, two large reservoirs (Lake Powell and Lake Mead) and two smaller reservoirs located downstream of Lake Mead (Lake Mohave and Lake Havasu, Figure 3.2-2). The Colorado River and adjacent areas (i.e., backwaters and marshes) comprise heterogeneous geographic and hydrologic regimes, which differ in their resource composition and resource management administration.

Figure 3.2-1
Geographic Scope

Figure 3.2-2
Colorado River Reaches



For ease of discussion with respect to affected areas and potential effects, the Colorado River has been divided into the following reaches (Table 3.2-1).

Table 3.2-1
Colorado River Reaches and Reach Limits

Reach	Reach Limits[2]
Lake Powell and Glen Canyon Dam	Gypsum Canyon to Glen Canyon Dam (RM 712.9)
Glen Canyon Dam to Lake Mead	Glen Canyon Dam to Separation Canyon (RM 450.6), *including Grand Canyon National Park*
Lake Mead and Hoover Dam[1]	Separation Canyon (RM 450.6) to Hoover Dam (RM 342.2), *including Lake Mead*
Hoover Dam to Davis Dam[1]	Hoover Dam (RM 342.2) to Davis Dam (RM 276), *including Lake Mohave*
Davis Dam to Parker Dam[1]	Davis Dam (RM 276) to Parker Dam (RM 192.3), *including Lake Havasu*
Parker Dam to Cibola Gage (Adobe Ruin) [1]	Parker Dam (RM 192.3) to Adobe Ruin and Reclamation's Cibola Gage (RM 87.3)
Cibola Gage to Imperial Dam[1]	Reclamation's Cibola Gage (RM 87.3) to Imperial Dam (RM 49.2)
Imperial Dam to Northerly International Boundary (NIB) [1]	Imperial Dam (RM 49.2) to the NIB (RM 23.1)
NIB to SIB[1]	NIB (RM 23.1) to SIB (RM 0.0)

1 These reaches are identical to those described in the LCR MSCP (Reclamation 2004a-e).

2 For purposes of this Final EIS, river miles are numbered along the length of the Colorado River channel south to north starting with RM 0.0 at the SIB with Mexico. Dam locations, other features and reach limits are identified and noted at their respective river miles.

These reaches and their associated issues are discussed briefly below and in more detail in Section 3.3, Hydrologic Resources. Each of the resource discussions is generally organized by river reaches and in some instances the river reaches are combined to better focus the discussion of issues.

3.2.1.1 Lake Powell and Glen Canyon Dam

Lake Powell is the second largest reservoir on the Colorado River and has a total storage capacity of 24.32 maf. It is formed by waters of the Colorado River impounded by Glen Canyon Dam. The reservoir is narrow, over 180 miles in length, and has a shoreline that is over 1,900 miles long. Lake Powell primarily provides water storage for use in meeting the delivery requirements to the Lower Basin consistent with the Law of the River. At the full pool elevation of Lake Powell, this reach includes approximately 25 miles of Cataract Canyon, 50 miles of the San Juan River, and approximately 170 miles of Glen Canyon.

Lake Powell is located within the GCNRA which is administered by NPS. Reclamation retains authority and discretion for the operation of Glen Canyon Dam and Lake Powell. The Navajo Indian Reservation also borders a segment of this river reach. The City of Page, Arizona is also located within this reach and diverts water from Lake Powell.

3.2.1.2 Glen Canyon Dam to Lake Mead

This reach of the Colorado River extends from Glen Canyon Dam to the upper limits of Lake Mead. It is comprised of a narrow river corridor through the last 15 miles of Glen Canyon, Marble Canyon, and Grand Canyon. These canyons are in the GCNRA and Grand Canyon National Park which are administered by NPS. Navajo Indian Reservation and Hualapai Indian Reservation also border segments of this river reach.

3.2.1.3 Lake Mead and Hoover Dam

Lake Mead, formed by Hoover Dam, is the largest reservoir on the Colorado River and has a total storage capacity of 27.38 maf. The reservoir is approximately 115 miles in length and has a shoreline that is over 550 miles long. The reservoir provides water storage to regulate the water supply and meet the delivery requirements of the Lower Division states and Mexico. The reservoir is located within the LMNRA which is administered by NPS. Reclamation retains authority and discretion for the operation of Hoover Dam and Lake Mead.

3.2.1.4 Hoover Dam to SIB

The Colorado River reach from Hoover Dam to the SIB is contained within the shallow Colorado River Valley in which Lake Mohave, Lake Havasu and other smaller diversion reservoirs are located. Under the BCPA and the Consolidated Decree (Chapter 1), releases from Hoover Dam are generally made to meet the downstream water delivery requirements for Arizona, California, Nevada, and Mexico. The northern segment of this river reach, which includes Lake Mohave, lies within the LMNRA, which is administered by NPS. The lower reach is bordered by a combination of federal, Tribal and private land. Lake Havasu State Park is administered by the State of Arizona. Picacho State Recreation Area is administered by the State of California. Refuges managed by FWS include Havasu National Wildlife Refuge (NWR), Bill Williams River NWR, Cibola NWR, and Imperial NWR. Fort Mojave, Chemehuevi, Colorado River Indian, Fort Yuma Indian, and Cocopah Indian Reservations are located along this river reach. The 23.7 mile long reach that extends between the NIB to the SIB also forms part of the international boundary with Mexico.

The individual reaches included between Hoover Dam and the SIB are:

- **Hoover Dam to Davis Dam.** This reach extends from Hoover Dam to Davis Dam and includes Lake Mohave up to its full pool elevation. The approximately 67-mile length of this reach generally comprises Lake Mohave. The reach is bound for most of its length by the steep walls of Pyramid Canyon, El Dorado Canyon, and Black Canyon. Lake Mohave is relatively narrow, not more than four miles across at its widest point. A major feature located within this reach is the Willow Beach National Fish Hatchery which is located on the Colorado River approximately five miles downstream of Hoover Dam. The Willow Beach National Fish Hatchery is managed by FWS and is used as a hatchery and for rearing razorback suckers and bonytail chub which are used for stocking nearby Lake Mohave and Lake Mead.

- **Davis Dam to Parker Dam.** This reach extends from Davis Dam to Parker Dam and includes Lake Havasu up to its full pool elevation. Parker Dam is located approximately 155 miles downstream from Hoover Dam. The upper 39 miles of this reach comprises an open river reach. Lake Havasu, formed by Parker Dam, comprises the lower 45 miles of this reach and can store approximately 0.648 maf of water. At its maximum elevation of 450.5 feet msl, Lake Havasu has a surface area of approximately 20,390 acres.

  Several communities are located adjacent to this reach and include Laughlin, Needles, Bullhead City, and Lake Havasu City. The Fort Mojave and Chemehuevi Indian Reservations are also located within this reach. Other important features located within this reach include Topock Marsh and the Havasu NWR, both managed by FWS. Topock Marsh is located on the Arizona side of the Colorado River midway between Davis Dam and Parker Dam and it is almost entirely within the Havasu NWR. Topock Marsh was created by backwaters resulting from the construction of Parker Dam. The Bill Williams River, a major tributary to the Colorado River, discharges to this reach at a point located just upstream of Parker Dam.

  Lake Havasu provides a forebay and desilting basin from which water is pumped into the Colorado River Aqueduct (California) and the CAP Aqueduct System (Arizona). The pumping plant that pumps water into the Colorado River Aqueduct is located on the west side of the river and operated by the MWD. The pumping plant that pumps water into the CAP Aqueduct System is located on the east side of the river and operated by the Central Arizona Water Conservation District (CAWCD).

- **Parker Dam to Cibola Gage.** This reach is approximately 105 miles long and extends from Parker Dam to Adobe Ruin and Reclamation's Cibola Gage located at RM 87.3. The reach is generally channelized with the greater portion bound by levees. Several features located downstream of Parker Dam are also used to manage the flows in the river and make deliveries to the Colorado River water users that divert water downstream of Parker Dam. These features include Palo Verde Diversion Dam and Headgate Rock Dam. Lake Moovalya, the reservoir impounded by Headgate Rock Dam, is located between Parker Dam and Headgate Rock Dam. Several communities are located adjacent to this reach and include the cities of Parker, Arizona and Blythe, California. The Colorado River Indian Reservation is also located within this reach, as is the Cibola NWR.

- **Cibola Gage to Imperial Dam.** This reach is approximately 38 miles long and extends from Cibola Gage to Imperial Dam. The major features located within this reach include Senator Wash Dam, Martinez Lake, Imperial NWR, and Imperial Dam. Senator Wash Dam and Regulating Reservoir are located approximately two miles upstream of Imperial Dam on the California side of the Colorado River. This is an off-stream water storage reservoir that is used by Reclamation to facilitate water scheduling and to help in balancing the river flows and supply with demands. Imperial Dam and the impoundment that it forms upstream of the dam raises the water surface of the river flows by approximately 25 feet to provide controlled gravity flow of water into the AAC and the Gila Gravity Main Canal. The AAC system diverts water from the California side of Imperial Dam and serves the Imperial Irrigation District (IID), the Coachella Valley Water District (CVWD), the Yuma Project in Arizona and California, and the City of Yuma. The Gila Gravity Main Canal system diverts water from the Arizona side of Imperial Dam and serves the north and south Gila Valley, Yuma Mesa, and Wellton-Mohawk area. Imperial Dam is also used to regulate deliveries to Mexico. The AAC Desilting Works, which is located adjacent to the AAC diversion structure, is used to remove most of the sediment carried by the Colorado River prior to the water entering the AAC. The Imperial NWR is located mostly on the Arizona side of the Colorado River. Martinez Lake is a small water cove formed by the impoundment and backwater located upstream of Imperial Dam.

- **Imperial Dam to NIB.** This reach extends from Imperial Dam to the NIB between the United States and Mexico. The entire extent of the channel within this reach is bound by a system of levees. Several features located downstream of Imperial Dam are also used to manage river flows and make deliveries to the Colorado River water users that divert water downstream of Imperial Dam. These features include Laguna Dam, Laguna Desilting Basin, Morelos Diversion Dam, California Wasteway, and Pilot Knob Wasteway. Other features include water conveyance system components (levees, bypass channels, wasteways, etc.), access roads, farmlands, and vegetation. Mittry Lake is also located on the Arizona side of the Colorado River. The Gila River, a major tributary of the Colorado River, also discharges to the river at a point located approximately nine miles downstream of Laguna Dam.

  Laguna Dam is located on the Colorado River some five miles downstream of Imperial Dam. The original purpose of this dam was to divert Colorado River water to the Yuma Project area. Laguna Dam now serves as a regulating structure for Colorado River water, for regulating sluicing flows from Imperial Dam, and for downstream toe protection for Imperial Dam. The reservoir created by Laguna Dam is commonly referred to as Laguna Reservoir.

Mittry Lake is located on the east side of the Colorado River between Laguna Dam and Imperial Dam. The Mittry Lake Wildlife Area generally surrounds and includes Mittry Lake and includes approximately 600 acres of water surface and 2,400 acres of marsh or upland habitat. Numerous serpentine waterways connect to the main lake body. The Mittry Lake Wildlife Area is jointly managed by BLM, Reclamation, and the Arizona Game and Fish Department.

The California Wasteway of the Yuma Main Canal is located approximately four miles downstream of the mouth of the Gila River. This wasteway returns to the river the water which is used to fulfill the 1944 Treaty obligation to Mexico. The Rockwood Heading, an old intake structure on the Alamo Canal, is located approximately two miles upstream of Morelos Diversion Dam. It is no longer used for an intake structure but it is used as a point of return for the Pilot Knob Powerplant and Wasteway from the AAC. Under normal operating procedures, a portion of the water scheduled to be delivered to Mexico is diverted at Imperial Dam, conveyed via the AAC, and then returned to the Colorado River through the California and Pilot Knob waterways.

- **NIB to SIB.** This reach extends from the NIB to the SIB and it is 23.7 miles long. This section of the Colorado River, referred to as the limitrophe section, serves as the international boundary between the United States and Mexico, and has levees on both sides.

  Located approximately 1.1 miles downstream of the NIB is Morelos Diversion Dam. This dam functions as a diversion control structure for the Alamo Canal, which conveys water to Mexico. The Morelos Diversion Dam and the limitrophe section of the Colorado River channel, including the floodplain, are designed to handle a maximum flow of 140,000 cubic feet per second (cfs). Other major features located within this reach include water conveyance system components (levee, bypass channel, wasteways, etc.) and access roads.

3.2.2 Colorado River Water User Service Areas

In addition to the mainstream river reaches and potentially affected service areas of mainstream water users, certain off stream service areas of Colorado River water users may be affected as a result of water management programs associated with the proposed federal action. These potential effects correspond to the following agency water service areas.

3.2.2.1 Arizona Water Users, Central Arizona Project Service Area

The largest Arizona diversion of water is the CAP, which delivers water to contractors in the central part of the state. CAP's diversion is located at Lake Havasu. The CAWCD administers the CAP water diversions. The CAP has more than 80 customers that generally fall within three classifications of CAP users: municipal (e.g., cities such as Phoenix, Mesa, and Scottsdale), agricultural (irrigation districts such as the Maricopa-Stanfield Irrigation District), and Indian communities (12 tribes with Colorado River water allocations within Arizona). Figure 3.2-3 presents the general service area of the CAP, and Table 3.2-2 provides a listing of the CAP water users.

Figure 3.2-3
CAP Service Area

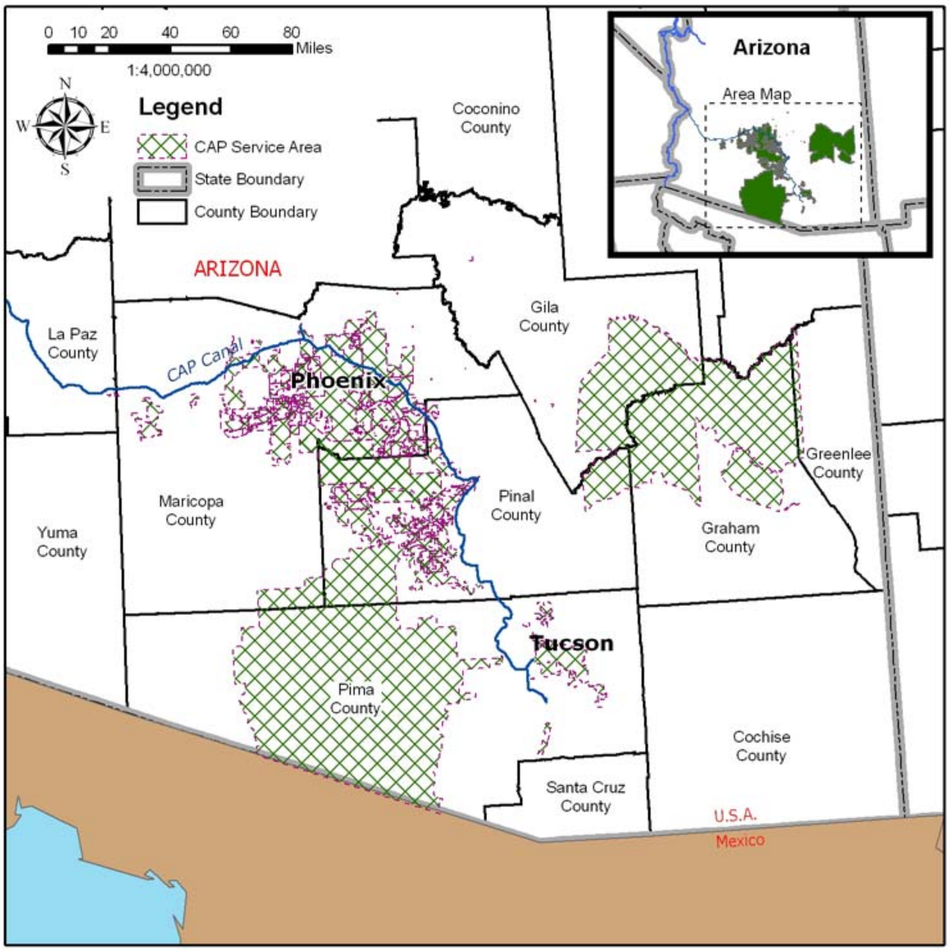


Table 3.2-2
CAP Water Users

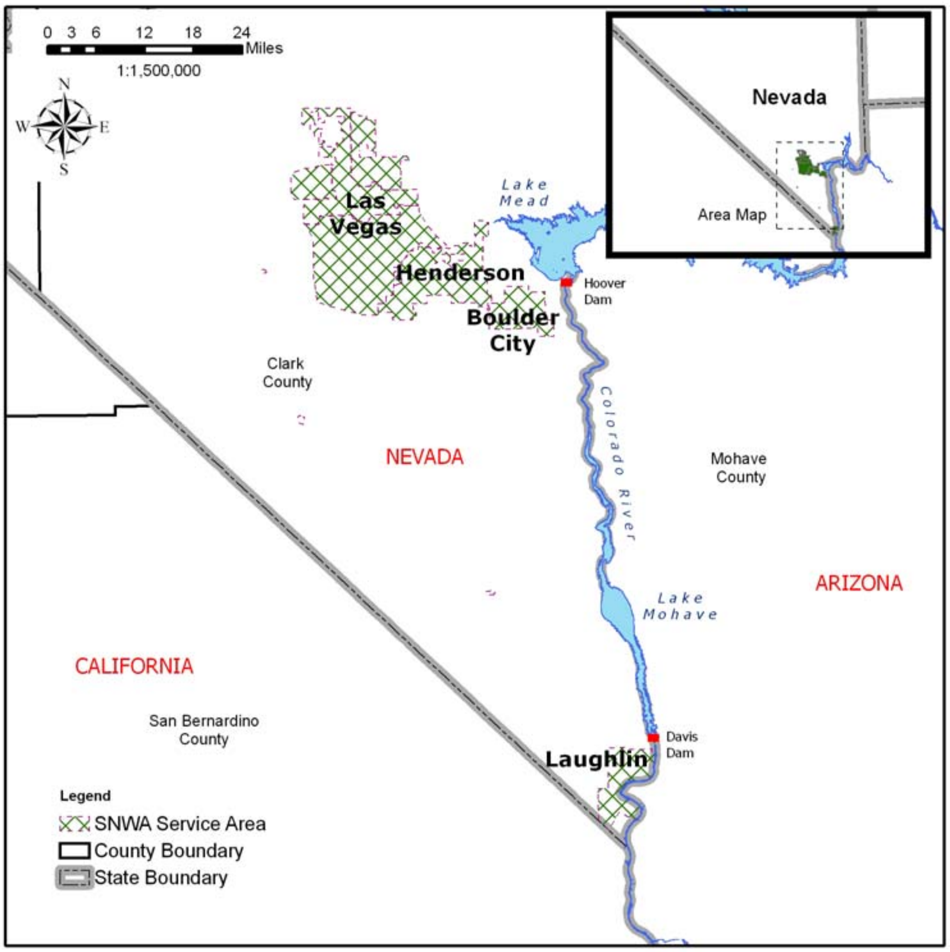
Ak-Chin Indian Community	Eloy	Salt River Pima-Maricopa Indian Community
Apache Junction (AZ Water Co)	Florence	San Carlos (Phelps Dodge/Globe)
ASARCO (Ray Mine)	Flowing Wells ID	San Carlos Apache Tribe
Avondale	Fort McDowell Yavapai Nation	San Tan ID
Avra Coop	Gila River Indian Community	Scottsdale
AZ State Land Dept.	Gilbert	Spanish Trail Water Co
AZ-American (Agua Fria)	Glendale	Superior
AZ-American (Paradise Valley)	Goodyear	Surprise
AZ-American (Sun City West)	Green Valley DWID	Tempe
AZ-American (Sun City)	H2O Water Co	Tohono O'odham Nation Chui Chu District
Berneil Water Co (Cave Creek)	Marana	Tohono O'odham Nation San Xavier District
Buckeye	Maricopa County Parks & Rec	Tohono O'odham Nation Schuk Toak District
CAGRD	MDWID	Tonto Apache Tribe
Carefree Water Co	Mesa	Tonto Hills Utility Co
Casa Grande (AZ Water Co)	Oro Valley	Tucson
Cave Creek Water Co	Pascua Yaqui Tribe	Unallocated HVID
Chandler Heights Citrus ID	Peoria	Vail Water Co
Chandler	Phelps Dodge Miami	Valley Utilities Water Co
Chaparral City Water Co	Phoenix Memorial Park	Water Util. Comm. Fac. Dist. (AJ)
Circle City Water Co	Phoenix	Water Util. Greater Buckeye
Comm. Water Co (Green Valley)	Pine Water Co	Water Util. Greater Tonopah
Coolidge (AZ Water Co)	Queen Creek Water Co	White Tank Sys. (AZ Water Co.)
El Mirage	Rio Verde Utilities	Yavapai-Apache Nation (Camp Verde)
		Yavapai-Prescott Tribe

AZ; Arizona
ID; Irrigation District

3.2.2.2 Southern Nevada Water Authority Service Area

Most of the Colorado River water use in Nevada occurs in the southern portion of Nevada, primarily within the Las Vegas Valley and the Laughlin area approximately 60 miles south. The largest diversion is associated with the Las Vegas Valley water users who pump water from Lake Mead at Saddle Island (on the west shore of the lake's Boulder Basin) through facilities of SNWA. SNWA is a wholesale water purveyor whose member agencies are: Big Bend Water District, Boulder City, Clark County Water Reclamation District, Henderson, Las Vegas, Las Vegas Valley Water District, and North Las Vegas (Figure 3.2-4).

Figure 3.2-4
SNWA Service Area

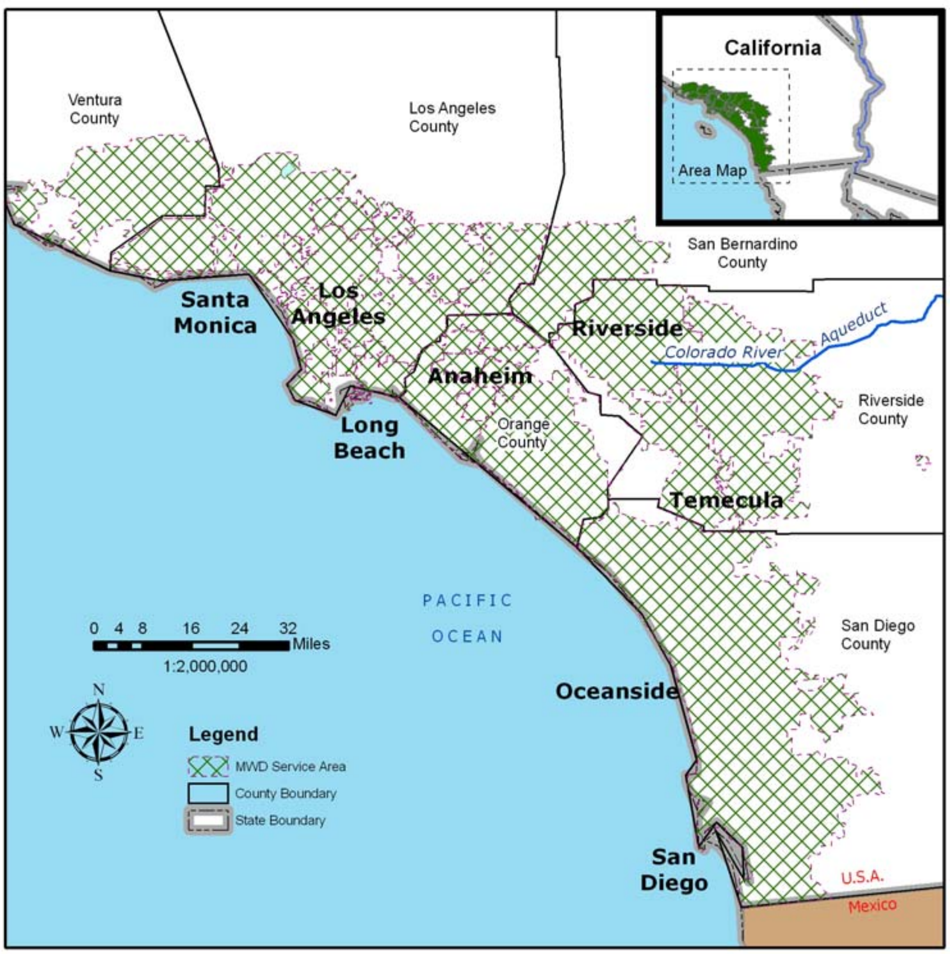


3.2.2.3 Metropolitan Water District of Southern California Service Area

MWD is a wholesale water agency that develops, stores, and distributes water to its member agencies. MWD owns and operates the Colorado River Aqueduct, which it uses to convey water from the Colorado River to its service area. MWD's Colorado River Aqueduct diversion is located at Lake Havasu.

MWD's service area covers the Southern California coastal plain. The total area served is nearly 5,200 square miles, and it includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties. MWD is currently composed of 26 member agencies, including 14 cities, 11 municipal water districts, and one county water authority. Figure 3.2-5 shows the member agencies of MWD and the cities and communities served by those member agencies.

Figure 3.2-5
MWD Service Area



3.3 Hydrologic Resources

Hydrologic resources within the study area that could potentially be affected by implementation of the proposed federal action include:

- reservoir storage, reservoir releases, and corresponding changes in Colorado River flows downstream of the reservoirs; and
- groundwater located within the Colorado River corridor and/or off-stream.

This section presents an overview of the hydrology of the Colorado River Basin, followed by descriptions of potentially affected hydrologic resources by river reach, from Lake Powell to the SIB.

A detailed description of the system facilities and current operations is provided in Appendix B. Water supply and water quality resources are discussed in Section 3.4 and Section 3.5, respectively.

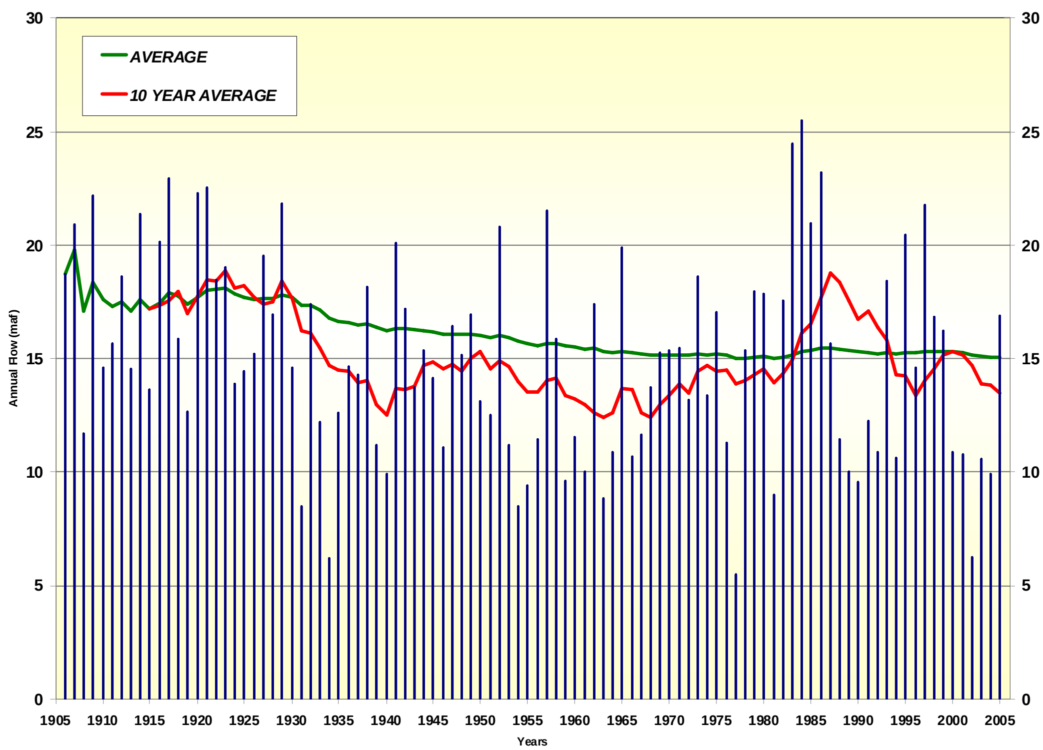
3.3.1 Hydrologic Overview

Inflows into Lake Powell originate from the mainstream of the Colorado River, Green River, and San Juan River. Although most of the Colorado River Basin is comprised of desert or semi-arid rangelands, which generally receive less than ten inches of precipitation per year, many of the mountainous areas that rim the Upper Basin receive, on average, over 40 inches of precipitation per year. Most of the total annual flow in the Colorado River Basin is the result of runoff from mountain snowmelt. As such, river flows are typically very high in the late spring and early summer and diminish rapidly by mid-summer. While flows in late summer through autumn sometimes increase following rain events, flow in the late summer through winter is generally low.

Due to variability in climatic conditions, natural flow in the Colorado River Basin is highly variable from year to year. Natural flow is an estimate of the flow that would exist at a specific point in a natural setting, without upstream storage, alteration or depletion by humans. About 92 percent of the total natural flow in the lower Colorado River originates in only 15 percent of the watershed in the mountains of Colorado, New Mexico, Utah, and Wyoming. While the average annual natural flow from 1906 through 2005 at Lees Ferry Gaging Station in Arizona is currently calculated as approximately 15.072 maf, annual flows have ranged between 5.399 maf and 25.432 maf.

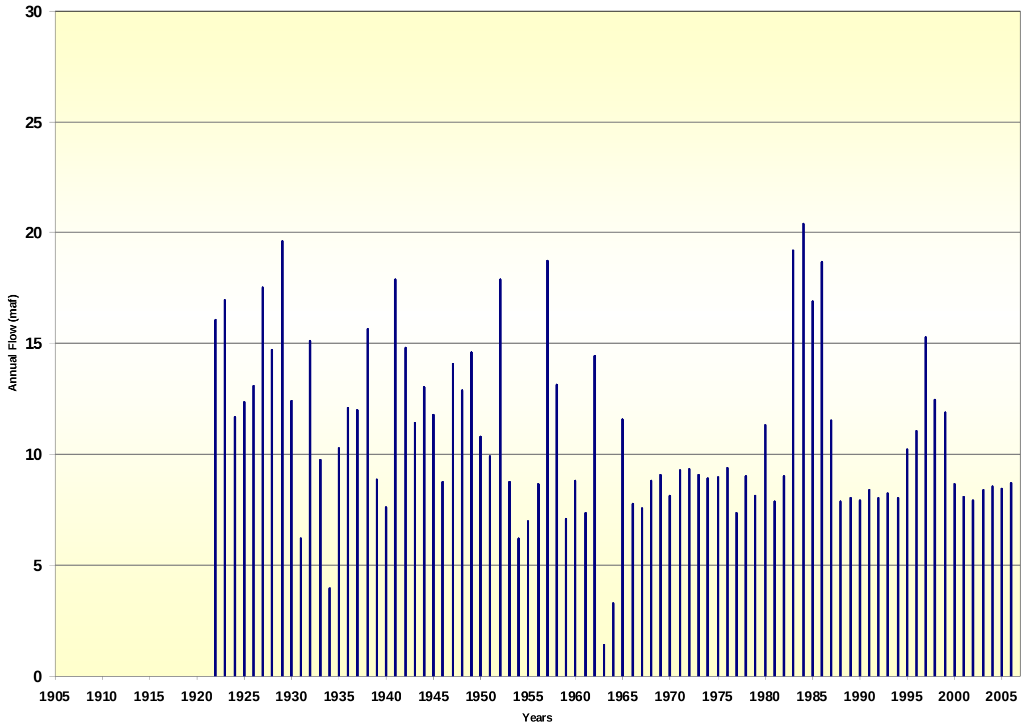
The natural flow calculated at Lees Ferry Gaging Station from 1906 through 2005 is shown in Figure 3.3-1. By comparison, the observed flows recorded at Lees Ferry Gaging Station for the period 1922 through 2005 are shown in Figure 3.3-2. The natural flow has been calculated from the observed flow by correcting for upstream reservoir changes in storage and release, losses including evaporation, as well as depletions due to agriculture and domestic uses (Reclamation 2005b). The natural flow record at Lees Ferry Gaging Station has also been extended from 1922 back to 1906 by using other observed records (Lee et al. 2006).

Figure 3.3-1
Natural Flow of the Colorado River at Lees Ferry Gaging Station, Arizona
1906 through 2005



Provisional data, subject to change.

Figure 3.3-2
Historic Annual Flow of the Colorado River at Lees Ferry Gaging Station, Arizona
1922 through 2005



Data from Upper Colorado Hydrologic Database

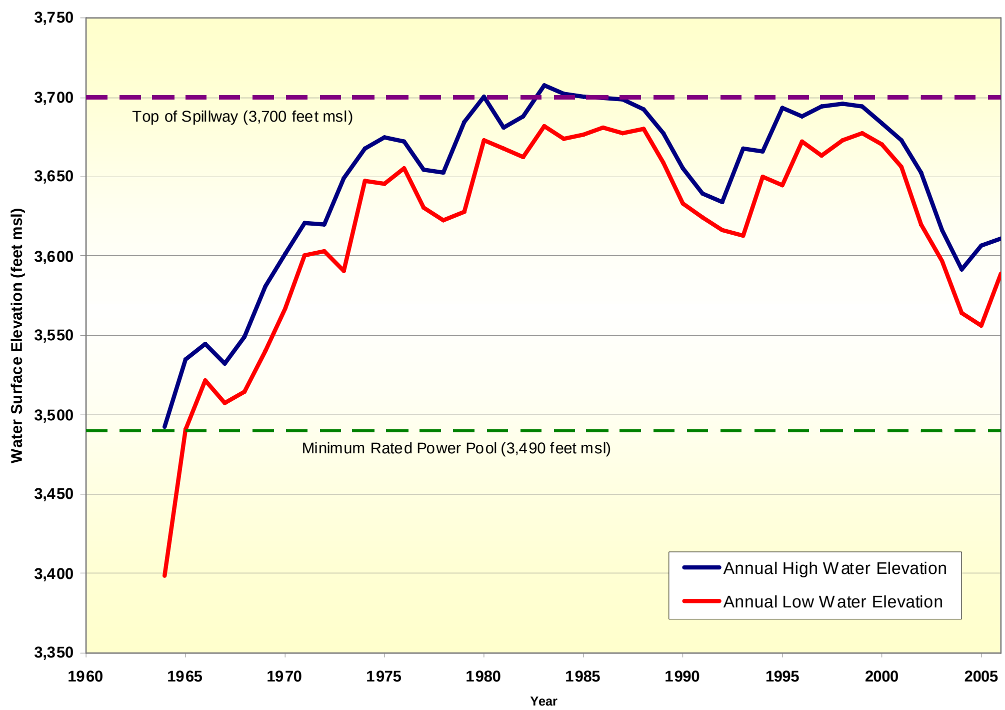
3.3.2 Lake Powell and Glen Canyon Dam

Lake Powell is the reservoir impounded by Glen Canyon Dam. Glen Canyon Dam and Lake Powell are operated consistent with the Colorado River Storage Project Act, the authorizing legislation, which states that the purpose of the project is … "to initiate the comprehensive development of the water resources of the Upper Colorado River Basin, for the purposes, among others, of regulating the flow of the Colorado River, storing water for beneficial consumptive use, making it possible for the States of the Upper Basin to utilize, consistently with the provisions of the Colorado River Compact, the apportionments made to and among them in the Colorado River Compact and the Upper Colorado River Basin Compact, respectively, providing for the reclamation of arid and semiarid land, for the control of floods, and for the generation of hydroelectric power, as an incident of the foregoing purposes … "Additionally, some water deliveries are made directly from Lake Powell (e.g., for the City of Page, Arizona and for the Navajo Generating Station's cooling water).

The operating range of Lake Powell is between elevations 3,490 feet msl and 3,700 feet msl. Elevation 3,490 feet msl corresponds to the minimum power pool. Releases from Glen Canyon Dam can be made below elevation 3,490 feet msl down to elevation 3,370 feet msl through the river bypass tubes. Elevation 3,700 feet msl corresponds to the top of the spillway radial gates, with the crest of each spillway at elevation 3,648 feet msl. The crest of Glen Canyon Dam itself is at elevation 3,715 feet msl.

Lake Powell began filling in 1963 and reached a high elevation of 3,708.34 feet msl in 1983. The elevation of the reservoir has ranged from approximately 3,400 feet msl in 1964 to the 1983 maximum high of 3,708.34 feet msl, as illustrated in Figure 3.3-3. The fluctuations in Lake Powell elevations are primarily the result of the highly variable hydrologic inflows into Upper Basin as discussed in Section 1.7.

Figure 3.3-3
Historic Annual Lake Powell Elevations
(Annual Highs and Lows)



Under the proposed federal action, future elevations of Lake Powell are expected to be within the range of historic reservoir elevations. However, the length of time that the reservoir may be at any given elevation in the future may be affected by the proposed federal action. These potential effects are analyzed and discussed in Section 4.3.

Releases from Glen Canyon Dam are scheduled on an annual, monthly and hourly basis. The annual volume of water released from Glen Canyon Dam is made according to the provisions of the LROC that includes a minimum objective release of 8.23 maf, storage equalization between Lake Powell and Lake Mead under prescribed conditions, and the avoidance of spills. Annual releases from Lake Powell greater than the minimum objective release occur if Upper Basin storage is greater than the storage required by Section 602(a) of the CRBPA, if storage in Lake Powell is greater than the storage in Lake Mead, and to avoid anticipated spills (Appendix A).

Monthly release decisions are generally made to meet intermediate targets needed to systematically achieve the annual operating requirements, comply with the coordinated operation requirements of the CRBPA, and provide other authorized project benefits. The actual volume of water released from Lake Powell each month depends on the inflow forecast, storage targets, and annual release requirements described above. Demand for energy is also considered and accommodated within the constraints described above.

Glen Canyon Dam is operated consistent with the 1996 Glen Canyon Dam ROD (62 Fed. Reg. 9447-9448) developed as directed under the Grand Canyon Protection Act of 1992. The 1996 Glen Canyon Dam ROD describes criteria to ensure that Glen Canyon Dam is operated in a manner consistent with the Grand Canyon Protection Act of 1992. The daily and hourly release constraints of Glen Canyon Dam are as presented in Table 3.3-1.

Table 3.3-1
Glen Canyon Dam Release Constraints

Parameter	Release Volume (cfs)	Conditions
Maximum Flow[1]	25,000	
Minimum Flow	5,000	Nighttime
	8,000	7:00 a.m. to 7:00 p.m.
Ramp Rates		
Ascending	4,000	Per hour
Descending	1,500	Per hour
Daily Fluctuations[2]	5,000 to 8,000	

1 May be exceeded for emergency and during extreme hydrological conditions.

2 Daily fluctuation limit is 5,000 cfs for months with release volumes less than 0.6 maf; 6,000 cfs for monthly release volumes of 0.6 maf to 0.8 maf; and 8,000 cfs for monthly volumes over 0.8 maf.

Pending the outcome of the Long-Term Experimental Plan (Section 5.2), future daily and hourly releases are expected to continue to be made according to the parameters of the 1996 Glen Canyon Dam ROD and will not be affected by the proposed federal action. However, the annual release as well as the monthly distribution of releases may be affected; these potential effects are analyzed and discussed in Section 4.3.

In addition to the daily and hourly release constraints discussed above, the 1996 Glen Canyon Dam ROD implemented an Adaptive Management Program that provides a process for assessing the effects of Glen Canyon Dam operations on downstream resources, and by using the results to develop recommendations to the Secretary with regard to Glen Canyon Dam operations and other resource management actions. These recommendations have included releases for sediment conservation (i.e., BHBF), modification of powerplant fluctuations, non-native fish removal, and native fish translocation. Recommendations are developed by the AMWG, a federal advisory committee. Long-term monitoring and research activities provide a continuous record of resource conditions for use in evaluating the effectiveness of any experimental and management actions.

3.3.3 Glen Canyon Dam to Lake Mead

The Colorado River reach between Glen Canyon Dam and Lake Mead is a narrow river corridor through Marble Canyon, Glen Canyon, and Grand Canyon. The flows in this river reach are primarily from controlled Glen Canyon Dam releases (Lake Powell) with contributions from tributaries between Glen Canyon Dam and Lake Mead. Releases from Glen Canyon Dam are managed as discussed in the previous section.

The Paria River and Little Colorado River are the major tributaries that discharge to the Colorado River within this reach. The Paria River is a perennial stream which also provides the principal drainage for the Painted Desert. The Little Colorado River is also a perennial stream and it drains the rugged and arid region southeast of the Colorado River.

Inflows from these two tributaries are variable and on average provide less than 3 percent of the total flow in this reach. For the 100-year period from 1906 through 2005, annual inflow from the Little Colorado River ranged from 17 kaf to 643 kaf and averaged 180 kafy. During this same period, annual inflow from the Paria River ranged from 9 kaf to 48 kaf and averaged 21 kafy. By contrast, the annual Glen Canyon Dam releases from 1996 through 2005 ranged from 7,795 kaf to 15,289 kaf and averaged 9,975 kafy. The daily and hourly releases from Glen Canyon Dam and therefore the daily and hourly flows in this reach will not be affected by the proposed federal action. However, the monthly and annual flows in this reach may be affected; these potential effects are analyzed and discussed in Section 4.3.

Groundwater in hydraulic connection with the Colorado River in Grand Canyon is limited to sandbars. Due to the incised nature of this river corridor, there are no anticipated groundwater related issues that need to be considered.

3.3.4 Lake Mead and Hoover Dam

Lake Mead is the reservoir impounded by Hoover Dam and in accordance with the BCPA, is operated to meet the following priorities:

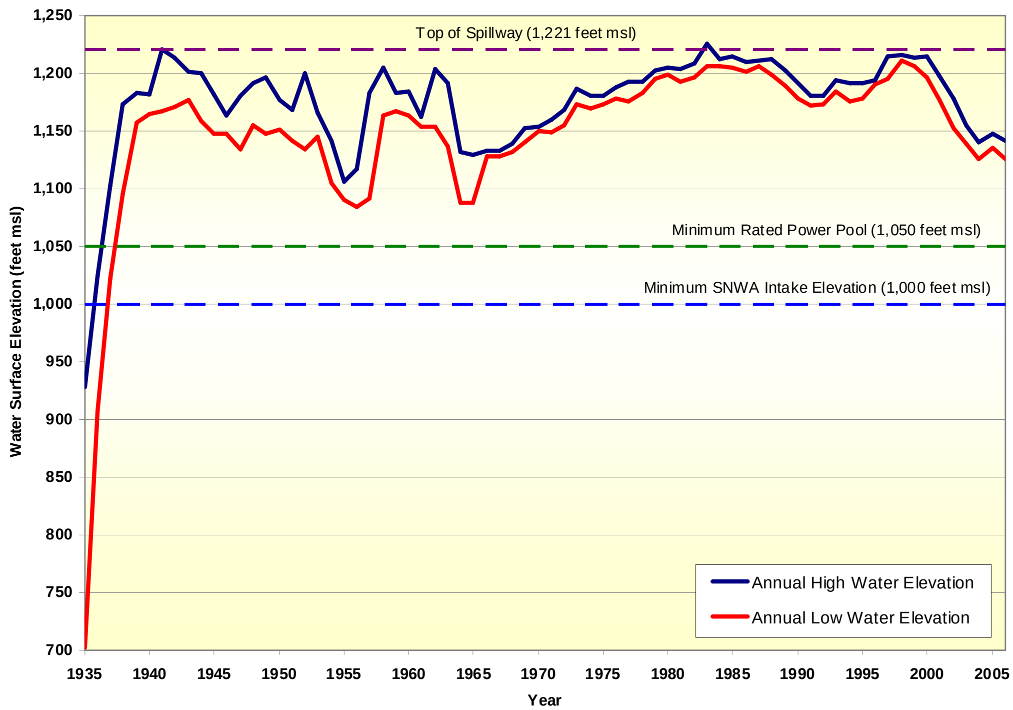
1) to provide river regulation, improvement of navigation, and flood control;

2) to provide water to meet irrigation and domestic uses, including the satisfaction of PPRs; and

3) to generate hydroelectric power.

The typical operating range of Lake Mead is between elevations 1,219.6 feet msl and 1,050 feet msl. Elevation 1,050 feet msl corresponds to the minimum power pool. Releases through the turbines can be made from Hoover Dam below elevation 1,050 feet msl down to elevation 895 feet msl through the intake towers, although the turbines currently in place would require modification or replacement to consistently generate hydroelectric power below elevation 1,050 feet msl. The crest of the spillways is at elevation 1,205.4 feet msl and the top of the raised spillway gates is at elevation 1,221.0 feet msl. The storage space above elevation 1,219.6 feet msl is reserved exclusively for flood control purposes. Since its initial filling in the late 1930s, Lake Mead elevations have fluctuated from a high of 1,225.8 feet msl in July 1983 to a low of 1,083.2 feet msl in April 1956, as illustrated in Figure 3.3-4.

Figure 3.3-4
Historic Annual Lake Mead Elevations
(Annual Highs and Lows)



Future Lake Mead elevations may be affected by the proposed federal action. These potential effects are analyzed and discussed in Section 4.3.

Lake Mead's annual release is determined either by strict flood control regulations or to meet water use apportionments to the Lower Division states and allotment to Mexico.

The USACE is responsible for developing the flood control operation plan for Hoover Dam and Lake Mead (33 C.F.R. pt. 208.11) and the Secretary is responsible for operating Hoover Dam in accordance with these regulations. The current regulations were implemented under the Field Working Agreement[1] which set forth criteria to meet system space requirements from August through December and to determine reservoir releases from January through July. During all months of the year, the top 1.5 maf of space (the space above elevation 1,219.6 feet msl) is reserved exclusively for flood control purposes. Lake Mead is considered to be under flood control operations when the regulations determine that releases need to be made in excess of those necessary to meet water use demands in order to make available this flood control space.

Water use demands are determined by the apportionments to each Lower Division state and Mexico. For the Lower Division states, the Secretary determines the water supply condition for each year (Surplus, Normal, or Shortage), as specified by the Consolidated Decree and the LROC. Under a Normal Condition, water is delivered to meet a total of 7.5 maf of use by the Lower Division states. Under a Surplus Condition, additional water can be made available for consumptive use in the Lower Division states. Adopted in 2001 and extending through 2016, the ISG provide additional guidance on the amount and use of surplus water depending upon Lake Mead's elevation and other factors. Under a Shortage Condition, an amount of water less than 7.5 maf would be made available for use by the Lower Division states. However, there are currently no guidelines with regard to when and by how much water supplies would be reduced (Section 1.3).

In addition to the releases made to meet the Lower Division states' consumptive use, releases are made from Hoover Dam to meet Mexico's water delivery schedule. In accordance with the 1944 Treaty, Mexico can schedule a total delivery of 1.5 maf each year and under current practice, up to an additional 200 kaf during flood control years when water supply exceeds the needs of Colorado River water users in the United States.

During non-flood control operations, the end-of-month Lake Mead elevations are driven by water needs pumped from and delivered downstream of Hoover Dam, releases from Glen Canyon Dam, and tributary inflows. Lake Mead end-of-month target elevations are not fixed as are the end-of-month target elevations for Lake Mohave and Lake Havasu. Normally, Lake Mead elevations decline with increasing irrigation deliveries through June and July and then rise slightly by November and December.

Hoover Dam releases are managed on an hourly basis to maximize the value of generated power by providing peaking during high-demand periods. The monthly release is determined

[1] Field Working Agreement between Reclamation and USACE for Flood Control Operation of Hoover Dam and Lake Mead, Colorado River, Nevada and Arizona, dated February 8, 1984 as prescribed by the Water Control Manual of December 1982.

based on water demands and is converted to a monthly energy target. Hoover Powerplant is run on a real-time basis to meet fluctuating energy and capacity demands while meeting the end-of-month energy target. This results in fluctuating hourly flows below Hoover Dam that can typically vary from 1,000 cfs to 49,000 cfs. However, these flows are regulated by Lake Mohave immediately downstream. For the 10-year period from 1996 through 2005, annual Hoover Dam releases ranged from 8.275 maf to 12.776 maf and averaged 10.380 mafy.

Hourly and daily releases from Hoover Dam will not be affected by the proposed federal action. However, the proposed federal action may alter the annual release as well as the monthly distribution of those releases. These potential effects are analyzed and discussed in Section 4.3.

3.3.5 Hoover Dam to Davis Dam

The 67-mile reach from Hoover Dam to Davis Dam is dominated by Lake Mohave, the reservoir formed by Davis Dam. The upper part of this reach is bounded by the steep walls of Pyramid Canyon, El Dorado Canyon, and Black Canyon. Lake Mohave is relatively narrow, not more than four miles across at its widest point. At the high reservoir elevations (635 feet msl), the backwater from Lake Mohave affects the river stage (known as the tailbay) just downstream of Hoover Dam. Although there are some minor side washes in this river reach, the flows in this reach are comprised almost entirely of releases from Hoover Dam.

The hourly and daily operation of Hoover Dam will not be affected by the proposed federal action. As such, the hourly and daily flows through this river reach will also not be affected.

Although the annual and monthly releases from Hoover Dam may be affected by the proposed federal action, Lake Mohave will continue to be operated to meet monthly target elevations as explained in Appendix B. Lake Mohave generally reaches its maximum elevation in the spring and its minimum elevation in the fall. Reclamation generally lowers the lake elevation in the fall to provide flood control storage space for runoff that results from large hurricane-type storms coming up-river from Baja California, Mexico. The minimum elevation of Lake Mohave under future conditions will continue to be about 630 feet msl. The maximum target elevation will continue to be 646.5 feet msl. Therefore, the proposed federal action will not change the range of elevations that have been historically observed in Lake Mohave. Combined with the extent of this reach occupied by Lake Mohave, the potential changes in Hoover Dam monthly and annual releases will have no effect on this reach.

The upper section of this reach is the narrow Black Canyon immediately below Hoover Dam. Groundwater connected to the river in this bedrock canyon is limited to a few small sandbars. The rest of this reach is dominated by Lake Mohave. The proposed federal action will have no effect on the operation of Lake Mohave or the elevations in this reservoir. Therefore, there are no anticipated effects of the proposed federal action to these groundwater basins.

3.3.6 Davis Dam to Parker Dam

This reach is approximately 84 miles long and it is bounded downstream by Parker Dam which forms Lake Havasu. Lake Havasu provides a forebay and desilting basin from which water is pumped into aqueducts for delivery to the MWD and CAP service areas. Above Lake Havasu, there are some minor tributaries. However, the flows in this reach are comprised almost entirely of releases from Davis Dam.

The largest tributary in this reach is the Bill Williams River, which flows directly into Lake Havasu. Inflows from the Bill Williams River are regulated by USACE operations of Alamo Dam upstream and are typically small (on the order of 50 cfs). Larger flows from Bill Williams River are concentrated over short periods of time and are due to flood control operations at Alamo Dam. For the 100-year period from 1906 through 2005, the annual inflow to the Colorado River mainstream from the Bill Williams River ranged from 1.3 kaf to 702 kaf and averaged 102 kafy. By contrast, during the 10-year period from 1996 through 2005, annual releases from Davis Dam ranged from 8,000 kaf to 12,587 kaf and averaged approximately 10,092 kafy.

Releases from Davis Dam are scheduled on a daily and hourly basis, primarily to meet downstream water needs, although the hourly release pattern is typically shaped to meet demand for power. Releases can range from a maximum of 28,000 cfs to a minimum of about 1,000 cfs, the minimum flow needed to run one turbine at about one-half capacity. Such low flows are usually associated with downstream flooding, construction, search and rescue, or other emergency conditions.

The range of hourly releases from Davis Dam and the corresponding range of flows in this river reach will not be affected by the proposed federal action. However, the shape and duration of hourly flows and the corresponding daily, monthly, and annual flows may be affected; these potential effects are analyzed and discussed in Section 4.3.

Although releases from Davis Dam may be affected by the proposed federal action, Lake Havasu will continue to be operated to meet monthly target elevations as explained in Appendix B.

Lake Havasu generally reaches its maximum elevation in the spring and its minimum elevation in the winter. Similar to Lake Mohave, Reclamation generally lowers the lake elevation during the winter months to provide flood control storage space for runoff that results from large storms coming up-river from Baja California, Mexico. The minimum elevation of Lake Havasu under future conditions will continue to be about 445.8 feet msl. Reclamation attempts to accommodate this minimum target elevation when other higher priority uses are not compromised. The maximum target elevation will continue to be 450.5 feet msl. Therefore, the proposed federal action will not affect the range of historically observed Lake Havasu elevations.

The Davis Dam to Parker Dam reach of the Colorado River flows through two separate groundwater basins. The bedrock Topock Narrows separates the Mohave Valley to the north of the narrows from the Chemehuevi Valley to the south. On the Arizona side, the valley south of Topock Narrows is called the Lake Havasu basin.

The aquifer in Mohave Valley is mostly alluvial fill deposited by both the Colorado River and the washes draining to the river from the mountains bounding the valley, and may be affected by the proposed federal action. The potential effects due to the potential change in river flows in this segment of this river reach are analyzed and discussed in Section 4.3.

The portion of the Colorado River reach that is located within the Chemehuevi Valley and the Lake Havasu basin is dominated by Lake Havasu. As noted above, the proposed federal action will have no effect on the operation of Lake Havasu or the elevations in this reservoir. Therefore, there are no anticipated effects of the proposed federal action to the groundwater basins underlying the Chemehuevi Valley and the Lake Havasu basin.

3.3.7 Parker Dam to Cibola Gage

This reach is approximately 105 miles long and it is bounded by Reclamation's Cibola Gage at RM 87.3 downstream. Although there are some minor drainages, flows in this reach are almost entirely comprised of releases from Parker Dam to meet water delivery requirements in the United States and Mexico.

Similar to Davis Dam, releases from Parker Dam are scheduled on a daily and hourly basis, primarily to meet downstream water needs, although the hourly release pattern is typically shaped to meet demand for power. Releases can range from a maximum of 16,800 cfs to a minimum of about 1,000 cfs, the minimum flow needed to run one turbine at about one-half capacity. Such low flows are usually associated with downstream flooding, construction, search and rescue, or other emergency conditions. For the 10-year period from 1996 through 2005, annual Parker Dam releases have ranged from 6.185 maf to 10.344 maf and averaged 7.578 mafy.

The ranges of hourly releases from Parker Dam and the corresponding ranges of flows in this river reach will not be affected by the proposed federal action. However, the shape and duration of hourly flows and the corresponding daily, monthly, and annual flows may be affected; these potential effects are analyzed and discussed in Section 4.3.

Impoundments associated with the two major diversion dams located in this reach (Headgate Rock Dam, used to divert water for use by the Colorado River Indian tribes, and Palo Verde Diversion Dam, used to divert water for use by the Palo Verde Irrigation District) are operated at nearly constant elevations in order to facilitate the diversion of water. These facilities will continue to be operated in this same manner and, therefore, the elevations of these impoundments will not be affected by the proposed federal action. However, releases from the diversion dams may be affected. These potential effects are analyzed and discussed in Section 4.3.

The Colorado River reach from Parker Dam to Cibola Gage flows through one very large groundwater basin but it is typically referred to by separate valley names (Parker Valley, Cibola Valley, and Palo Verde Valley). The aquifer underlying these valleys is mostly alluvial fill deposited by the Colorado River and secondarily by the washes draining to the Colorado River from the mountains bounding the valleys. The potential effects due to the potential change in river flows are analyzed and discussed in Section 4.3.

3.3.8 Cibola Gage to Imperial Dam

This reach is approximately 38 miles long and it is bounded by Imperial Dam downstream. Although there are some minor drainages, flows in this reach are almost entirely comprised of releases from Parker Dam reduced by upstream depletions, including diversions of water for the Colorado River Indian tribes and the Palo Verde Irrigation District.

The ranges of hourly releases from Parker Dam and the corresponding ranges of flows in this river reach will not be affected by the proposed federal action. However, the shape and duration of hourly flows and the corresponding daily, monthly, and annual flows may be affected; these potential effects are analyzed and discussed in Section 4.3.

The impoundment associated with Imperial Dam is operated at a nearly constant elevation in order to facilitate the diversion of water. The AAC diverts water from the California side of Imperial Dam and serves IID, CVWD, the Yuma Project in Arizona and California, the City of Yuma, and Mexico. The Gila Gravity Main Canal system diverts water from the Arizona side of Imperial Dam and serves the north and south Gila Valley, Yuma Mesa, and Wellton-Mohawk area. This facility will continue to be operated in this same manner and, therefore, the elevations of this impoundment will not be affected by the proposed federal action.

Senator Wash, an off-stream reservoir just upstream of Imperial Dam is used to store and release mainstream Colorado River water to meet demands at Imperial Dam. It will continue to be operated in the same manner to manage water deliveries and will not be affected by the proposed federal action.

The Colorado River reach from Cibola Gage to Imperial Dam is located in a relatively narrow alluvial fill valley. There is no irrigated agriculture along this reach and there are many backwaters, especially in the southern half of the reach. The potential effects due to the potential change in river flows are analyzed and discussed in Section 4.3.

3.3.9 Imperial Dam to NIB

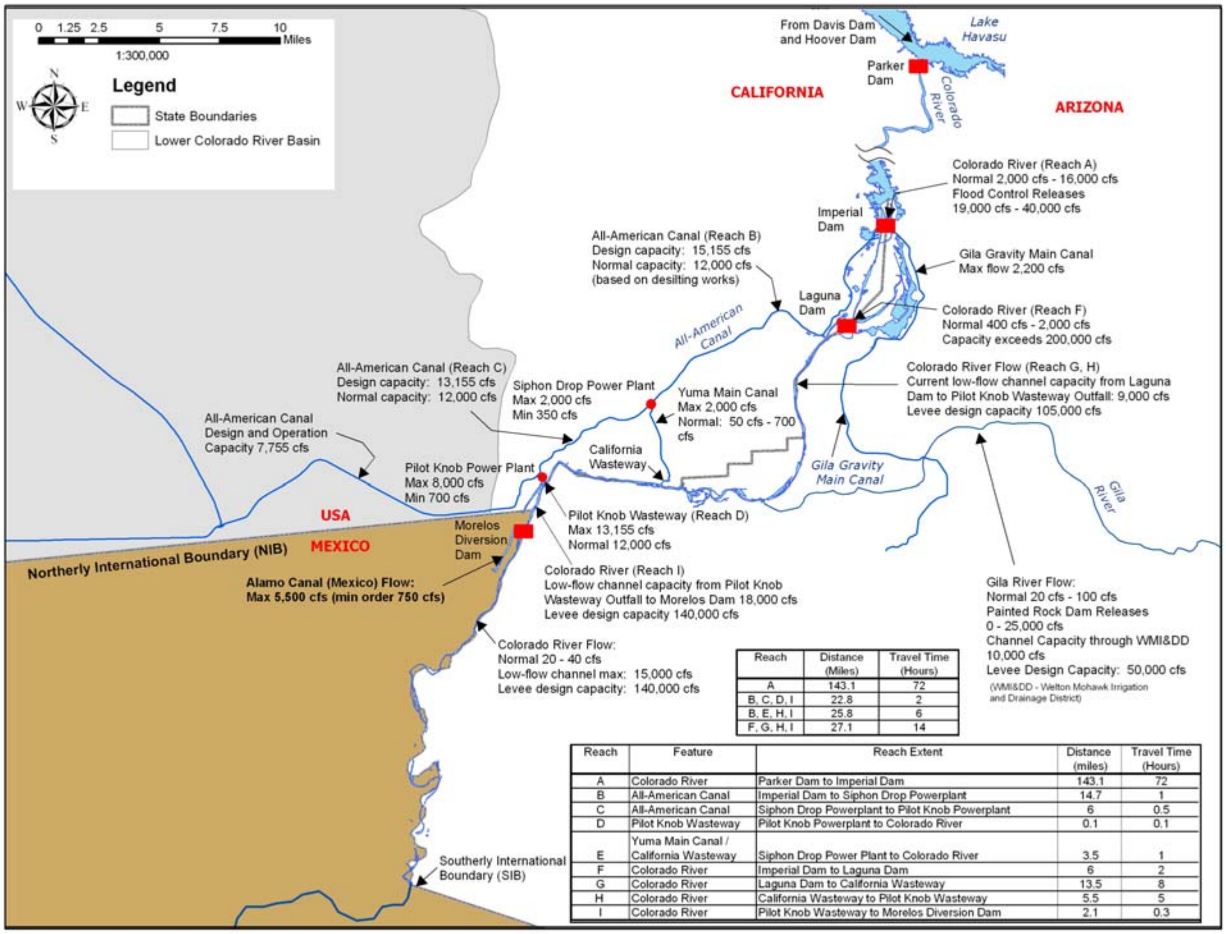
This reach is approximately 26 miles long and is bounded by the NIB downstream. Excluding inflows from the confluence of Gila River, flows in this reach are comprised primarily of water that has leaked from or has been released from Imperial Dam, and return flows from water diverted at Imperial Dam.

The flows in the upper portion of this reach (just downstream of Imperial Dam) typically range from about 250 cfs to 350 cfs and are comprised principally of return flows from the AAC desilting basins, gate leakage from the California sluiceway gates at Imperial Dam, and occasional small releases to meet Mexico’s scheduled water deliveries at the NIB. In addition, water may be released to remove accumulated sediment from the desilting basins in the sluiceway channel (known as “sluicing flows”). These flows occur two to three times per month, may range from 8,000 cfs to 12,000 cfs, and the duration may be up to 20 minutes. Laguna Dam, just downstream of Imperial Dam, is used to capture these sluicing flows for subsequent delivery downstream. These operations and the flows in the upper portion of the reach will not be affected by the proposed federal action.

The drainage return flows discussed above originate from the irrigated lands located in the Yuma area and are nearly constant throughout the year and from year to year. These drainage return flows comprise both gravity and pumped drainage flows and are not expected to be affected by the proposed federal action.

Most of Mexico's scheduled delivery at the NIB is diverted at Imperial Dam into the AAC and returned to the Colorado River through Pilot Knob and Siphon Drop Powerplants and their respective wasteway channels, 2.1 miles and 7.6 miles upstream of the NIB, respectively. Mexico diverts that water at Morelos Diversion Dam which it owns, operates, and maintains. Figure 3.3-5 shows how water deliveries to Mexico pursuant to the 1944 Treaty are routed from Imperial Dam to the NIB, as well as the source and routing of other flows that occur between Imperial Dam and the NIB. The proposed federal action will not alter the operation of these diversions and wasteways.

Figure 3.3-5
Water Routing from Imperial Dam to NIB
Deliveries to Mexico Pursuant to the 1944 Treaty



Reach	Distance (Miles)	Travel Time (Hours)
A	143.1	72
B, C, D, I	22.8	2
B, E, H, I	25.8	6
F, G, H, I	27.1	14

Reach	Feature	Reach Extent	Distance (miles)	Travel Time (Hours)
A	Colorado River	Parker Dam to Imperial Dam	143.1	72
B	All-American Canal	Imperial Dam to Siphon Drop Powerplant	14.7	1
C	All-American Canal	Siphon Drop Powerplant to Pilot Knob Powerplant	6	0.5
D	Pilot Knob Wasteway	Pilot Knob Powerplant to Colorado River	0.1	0.1
E	Yuma Main Canal / California Wasteway	Siphon Drop Power Plant to Colorado River	3.5	1
F	Colorado River	Imperial Dam to Laguna Dam	6	2
G	Colorado River	Laguna Dam to California Wasteway	13.5	8
H	Colorado River	California Wasteway to Pilot Knob Wasteway	5.5	5
I	Colorado River	Pilot Knob Wasteway to Morelos Diversion Dam	2.1	0.3

The Gila River is highly regulated and although inflows from the Gila River to the mainstream Colorado River have averaged approximately 250 kafy over the past 75 years, these inflows occur very sporadically and they are of very high magnitudes. These inflows are not expected to be affected by the proposed federal action.

Groundwater basins proximal to the Colorado River within this reach include portions of the Yuma Valley and the South Gila Valley. With the exception of the Yuma Valley, these basins are generally small in size and are bounded by zones of non-water-bearing rock. The method used to route water from Imperial Dam to the NIB bypasses most of the river channel and the proposed federal action will not affect these operations. Therefore, the portions of the groundwater basins adjacent to this reach are not anticipated to be affected by the proposed federal action.

3.3.10 NIB to SIB

Mexico diverts the majority of its Colorado River water supply at Morelos Diversion Dam, and only limited flows occur in the river reach that extends between Morelos Diversion Dam and the SIB. These flows may occur as a result of:

1) seepage from Morelos Diversion Dam;
2) water in excess of Mexico's scheduled delivery (e.g. flood flows, cancelled orders in the United States) not diverted by Mexico and released from Morelos Diversion Dam;
3) irrigation return flows from Mexico and the United States; and
4) groundwater accumulation from both the United States and Mexico.

Water released from Parker Dam for irrigation districts in Imperial Valley, Coachella Valley, and the lower Colorado River Valley, normally takes up to three days to reach its point of diversion. Occasionally, unforeseen events such as localized precipitation force the irrigation districts to cancel these water delivery orders after the water has been released at Parker Dam. Usually, the water is diverted at Morelos Diversion Dam for use in Mexico. However, some of this water may flow past Morelos Diversion Dam. The proposed federal action will not affect water that flows past the NIB as a result of canceled water orders.

Morelos Diversion Dam forms an impoundment that facilitates Mexico's diversion of water from the Colorado River. The elevation of this impoundment is maintained nearly constant in order to facilitate the diversion of water by Mexico. It is anticipated that Mexico will continue to operate Morelos Diversion Dam and this impoundment in this same manner, and therefore, elevations of this impoundment will not be affected by the proposed federal action. Accordingly, the rate of seepage that occurs at Morelos Diversion Dam will not be affected by the proposed federal action.

Gila River flood events reaching the mainstream of the Colorado River are rare. Only once has flow been recorded over 4,000 cfs at Dome Gaging Station, Arizona, since 1941. In 1993, up to 27,500 cfs flowed past Dome Gaging Station as a result of the 1993 Gila River flood (USGS 1999). The 1993 flood created much of the habitat presently found along the Colorado River below its confluence with the Gila River (Hernandez et al. 2000). The proposed federal action will not affect water that flows past the NIB as a result of Gila River flood events.

Flows in excess of Mexico's scheduled diversion at the Morelos Diversion Dam resulting from flood control releases from Lake Mead may be affected by the proposed federal action. These flood control releases are dictated by the flood control criteria established for Lake Mead and Hoover Dam and are largely dependent upon hydrologic conditions. The proposed federal action may affect the frequency and magnitude of flood control operations that originate at Hoover Dam due to potential changes in reservoir storage that occurs under the different action alternatives. These potential effects are analyzed and discussed in Section 4.3.

The Colorado River reach from the NIB to the SIB flows through the large and deep Colorado River delta groundwater basin. The upstream portion of this reach is a gaining reach, which means that groundwater enters the channel and provides a portion of the river's surface flow. This occurs because the high groundwater level in the adjacent lands has a sloping gradient that intercepts the Colorado River channel. The proposed federal action is not expected to affect this gaining reach because the high groundwater levels occur due to application of water on the adjacent irrigated lands, a condition that will remain unchanged.

The downstream portion of this reach is a losing reach, which means that a portion of the surface flows from the Colorado River channel provides recharge to the groundwater basin. However, the proposed federal action will not affect the flows that normally occur in this part of the river reach and that contribute to groundwater recharge. Therefore, the portions of groundwater basins adjacent to this reach are not anticipated to be affected by the proposed federal action.

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3.4 Water Deliveries

Colorado River water is delivered to entities in the seven Basin States and Mexico, consistent with a body of documents often referred to as the Law of the River, as discussed in Section 1.7. Water is diverted from the Colorado River at various points and used for irrigation and domestic purposes. A portion of the diverted water may be returned to the river for subsequent use downstream, which is referred to as return flow. The net amount of water used (termed consumptive use, or depletion) is equal to the diversion less the return flow.[1]

This section describes the water deliveries to entities within the study area that could potentially be affected by implementation of the proposed federal action, including shortage determinations, the storage and delivery of conserved water in Lake Mead, and modification and/or extension of the ISG.

3.4.1 Apportionments to the Upper Division States

The Compact apportioned 7.5 maf of water per year for consumptive use in the Upper Basin and stipulated that the flow in the Colorado River at the Lee Ferry Compact Point not be depleted below 75 maf for any consecutive 10-year period (Section 1.7). The Upper Colorado River Basin Compact of 1948 allocated the Upper Basin apportionment among the four Upper Division states. The apportionments are based on percentages of the total quantity of consumptive use available each year within the Upper Basin remaining after deduction of the use, not to exceed 50,000 af made in the State of Arizona. These apportionment percentages are provided in Table 3.4-1.

Table 3.4-1
Upper Division States Apportionment

State	Annual Apportionment (%)
Colorado	51.75
New Mexico	11.25
Utah	23.00
Wyoming	14.00

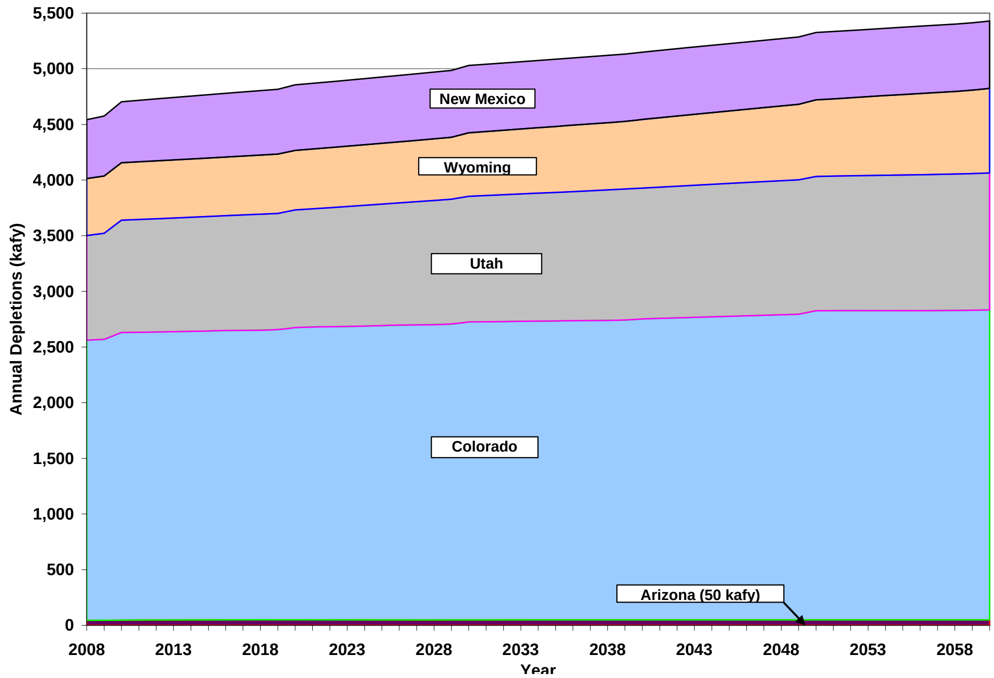
The Upper Colorado River Basin Compact of 1948 also established the Upper Colorado River Commission (Commission). The Commission is an interstate administrative agency, that among other duties, makes findings with regard to the annual quantities of Colorado River water that are available for use and are used by each Upper Basin state, and the annual quantity of water delivered at Lee Ferry. Reclamation operates the mainstream reservoirs to meet the project purposes including the delivery of water downstream. Each Upper Division state regulates and controls the use of Colorado River water within its boundaries.

[1] Alternatively, consumptive use in the Upper Basin is defined in the Upper Colorado River Compact as man-made depletions of natural flow at Lees Ferry. In this EIS for purposes of analyzing the potential impacts of the proposed federal action within the geographic scope, consumptive use is defined as diversions less return flow.

Depletion schedules for the Upper Basin states were developed by each Upper Basin state and approved for transmittal by the Commission. The schedules were submitted by the Commission to Reclamation in December 1999. These depletion schedules were subsequently updated by Reclamation in coordination with the Commission to include updated Indian tribe depletions (Appendix C).

Figure 3.4-1 shows that the total scheduled depletions of the Upper Division states increases from approximately 4,500 kaf in 2008 to approximately 5,400 kaf by 2060. The schedules shown in Figure 3.4-1 and detailed in Appendix C do not include the evaporation losses from the CRSPA reservoirs (Lake Powell and Flaming Gorge, Blue Mesa, Morrow Point, and Crystal reservoirs) and the Navajo Reservoir, estimated to average approximately 574,000 afy.

Figure 3.4-1
Upper Basin Scheduled Depletions
2008 through 2060



The proposed federal action would not affect the apportionments to the Upper Division states nor their ability to use those apportionments.

3.4.2 Apportionments to the Lower Division States and Water Entitlements within Each State

The apportionments to the Lower Division states which were established by the BCPA and confirmed by the Consolidated Decree are provided in Table 3.4-2.

Table 3.4-2
Lower Division States Apportionment

State	Annual Apportionment (maf)
Arizona	2.8
California	4.4
Nevada	0.3
Total	7.5

The apportionments to the Lower Division states would not be affected by the proposed federal action.

3.4.2.1 Water Delivery Entitlements to Entities in the Lower Division States

With the exception of approximately 10,000 af in the state of Arizona, all of the water apportioned to each Lower Division state by the BCPA is allocated to specific entities within each state. These allocations, known as entitlements, are established in accordance with the BCPA and the Consolidated Decree.

Section 5 of the BCPA authorizes the Secretary to operate as the contracting authority for the delivery of water from the lower Colorado River and requires any user of Colorado River water in the Lower Basin to have a water delivery contract with Reclamation. This requirement, which was confirmed by the Consolidated Decree, applies to all diversions made from the Colorado River except for federal establishments and PPRs.

For Colorado River water users in the Lower Division states, an entitlement to use Colorado River water can exist in one of three forms: (i) a decreed right, (ii) a Section 5 water delivery contract with the Secretary, or (iii) a Secretarial Reservation.

A decreed right is a right to use water defined by the Consolidated Decree. The right, which must have existed prior to June 15, 1929 (the effective date of the BCPA), is also referred to as a PPR. The Consolidated Decree lists and quantifies these PPRs. A summary of the total amounts of water apportioned to the PPRs in the Lower Division state is provided in Table 3.4-3. These entitlements are summarized based on the diversion and consumptive-use entitlements. The return flow credits used to compute consumptive use have been estimated from historical data.

Table 3.4-3
Colorado River Water Apportioned to PPRs in the Lower Division States

State	Estimated Diversion Entitlement (afy)	Estimated Consumptive-use Entitlement (afy)
Arizona	1,077,971	618,172
California	3,019,573	2,723,325
Nevada	13,034	8,898
Total Lower Division States	4,110,578	3,350,395

A Section 5 water delivery contract is a written agreement between the United States, through the Secretary or his/her duly authorized representative, and another person or entity. All Colorado River water delivery contracts in the Lower Basin are for permanent service, as provided in the BCPA. The form and content of these contracts have evolved since 1929 to reflect advancements in flow measurement, water scheduling, and water accounting technology. Water delivery contracts describe the entitlement in terms of an annual diversion right, an annual consumptive use right, or in some cases both.

A Secretarial Reservation is an entitlement established by the Secretary. Secretarial Reservations have been used to reserve Colorado River water for use at federal facilities or lands. Secretarial Reservations have been exercised for Colorado River water use at the Cibola NWR, for use on BLM lands, and for uses at Hoover Dam and Davis Dam.

The proposed federal action will not affect the entitlements to Colorado River water for water users in the Lower Division states. However, water deliveries to each Lower Division state and to users within each Lower Division state may potentially be affected; these potential effects are analyzed and discussed in Section 4.4.

3.4.3 Lower Division States Water Supply Determination

In accordance with the Consolidated Decree and Article III of the LROC, the Secretary determines yearly the water supply condition for the Lower Division states. The conditions are as follows:

- Normal Condition: when sufficient mainstream water is available to satisfy 7.5 maf of consumptive use in the Lower Division states;
- Surplus Condition: when sufficient mainstream water is available to satisfy in excess of 7.5 maf of consumptive use in the Lower Division states; and
- Shortage Condition: when insufficient mainstream water is available to satisfy 7.5 maf of consumptive use in the Lower Division states.

Under a Surplus Condition, the Consolidated Decree apportioned 46 percent of the surplus in excess of 7.5 maf for use in Arizona, 50 percent for use in California, and four percent for use in Nevada. The ISG established further guidelines for the Secretary's decision with regard to when a surplus would be declared, and the amounts and types of use (e.g., agricultural use, domestic use) of that surplus water, including the recognition of any agreements between the states that might modify how the surplus waters would be divided amongst the states (known as "forbearance" agreements).

Under a Shortage Condition, the Consolidated Decree directs the Secretary to first satisfy all PPR's in order of their priority dates without regard to state lines, and then to apportion any remaining shortage amount consistent with the BCPA and other applicable federal statutes. The CRBPA states that satisfaction of all PPRs and California's 4.4 maf apportionment would have priority over CAP and other post-1968 water delivery contracts (contracts with approval dates after September 30, 1968). It also states that Nevada shall not be required to bear shortages in any proportion greater than would have been imposed in the absence of the CRBPA. The proposed federal action will provide guidance to the Secretary's annual determination of the water supply condition for the Lower Division states.

3.4.4 Depletion Schedules for Lower Division States (Normal and Surplus)

The following sections describe the projected depletions of the three Lower Division states, Arizona, California, and Nevada, for Normal and Surplus conditions, under the No Action Alternative. Surplus schedules for each action alternative are presented in Appendix D.

3.4.4.1 State of Arizona

Arizona's depletion schedule for a Normal Condition is shown on Figure 3.4-2. These depletions are projected to be 2.8 maf throughout the period of analysis (2008 through 2060). The CAP is the largest single Arizona diverter and its consumptive use is projected to be approximately 1.382 maf in 2008 and gradually decrease to 1.271 maf by 2060. Concurrently, the demands of Arizona's non-CAP users increase towards their full apportionment during this period, making up the balance of Arizona's normal 2.8 maf apportionment.

Figure 3.4-2
Arizona's Projected Colorado River Water Depletion Schedules Under the No Action Alternative

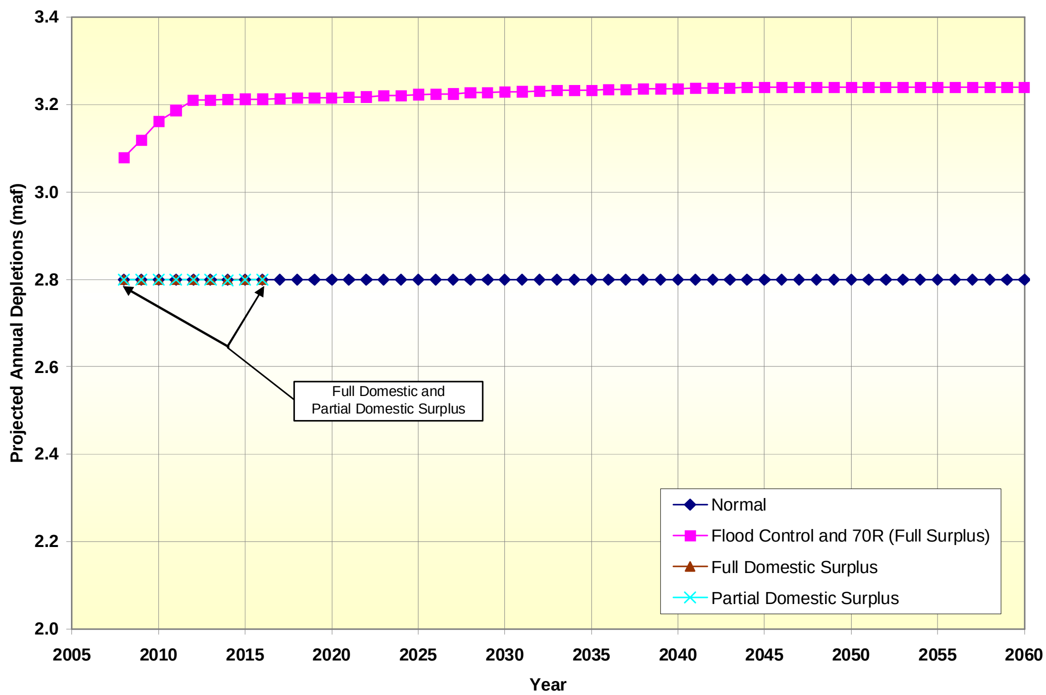


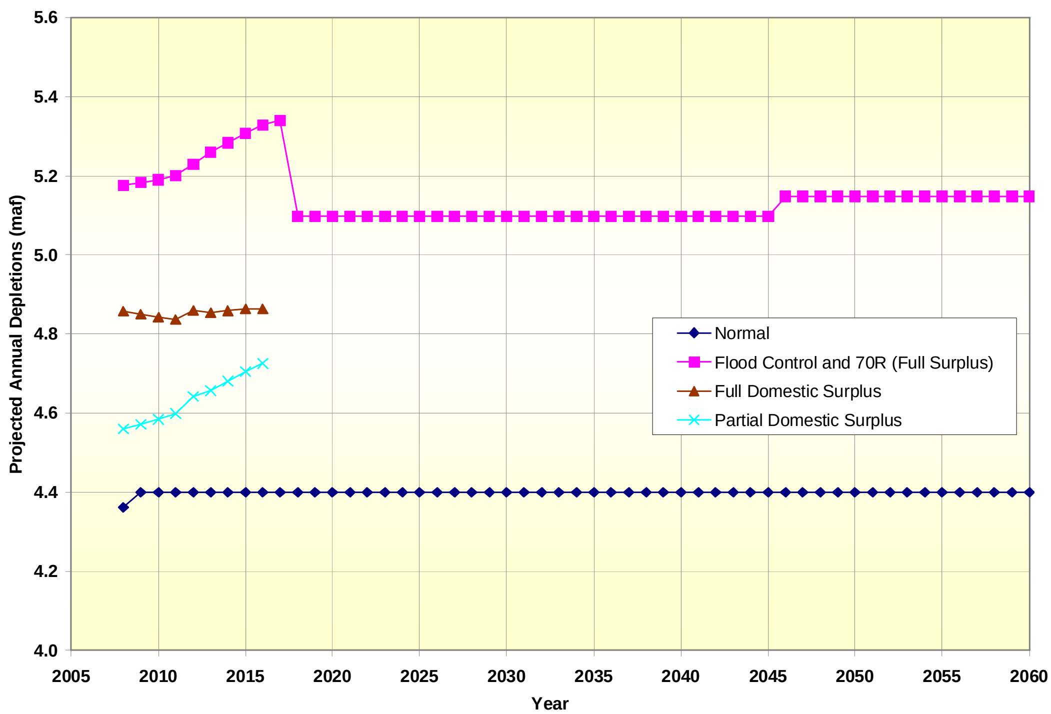
Figure 3.4-2 also shows Arizona's scheduled depletions for the Flood Control Surplus, 70R Surplus, Full Domestic Surplus, and Partial Domestic Surplus conditions for the No Action Alternative. Arizona's projected Full Surplus depletions increase from 3.08 maf in 2008 to approximately 3.24 maf in 2060. Arizona's Full Domestic Surplus and Partial Domestic Surplus schedules are 2.8 maf thought the modeling period.

3.4.4.2 State of California

California's depletion schedule for a Normal Condition is shown on Figure 3.4-3. These depletions are projected to be 4.4 maf throughout the period of analysis (2008 through 2060). The exception to this is the first year (2008) wherein the depletion schedule reflects a delivery reduction of 23,315 af which coincides with scheduled repayment of inadvertent overruns by IID (14,763 af) and CVWD (8,552 af). As such, California's scheduled depletion for 2008 is modeled as 4.377 maf.

The surplus schedules for California consider its continued need for surplus water, when available, in order to help the state implement the provisions of the Quantification Settlement Agreement. California's surplus schedule considers the potential availability of more surplus water during the effective period of the ISG, which are scheduled to expire in 2016. Figure 3.4-3 also shows California's surplus depletion schedules under the Flood Control Surplus, 70R Surplus, Full Domestic Surplus, and Partial Domestic Surplus conditions for the No Action Alternative.

Figure 3.4-3
California's Projected Colorado River Water Depletion Schedules Under the No Action Alternative

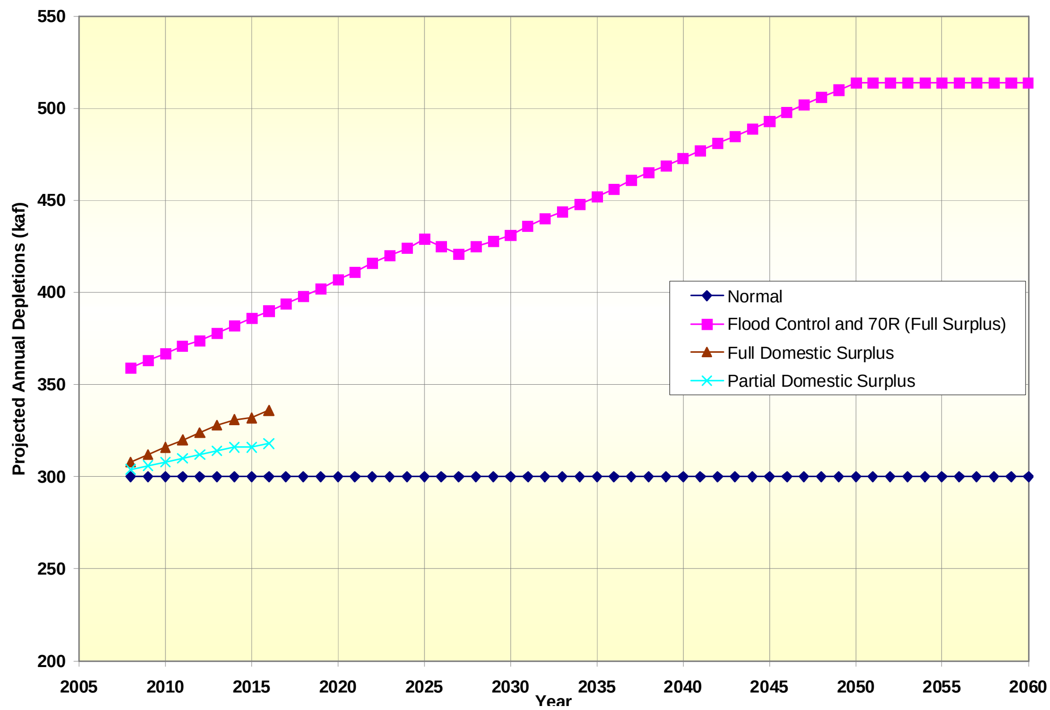


3.4.4.3 State of Nevada

Nevada's depletion schedule for a Normal Condition is shown on Figure 3.4-4. These depletions are projected to be 300 kaf throughout the period of analysis (2008 through 2060). The SNWA is the largest single Nevada diverter and its depletions are projected to be approximately 271 kaf for the period 2008 through 2025, increasing to 279 kaf in 2026, increasing to 287 kaf in 2027 and remains at that level through 2060. Figure 3.4-4 also shows Nevada's surplus depletion schedule under the Flood Control Surplus, 70R

Surplus, Full Domestic Surplus, and Partial Domestic Surplus conditions for the No Action Alternative. Nevada's projected Full Surplus depletions increase from 330 kaf in 2008 to approximately 514 kaf in 2060.

Figure 3.4-4
Nevada's Projected Colorado River Water Depletion Schedules Under the No Action Alternative



3.4.5 Mexico's Allotment

Mexico has an allotment to Colorado River water under Article 10 of the 1944 Treaty (Section 1.7) that states the following:

> "Of the waters of the Colorado River, from any and all sources, there are allotted to Mexico:
>
> (a) A guaranteed annual quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) to be delivered in accordance with the provisions of Article 15 of this Treaty.
>
> (b) Any other quantities arriving at the Mexican points of diversion, with the understanding that in any year in which, as determined by the United States Section, there exists a surplus of waters of the Colorado River in excess of the amount necessary to supply uses in the United States and the guaranteed quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) annually to Mexico, the United States undertakes to deliver to Mexico, in the manner set out in Article 15 of

> this Treaty, additional waters of the Colorado River system to provide a total quantity not to exceed 1,700,000 acre-feet (2,096,931,000 cubic meters) a year. Mexico shall acquire no right beyond that provided by this subparagraph by the use of waters of the Colorado River system, for any purpose whatsoever, in excess of 1,500,000 acre-feet (1,850,234,000 cubic meters) annually.
>
> In the event of extraordinary drought or serious accident to the irrigation system in the United States, thereby making it difficult for the United States to deliver the guaranteed quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) a year, the water allotted to Mexico under subparagraph (a) of this Article will be reduced in the same proportion as consumptive uses in the United States are reduced."

Additionally, Minute 242 provides, in part, that the United States will deliver to Mexico approximately 1,360,000 af annually upstream of Morelos Diversion Dam and approximately 140,000 af annually on the land boundary at San Luis and in the limitrophe section of the Colorado River downstream from Morelos Diversion Dam. While a portion of Mexico's 1.5 maf annual allotment is actually delivered downstream of Morelos Diversion Dam, the entire delivery to Mexico was modeled at Morelos Diversion Dam. This basic assumption, while different than actual practice, served to simplify and facilitate the analysis of water deliveries to Mexico under the No Action Alternative, the action alternatives, and the Preferred Alternative.

Allocation of Colorado River water to Mexico is governed by the 1944 Treaty. The proposed federal action will improve the Department's annual management and operation of key Colorado River reservoirs for an interim period through 2026. However, in order to assess the potential effects of the proposed federal action, certain modeling assumptions (Chapter 2) are used in this Final EIS that display projected water deliveries to Mexico. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

3.4.6 Distribution of Shortages To and Within the Lower Division States

The assumptions with respect to the distribution of shortages between the three Lower Division states are discussed in Section 4.2 and Appendix A. The following sections describe the priority systems and agreements that direct how shortages would be distributed within each state. The modeling assumptions regarding shortage distribution within each state are detailed in Appendix G.

3.4.6.1 Distribution of Shortages Within Arizona

Of Arizona's 2.8 maf apportionment, the largest use is the CAP which has historically diverted up to 1.7 mafy from Lake Havasu for delivery to water users in the central part of the state. Other noteworthy diversions are those of the Colorado River Indian Reservation at Headgate Rock Dam and the Gila and Yuma Projects at Imperial Dam. Other diversions serve irrigated areas and communities along the Colorado River corridor, including lands of the Fort Mojave Reservation, water used by federal agencies in Arizona, the cities of Bullhead, Lake Havasu and Parker, the Mohave Valley Irrigation and Drainage District, and the Cibola Valley Irrigation and Drainage District. A portion of the water from the Colorado River corridor is also diverted by wells located along the Colorado River.

Arizona established the Arizona Water Banking Authority (AWBA) in 1996 to store unused apportionment from Arizona and other states in groundwater basins in Arizona for future use. These banked water supplies help ensure an adequate water supply to municipal users of Colorado River water in times of shortages or disruptions of the CAP system, in meeting water management plan objectives of the Arizona state groundwater code, and in Indian water rights claims settlements.

Within Arizona, a priority system for the delivery of Colorado River water to water users within the state has been included in the water delivery contracts executed after 1992. Prior to 1992, the contracts defined priorities as existing in three time bands: entitlements existing before June 25, 1929, entitlements existing between June 26, 1929 and September 30,1968, and entitlements existing after September 30, 1968. For water delivery contracts in Arizona executed after 1992, Reclamation assigned a numerical rating to these priorities (priorities 1 through 4) and also defined priorities for unused apportionment (priority 5) and surplus water (priority 6) (Table 3.4-4).

Table 3.4-4
Arizona Priority System for Mainstream Colorado River

Priority	Rights to be Satisfied
First	Present Perfected Rights established prior to June 25, 1929
Second [1]	Federal reservations and perfected rights established or effective prior to September 30, 1968
Third [1]	Entitlements pursuant to contracts executed on or before September 30, 1968
Fourth	(1) Entitlements pursuant to contracts, Secretarial Reservations, and other arrangements between the United States and water users established subsequent to September 30, 1968 (2) Contract for CAP
Fifth	Any unused Arizona entitlement
Sixth	Entitlements to surplus water

1. The Arizona 2nd and 3rd priority entitlement holders are co-equal in their priority.

All Arizona water users in each priority are listed in Appendix E.

Under shortage conditions, any use of water occurring under contracts for unused entitlement would be the first eliminated. In the absence of shortage-sharing agreements, any remaining reduction in Arizona would most likely be shared proportionately among the CAP and the non-CAP holders with fourth priority entitlements. More severe shortages would result in holders of higher priority entitlements having to incur reductions in their water use.

Arizona's framework for responding to shortages is presented in the Arizona Drought Preparedness Plan and the Operational Drought Plan that was released in October 2004. Elements of this framework are discussed in Section 4.14. The framework includes an assortment of actions that collectively are designed to manage the impacts of reduced water supplies.

These actions in part rely on the water management actions and responses of the regional water agencies, irrigation districts, municipalities, and other local water purveyors. These actions include both supply and demand side management responses. A major component of Arizona's shortage management strategy is Arizona's Water Bank which is managed by AWBA. To date, the AWBA has stored some 2.6 maf in various groundwater basins throughout central and southern Arizona to meet future needs including providing a dry year supply.

Through the Arizona Department of Water Resources (ADWR) Director's Shortage Sharing Workgroup (Workgroup), a general agreement and recommendations were developed regarding how shortages should be allocated between the CAP and equivalent priority mainstream Colorado River water users. These recommendations were included in the modeling assumptions used in the Final EIS (Section 4.4 and Appendix G).

3.4.6.2 Distribution of Shortages Within California

Of California's 4.4 maf apportionment, the largest use is the IID which diverts approximately 3.1 mafy from Imperial Dam for delivery and use primarily for irrigated agriculture in the Imperial Valley. Other major water users include the Palo Verde Irrigation District (PVID), the CVWD, the Chemehuevi Reservation, the Fort Yuma Indian Reservation, the Colorado River Indian Reservation, the Fort Mojave Reservation, and the MWD. Other diversions serve irrigated areas and communities along the Colorado River corridor. A portion of the water from the Colorado River corridor is also diverted by wells located along the Colorado River.

Within California, a priority system for the delivery of mainstream Colorado River water to users within the state was established by Secretarial regulations that incorporated provisions of the California Seven-Party Agreement of 1931 (Table 3.4-5).

Table 3.4-5
California's Seven-Party Agreement for Mainstream Colorado River

Priority	Rights to be Satisfied
First	PVID for beneficial use upon 104,500 acres
Second	Reclamation's Yuma Project for beneficial use on up to 25,000 acres
Third[1,2]	(a) Imperial Irrigation District and Coachella Valley Water District (b) Palo Verde Irrigation District for use on 16,000 acres on the Lower Palo Verde Mesa
Fourth[3]	MWD and/or City of Los Angeles and/or others on the coastal plain of Southern California for 550,000 afy
Fifth	(a) MWD and/or City of Los Angeles and/or others on the coastal plain of Southern California for 550,000 afy (b) City and/or County of San Diego for 112,000 afy
Sixth[4]	(a) IID and CVWD (b) PVID for use on Lower Palo Verde Mesa
Seventh	All remaining water available within California for agricultural use

1. *The total beneficial use of priorities 1, 2, and 3 shall not exceed 3.85 mafy*
2. *Article 4.7 of the Quantification Settlement Agreement and the Agreement For Acquisition Of Conserved Water by and between Imperial Irrigation District and Coachella Valley Water District, dated October 10, 2003, contain provisions for shortage sharing between these two agencies.*
3. *The sum of priorities 1 through 4 totals 4.4 mafy.*
4. *The sum of priority 6 is 300 kafy*

The Consolidated Decree, however, also identified a number of PPRs in California as listed in Appendix E. Although some of the California PPRs were included in the Seven-Party Agreement, the Colorado River Water Delivery Agreement, and the Quantification Settlement Agreement (QSA) addressed how the rights of other PPRs would be met relative to the priority scheme set forth in the Seven-Party Agreement during the applicable term of these agreements as embodied in the QSA and related agreements.

Due to the provision in the CRBPA that CAP and other fourth priority rights in Arizona are junior to 4.4 maf of water use in California, reductions to California water users would occur only during severe shortages. If that were to occur, MWD would most likely incur the shortage owing to its lower priority within the 4.4 maf apportionment.

MWD's short-term and long-term strategies for managing and building its portfolio of water supplies are presented in its 2006 Integrated Water Resources Plan. Elements of this plan are discussed in Section 4.14.

MWD's 2006 Integrated Water Resources Plan integrates the following sources of dry-year water supply:

- ♦ Colorado River Aqueduct;
- ♦ conservation;
- ♦ recycling groundwater recovery, desalination;

- State Water Project;
- Central Valley storage and transfers;
- in-basin groundwater storage;
- in-basin surface water storage; and
- local groundwater, surface water and Los Angeles Aqueduct deliveries.

Together these resources represent MWD's tools for managing shortages that may occur due to a variety of factors including potential reductions in water deliveries from the Colorado River.

3.4.6.3 Distribution of Shortages within Nevada

Of Nevada's 0.3 maf apportionment, SNWA is the single largest diverter, with consumptive use of approximately 280 kafy. Established in 1991, SNWA delivers M&I water from Lake Mead to the service areas of Las Vegas, North Las Vegas, Henderson, Boulder City and Nellis Air Force Base. Water is pumped from two intakes at elevations 1,050 feet msl and 1,000 feet msl.

Existing water delivery contracts that authorize the use of Colorado River water by entities within Nevada are listed in Table 3.4-6. This priority system was developed and implemented in 1992 when Reclamation contracted with SNWA for the balance of Nevada's apportionment.

Under Shortage Conditions, Nevada would likely share in shortages due to the recent dates of the majority of its water delivery contracts. Within Nevada, reductions would most likely be borne by the lower priority use of SNWA. More severe shortages would result in holders of higher priority entitlements having to incur reductions in their water use. In accordance with the Consolidated Decree, the PPRs would not be affected.

SNWA and the State of Nevada's Colorado River Commission have developed a water resources management plan for southern Nevada to manage and develop water supplies to meet the current and future water demands of the region. This plan is summarized in SNWA's 2006 Water Resource Plan. Elements of this plan are discussed in Sections 4.4 and 4.16.

The SNWA Water Resource Plan identifies resources that are available to meet future water demands. The demands and resources considered in the Water Resource Plan are discussed in terms of two planning horizons:

- near-term (2006 through 2016); and
- long-term (2017 through 2055).

SNWA has taken a portfolio approach to water resource development and demand management. The portfolio approach emphasizes acquisition and development of a diverse set of resources (Colorado River and Nevada in-state resources), both surface water and groundwater, in an effort to offset the risks typically associated with any single resource option (e.g., availability, volume, timing of use).

Table 3.4-6
Nevada's Priority System for Mainstream Colorado River

Priority	Rights to be Satisfied
First	Fort Mojave Reservation (12,534 afy) Lake Mead National Recreation Area (Diversion = 500 afy or CU= 300 afy)
Second	Lake Mead National Recreation Area (1,500 afy, estimated)
Third	Boulder City (5,876 afy)
Fourth	City of Henderson (15,878 afy) Basic Management, Inc. (8,608 afy)
Fifth	Lakeview Co. (0 afy) Pacific Coast Building Products (PABCO) (928 afy)
Sixth	Las Vegas Valley Water District (15,407 afy)
Seventh	U.S. Air Force (Delivery from SNWA) (4,000 afy) Boy Scouts (Annexed by SNWA) (10 afy) Reclamation (300 afy) Nevada Department of Wildlife (formerly Nevada Department of Fish and Game) (25 afy)
Eighth	Robert B. Griffith Project (304,000 afy) Big Bend (10,000 afy) SNWA (balance of state apportionment, unused and surplus)

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3.5 Water Quality

This section describes the historic and existing water quality constituents that could potentially be affected by the proposed federal action. These water quality constituents of concern include:

- salinity;
- temperature;
- sediment;
- nutrients and algae;
- dissolved oxygen;
- metals; and
- perchlorate.

While other water quality-related issues and parameters were also considered, they were determined unlikely to be affected by the proposed federal action, or there was insufficient data to provide an assessment and are therefore not discussed here.

3.5.1 Salinity

Increased salinity levels are a primary water quality concern in the Colorado River because of its effects on agricultural, municipal and industrial users. As a result of increased salinity levels, agricultural water users may suffer economic damage due to reduced crop yields, added labor costs for irrigation management, and added drainage requirements. Urban or municipal users must replace plumbing and appliances more often, or spend increased money on water softeners or bottled water. Industrial users and water and wastewater treatment facilities incur reductions in the useful life of infrastructure (Colorado River Basin Salinity Control Forum 2005). Water treatment plants face increased costs when salinity is elevated, and high salinity source water may result in increased disinfection by-product (DBP) formation that exceeds drinking water regulations (Reclamation 1999).

Salinity occurs naturally in the Colorado River Basin due to the erosion of saline sediments and rocks; however, human activities such as agriculture, irrigation, and energy production may increase the rate of natural salt movement to the system (Colorado River Basin Salinity Control Forum 2005; USEPA 1971). Consumptive use of system water also reduces the dilution capacity of the watershed, increasing the salinity concentrations.

In 1972, the United States Environmental Protection Agency (USEPA) suggested the development of water quality criteria for salinity in the Colorado River following passage of the Federal Water Pollution Control Act (Clean Water Act [CWA]) of 1972, as amended. In 1973, the seven Basin States formed the Colorado River Basin Salinity Control Forum (Forum) to develop salinity criteria and an implementation plan to provide compliance while allowing the Basin States to continue to develop their Compact-allocated water. The Forum specifies flow-weighted average annual salinity criteria for three locations on the lower Colorado River (Table 3.5-1). The criteria, first established in 1975, are reviewed every three years; the latest review was completed in 2005.

Table 3.5-1
Numeric Salinity Criteria for the Colorado River[1]

Station	Flow-weighted average annual salinity (mg/L)[2]
Below Hoover Dam	723
Below Parker Dam	747
At Imperial Dam	879

[1] Developed by the Colorado River Basin Salinity Control Forum (2005)

[2] mg/L – milligram per liter

Historic salinity concentrations and Colorado River flows, and the criteria specified by the Forum by location for the lower reaches of the Colorado River downstream of Hoover Dam are shown in Figures 3.5-1 through 3.5-3. Since the adoption of the salinity criteria in 1975, salinity downstream of Glen Canyon Dam has varied between 390 to 660 mg/L. Prior to the adoption of the salinity criteria, episodes of higher salinity concentrations had been observed. As shown in Figures 3.5-1 through 3.5-3, increases in salinity typically correspond to decreases in river flow. Diluting effects of record high flows in the Colorado River during the 1980s have resulted in lower salinity levels. Conversely, low flows from 1988 through 1992 and 2000 through 2004 have caused relatively higher salinity levels. While the salinity concentrations vary from year to year, concentrations have not exceeded the criteria at any of the locations, even during the recent drought.

To address Mexico's concerns with regard to salinity, Minute 242 (Section 3.4) was developed in 1973 pursuant to the 1944 Treaty. Minute 242 limits the differential in annual salinity between Imperial Dam and the NIB to 115 parts per million (ppm) $\pm$ 30 ppm. The United States will continue to undertake activities to comply with the provisions of Minute 242 and these activities will not be affected by the proposed federal action. In addition, the Colorado River Basin Salinity Control Act of 1974 was authorized to implement desalting and salinity control projects to improve river water quality. Salinity control projects that have been implemented include projects to control irrigation seepage and reduce transport of groundwater salt loads to the Colorado River.

Figure 3.5-1
Historic Colorado River Salinity Concentrations and Flows Downstream of Hoover Dam
1941 through 2005

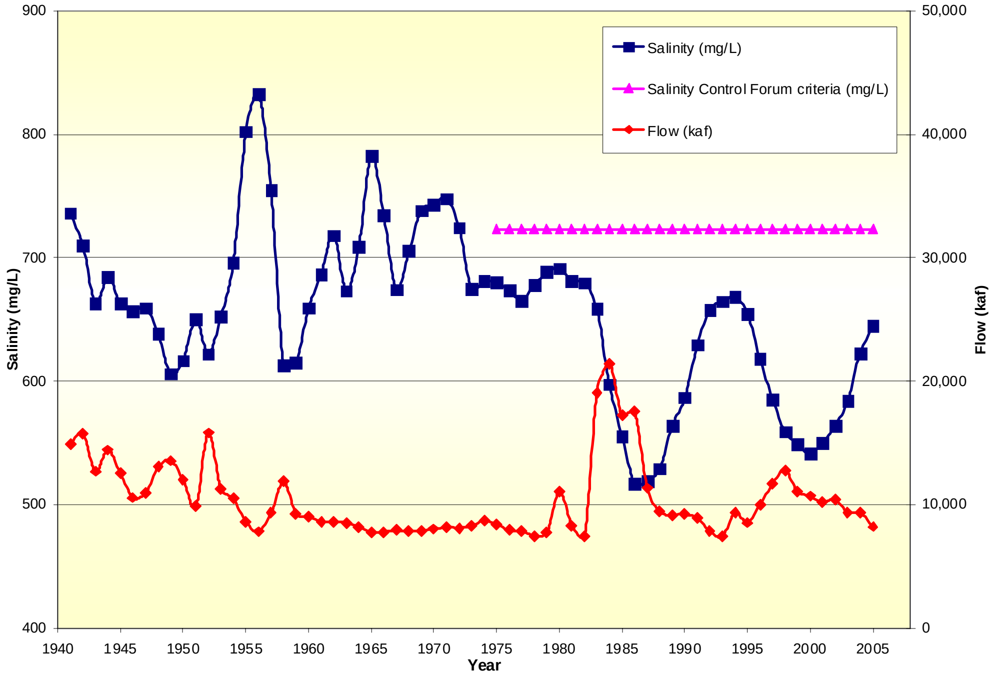


Figure 3.5-2
Historic Colorado River Salinity Concentrations and Flows Downstream of Parker Dam
1941 through 2005

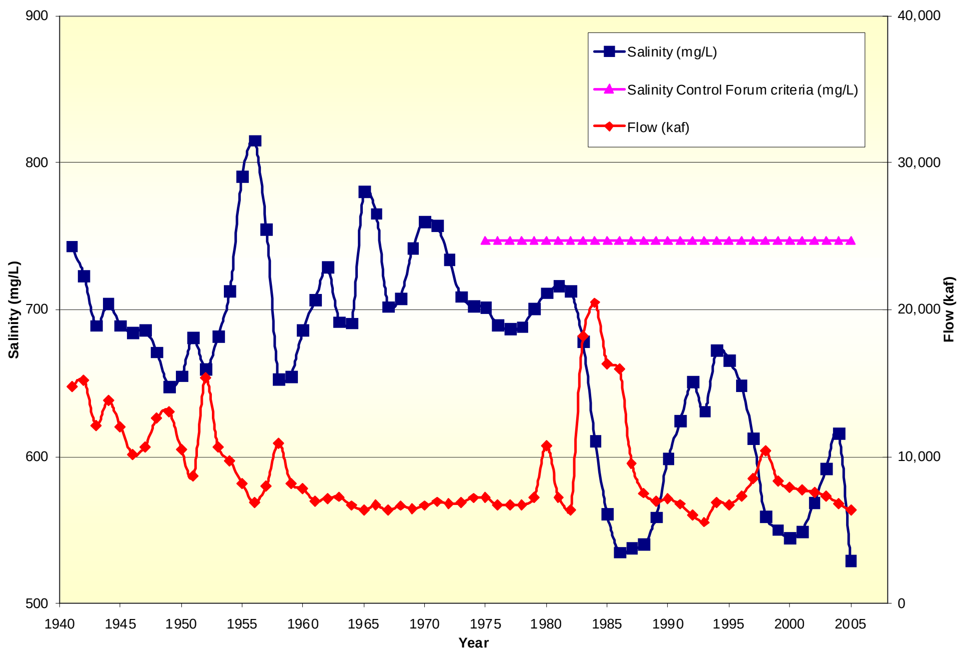
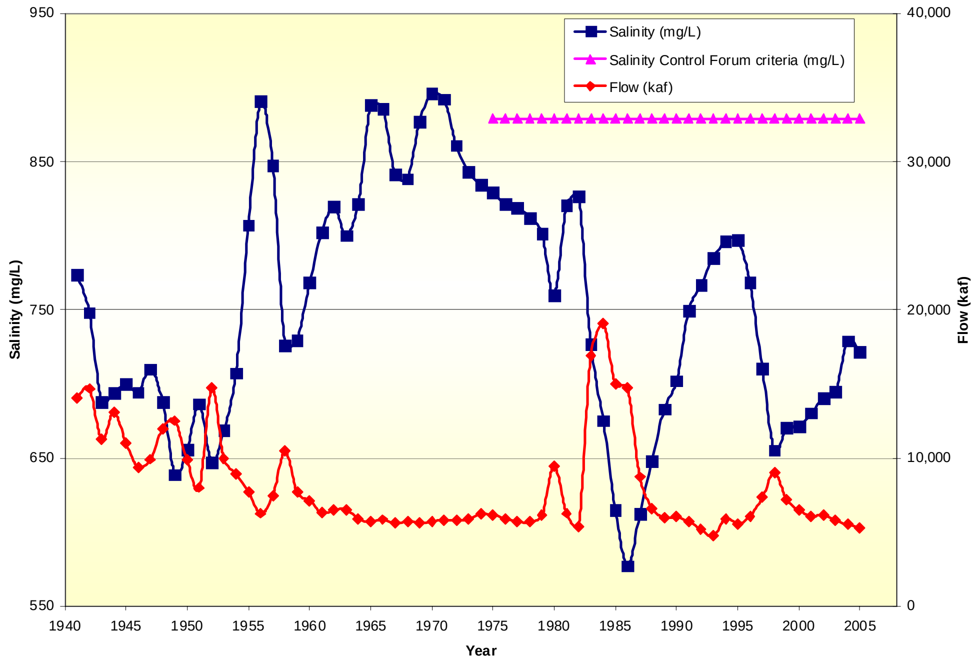


Figure 3.5-3
Historic Colorado River Salinity Concentrations and Flows at Imperial Dam
1941 through 2005

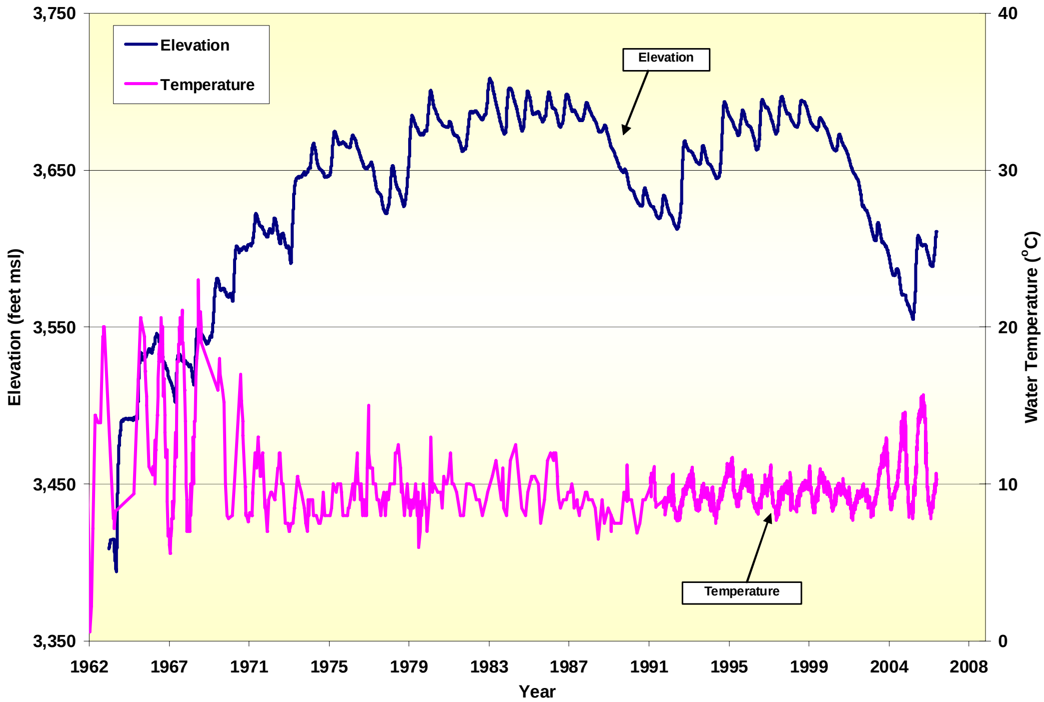


3.5.2 Temperature

Impounding water in reservoirs affects the water temperatures of dam releases due to stratification. The surface layers (epilimnion) of Lake Powell and Lake Mead warm as a result of inflows, ambient air temperature, and solar radiation. For example, during the summer, both Lake Powell and Lake Mead epilimnions reach temperatures as high as 30 degrees Celsius (30°C) or 86° Fahrenheit (F) (LaBounty and Horn 1997). Lake Mead's deeper layer (hypolimnion) remains around 12°C (54°F) year-round and Lake Powell's ranges from 6° to 9°C (43° to 48°F) (LaBounty and Horn 1997), typically resulting in cold dam release temperatures.

Water temperatures downstream of Lake Powell are influenced by Lake Powell elevations and release volumes. Figure 3.5-4 illustrates that Lake Powell release temperatures varied from 7° to 11°C (45° to 52°F) until 2002. Between 1999 and 2005, Lake Powell elevations dropped more than 140 feet as a result of a basin-wide drought. While winter release temperatures remained cold, Lake Powell release temperatures increased to 16°C (61°F) in the summer of 2005. The drop in Lake Powell elevation resulted in the warmer epilimnion being closer to the penstock withdrawal zone and the warmer water being released downstream. Release temperatures from Glen Canyon Dam during 2004 and 2005 were the highest since August 1971 when the reservoir was filling.

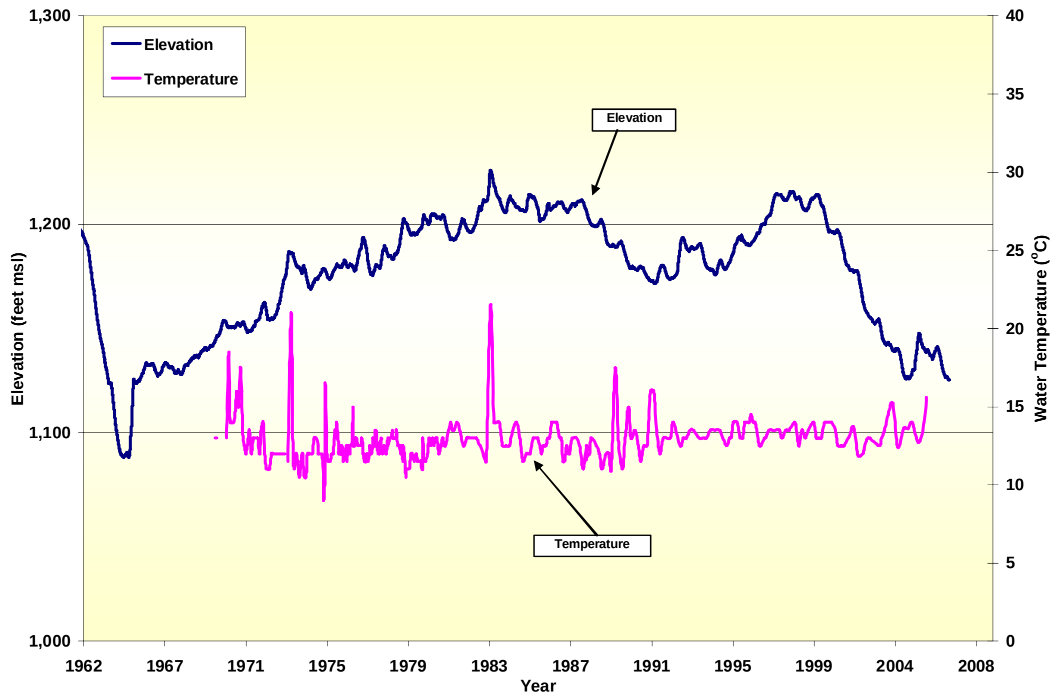
Figure 3.5-4
Historic Elevation and Dam Release Temperatures at Lake Powell



As water travels between Glen Canyon Dam and Lake Mead, water temperatures in the Colorado River can increase by 7°C (13°F) (Vernieu et al. 2005). The amount of warming is affected by season and release volume, with highest warming rates occurring in mid-summer and at low release volumes. Generally, during late fall and winter, as air temperatures decrease, water released from Glen Canyon Dam cools as it moves downstream towards Lake Mead.

Figure 3.5-5 illustrates that historic water release temperatures at Lake Mead have typically been approximately 13°C (55°F).

Figure 3.5-5
Historic Elevation and Dam Release Temperatures at Lake Mead



3.5.3 Sediment

After Glen Canyon Dam and Hoover Dam were constructed, the reservoirs behind these dams retained the vast majority of the inflowing sediment. Following dam closure, large sediment deltas formed near the inflow areas. When the reservoirs are drawn down during droughts, the Colorado River must cut new channels through the sediment deltas to reach the reservoirs. Generally the greater the reservoir drawdown, the greater the sediment delta headcut and the finer the sediment exposed. The resuspended sediments have a significant oxygen demand and also temporarily release nutrients which can result in greater algal growth.

Riverine sediment transport is an important concern in the Glen Canyon Dam to Lake Mead reach due to recreation and biological resource impacts, and is addressed in the AMP. Beach sediment volumes have declined since closure of Glen Canyon Dam eliminated annual replenishment by sediment-laden spring runoff. Recent efforts by the AMP have focused on making BHBF releases from Glen Canyon Dam timed with downstream tributary inputs from the Paria River and the Little Colorado River to rebuild these sandbar deposits.

Downstream of Hoover Dam, the only significant sediment inputs are produced by large, infrequent events on the Bill Williams River and the Gila River, affecting the reaches from Parker Dam to Imperial Dam and from Imperial Dam to the NIB. On-going Reclamation dredging operations remove this sediment at and upstream of Imperial Dam as well as upstream of Morelos Diversion Dam to improve diversion capability and to efficiently convey water to downstream users (Figure 3.3-5). These operations will continue and therefore the proposed federal action would have no impact.

3.5.4 Nutrients and Algae

Nutrients are organic and inorganic chemical elements or compounds that are essential for animal and plant growth. Carbon, hydrogen, and oxygen are consumed in the greatest quantities. In addition, nitrogen, phosphorous and potassium are also needed by animals and plants in large quantities. Elevated nitrogen and phosphorous are nutrients of concern because they foster algal growth which in excess can negatively impact water quality. Excess algal growth can affect drinking water treatment operations, and can contribute to taste and odor problems and potentially to DBP formation. Noxious and toxic blue-green algae blooms may also be a concern.

Large, long reservoirs like Lake Powell are very efficient at retaining nutrients through biological processes and settling. Paulson and Baker (1983) found phosphorus to be the limiting nutrient for primary biological activity in both reservoirs. More than 95 percent of the phosphorous reaching Lake Powell is in particulate form or associated with suspended sediment particles, and a large percentage of the particulate phosphorous load settles out of the water column in the upstream portion of the reservoir. Therefore, primary biological activity is phosphorous-limited by the time the water reaches Glen Canyon Dam. A similar storage effect is repeated at Lake Mead. This settling process can be reversed when the reservoirs are drawn down and deltaic sediments are re-suspended by the inflows. Nutrient concentrations remain elevated in the hypolimnion where the lack of light limits primary biological activity. Consequently, hypolimnetic releases from Glen Canyon Dam are relatively nutrient rich whereas periods of epilimnetic releases may cause a reduction in the amount of nutrients available to the downstream ecosystem.

Tributary inflows (Paria River and Little Colorado River) are important sources of phosphorus in the Colorado River between Glen Canyon Dam and Lake Mead (Maddux et al. 1987). However, most phosphorus arrives in particulate form adsorbed to fine sediment. This fine sediment causes high turbidity and restricts primary biological activity due to limited light penetration.

Lake Mead receives nutrient loads primarily from Las Vegas Wash and the Colorado River. A Total Maximum Daily Load (TMDL) has been developed by the Nevada Division of Environmental Protection (NDEP) and USEPA to reduce ammonia and phosphorous concentrations in Las Vegas Wash. Boulder Basin, the receiving body of Las Vegas Wash, has the highest nutrient concentrations in the Lake Mead system (Paulson and Baker 1981; Prentki and Paulson 1983). Except for the algae growth in the Boulder Basin substantial algae growth along the rest of the system is not common.

3.5.5 Dissolved Oxygen

Dissolved oxygen concentrations in reservoirs are affected by variations in inflow volume and temperature, seasonal reservoir circulation, and biological production and decomposition. In years of high inflows and when the reservoir elevations are low, flows cut through deltaic sediments, resuspending organic matter and nutrients that contribute to both chemical and biological oxygen demand as the inflow water passes down through the reservoir water column. The resulting plumes of low oxygen-water cause the release of oxygen-poor water. When deltaic sediments and organic matter are not resuspended, oxygen demand is lower and dissolved oxygen concentrations remain higher. Downstream of dams, turbulence, exposure to the atmosphere, and primary productivity reaerate the water column.

To date, low dissolved oxygen has only been an issue at Lake Powell with Glen Canyon Dam releases. The dissolved oxygen concentration reaches saturation downstream of Glen Canyon Dam before the confluence with the Little Colorado River (Gloss et al. 2005) after passing through several major rapids.

In Lake Mead, dissolved oxygen concentrations decrease in Boulder Basin as a result of nutrient contributions from Las Vegas Wash and algae growth. However, dissolved oxygen has not been documented to have dropped below acceptable minimum levels. Further, dissolved oxygen has not been documented as an issue in downstream reaches.

3.5.6 Metals

Metals of concern in the study area are selenium, chromium, and mercury. Selenium is an essential trace element, but can be bioconcentrated in a complex aquatic food chain to potentially hazardous levels to wildlife. A chronic standard to protect wildlife has been adopted by the Lower Basin states of 2 micrograms per liter (µg/L). This is a more stringent standard than the USEPA drinking water maximum contaminant level (MCL) for selenium of 50 µg/L. Selenium concentrations are currently not a drinking water public health concern.

The Forum established a selenium sub-committee in 2004 (Reclamation 2005). The long term average selenium concentration is 2.4 µg/L downstream of Glen Canyon Dam, greater than the Lower Basin states selenium standard of 2 µg/L (Reclamation 2005).

Selenium present in marine sedimentary rocks dissolves in runoff and groundwater flows to the Colorado River and its tributaries. Concentrations along the Colorado River in the Lower Basin indicate that selenium loads to the Colorado River are from the Upper Basin and Lower Basin tributaries only (Reclamation 2004a). The Colorado River from Hoover Dam to Lake Mohave inlet and from Parashant Canyon to Diamond Creek, as well as the reaches of the Gila River, Las Vegas Wash, and the Virgin River have all been designated as impaired waterbodies due to selenium. To date, TMDLs have not been drafted or approved for selenium in these waterbodies.

The USEPA drinking water MCL for the soluble hexavalent form of chromium (Cr(VI)) is 100 µg/L; at this concentration, it is considered potentially harmful to human health. Hexavalent chromium has been detected in groundwater in two known locations in the Lower Basin, at the former McCulloch Manufacturing Plant in Lake Havasu City, Arizona, and at the Pacific Gas & Electric (PG&E) Compressor Station near Needles, California. The Cr(VI) plume in Lake Havasu City has been delineated and is being monitored by the current land owner. Concentrations of Cr(VI) have been detected as high as 240,000 µg/L Cr(VI) and the plume is approximately 3,800 feet from the Colorado River.

The plume of contaminated groundwater from the PG&E facility has concentrations of Cr(VI) as high as 700 µg/L and has traveled several hundred feet from its source to within 60 feet of the Colorado River. Investigation and mitigation efforts are ongoing under the direction of the California Environmental Protection Agency (Cal EPA) Department of Toxic Substances Control (DTSC).

Mercury is naturally occurring in the Colorado River Basin and has been mobilized as a result of historic mining activities. Mercury can be toxic to both humans and wildlife and has been shown to bioaccumulate and biomagnify up the food chain. High levels of methylmercury have been detected in fish tissue at Alamo Lake in the Bill Williams Watershed, a tributary to Lake Havasu. Mercury is present in the discharge from Alamo Lake and may also be entering the Colorado River from the Little Colorado River and between Lake Mead and Lake Havasu. The USEPA drinking water MCL for mercury is 2.0 µg/L.

3.5.7 Perchlorate

Perchlorate in the form of ammonium perchlorate is a concern when found in drinking water because of its potential adverse effect on human thyroid function. No final USEPA drinking water regulations have been promulgated for perchlorate. Perchlorate contamination in water supplies in the lower Colorado River was traced to Lake Mead and Las Vegas Wash from a groundwater plume from the Kerr McGee Chemical Company in Henderson, Nevada. Containment control and mitigation activities are ongoing and have been reducing perchlorate concentrations in Lake Mead and downstream.

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3.6 Air Quality

The air quality issue related to the proposed federal action would be fugitive emissions (dust) generated from shorelines exposed by changes in Lake Powell and Lake Mead elevations.

3.6.1 Federal Air Quality Requirements

The Clean Air Act, as amended (42 United States Code [U.S.C.] Section (§) 7401) established Prevention of Significant Deterioration (PSD) provisions for use in protecting the nation's air quality and visibility. The PSD provisions apply to new or modified major stationary sources and are designed to keep an attainment area in continued compliance with the National Ambient Air Quality Standards (NAAQS). Major stationary sources are industrial-type facilities and include powerplants and manufacturing facilities that emit over 100 tons per year of a regulated pollutant. The USEPA promulgated NAAQS for six criteria pollutants to protect public health and welfare. One of the national air quality standards addresses particulate matter (PM), or dust.

No major stationary sources are being proposed for construction or modification by the proposed federal action; therefore the statutory provisions are not applicable. However, the standards do provide thresholds from which to evaluate potential effects to ambient air quality.

The PSD standards are most stringent in Class I Areas and are progressively less stringent in the Class II and Class III Areas (Table 3.6-1). Lake Powell and Lake Mead are designated as Class II Areas while the Grand Canyon National Park is designated as a Class I Area.

Table 3.6-1
Clean Air Act Prevention of Significant Deterioration Designations

Designation	Definition
Class I Area	Visibility is protected more stringently than under the NAAQS; includes national parks, wilderness areas, monuments, and other areas of special national and cultural significance.
Class II Area	Moderate change is allowed but stringent air quality constraints are nevertheless desired.
Class III Area	Substantial industrial or other growth is allowed and increases in concentrations up to the national standards would be considered insignificant.

The allowable PM concentrations increase over the baseline concentrations for the Class I, II and III Area designations are provided in Table 3.6-2.

Table 3.6-2
Clean Air Act Allowable Particulate Matter Concentration Increases over the Baseline Concentrations

Pollutant	Averaging Times	Class I Area [1,2]	Class II Area [1,2]	Class III Area [1,2]
Particulate Matter	Annual Geometric Mean	5	19	37
	24-Hour Maximum	10	37	75

1 *Unit of measure for standards is in micrograms per cubic meters of air (µg/m3)*

2 *Maximum allowable increases over baseline concentrations*

3.6.2 State and Local Air Quality Requirements

In 2006, USEPA established new PM10 (dust particles of 10 micrometers or less in diameter) and PM2.5 (dust particles less than 2.5 micrometers in diameter) standards for future implementation. These revised PM standards were promulgated to better protect the public from particulate exposures.

Additionally, each state must develop an implementation plan describing how it will attain and maintain the NAAQS. Some states have developed more stringent ambient air quality standards for PM10 and PM2.5, as listed in Table 3.6-3. California continues to have a more stringent PM10 standard than the other states and the federal standard. Arizona, Nevada, and Utah have adopted PM standards to meet the previous NAAQS (CalEPA 2006; Clark County AQEM 2006; MDAQMD 2006; Utah 2006; UDAQ 2006). These state standards were adopted prior to the new 2006 NAAQS.

Table 3.6-3
National and State Ambient Air Quality Standards for Particulate Matter

Jurisdiction	PM10 (µg/m^3)	PM2.5 (µg/m^3)	Averaging Times
2006 NAAQS	150	35	24-hours
	None [1]	15	Annual Arithmetic Mean
Arizona	150	65	24-hours
	50	15	Annual Arithmetic Mean
California	50	65	24-hours
	20	12	Annual Arithmetic Mean
Nevada	150	65	24-hours
	50	15	Annual Arithmetic Mean
Utah	150	65	24-hours
	50	15	Annual Arithmetic Mean

1 *Revoked in 2006 due to a lack of evidence linking health problems (effective December 17, 2006).*

Three state and local air quality agencies are responsible for attaining the state and federal standards within the study area, as listed in Table 3.6-4.

Table 3.6-4
State and Local Air Pollution Control Agencies Having Jurisdiction within the Lake Powell and Lake Mead Areas

Agency	Location	Colorado River Reaches
Arizona Department of Environmental Quality	Arizona	Lake Powell and Glen Canyon Dam Glen Canyon Dam to Lake Mead
Utah Department of Environmental Quality, Division of Air Quality	Utah	Lake Powell and Glen Canyon Dam
Clark County Air and Environmental Management	Nevada	Lake Mead and Hoover Dam Hoover Dam to Davis Dam

3.6.3 Ambient Air Quality by River Reach

A description of the PSD classification and the air quality standards within the reaches provides a means of characterizing the standards applied to the affected environment. Reaches meeting regulatory standards are classified as attaining a pollutant standard. The attainment status provides a qualitative characterization of a reach as compliant with the standards; attainment characterizes the specific pollutant as not a significant concern within the reach. Consequently, characterizing the PM attainment status in the reaches provides a qualitative assessment of the significance of fugitive emissions within the reach. The Glen Canyon to Lake Mead reach is included because particulate matter generated at the Lake Mead delta may be dispersed into this reach.

3.6.3.1 Lake Powell and Glen Canyon Dam

The Lake Powell and Glen Canyon Dam reach is a PSD Class II Area. North central Arizona and southern Utah, including Lake Powell, is in attainment of the PM10 and PM2.5 standards (USEPA 2006a; 2006b). This attainment status corresponds with windrose information for both areas (i.e., relatively low average wind speeds implying low wind-blown fugitive emissions on average) and the relatively low levels of fugitive emissions generated from human activities.

3.6.3.2 Glen Canyon to Lake Mead

This reach is located in northern portions of Mohave County and Coconino County and encompasses the Grand Canyon National Park. Consistent with the federal air quality designations for national parks, the Grand Canyon National Park is designated as a PSD Class I Area. Mohave County and Coconino County, including the Glen Canyon Dam to Lake Mead reach, is in attainment of the PM10 and PM2.5 standards (EPA 2006a). Within the Grand Canyon National Park, wind velocities with the greatest potential for particulate transport from the Lake Mead delta occur during the April and May windy season.

3.6.3.3 Lake Mead and Hoover Dam

Lake Mead is located in the LMNRA on the Nevada and Arizona boundary in Clark County and Mohave County, respectively, and is a PSD Class II Area. The Lake Mead and Hoover Dam reach is in attainment of the PM10 and PM2.5 standards (EPA 2006a; 2006c). While some urban areas (including Las Vegas, North Las Vegas, and Henderson) within Clark County are in non-attainment of the NAAQS for PM10, the remaining county, including Lake Mead, is in attainment of the standard. That portion of Mohave County, Arizona adjacent to Lake Mead is also in attainment of the PM10 standard (Reclamation 2000).

3.7 Visual Resources

This section discusses the visual resources within the study area that may be affected by the proposed federal action. The visual resources issues addressed include:

- attraction features;
- extent (height) of visible calcium carbonate ring; and
- exposure of sediment deltas at reservoir in-flow areas.

3.7.1 Lake Powell and Glen Canyon Dam Reach

3.7.1.1 Attraction Features

The general visual/scenic resources of the Glen Canyon/Lake Powell area are dominated by the presence of Navajo Sandstone and desert varnish. Resources include sweeping vistas of red rock towers, buttes, and mesa framed by Lake Powell. One geologic attraction feature within this reach is Rainbow Bridge. It is contained within the Rainbow Bridge National Monument that was established in 1910. At that time, it was accessible only by the rugged Wetherill Trail from Navajo Mountain. Today, it is estimated that more than 82,000 visitors see this attraction on an annual basis, most of them arriving by boat. With today's lower reservoir elevations, visitors must walk further from the boat docks to see the bridge and they do not see water under or near the bridge, whether looking to the bridge from the west along the Wetherill Trail or looking east along the trail from the boat docks. Therefore, while Rainbow Bridge is an important visual resource, also important are the potential effects of the alternatives on this visual resource with respect to how reservoir elevations impact water access. These potential effects are analyzed in Section 4.3.

This visual impact analysis includes another geologic attraction, Cathedral in the Desert. This feature was inundated by the waters of Lake Powell as the reservoir filled. This geologic feature is now only exposed at low Lake Powell elevations; it is completely visible and accessible when reservoir elevations are below 3,550 feet msl.

Glen Canyon Dam is also an attraction feature. The American Society of Civil Engineers considers it one of the finest examples of concrete thin arch dams in the United States.

3.7.1.2 Calcium Carbonate Rings

Lake Powell has deposits of calcium carbonate surrounding the reservoir that become visible as the reservoir is drawn down. At lower reservoir elevations the colorful sandstone canyon walls show a white band of calcium carbonate deposit between the full reservoir elevation and the lower reservoir elevation, which change the visual contrast of rock and water.

3.7.1.3 Sediment Deltas

Sediment deltas appear as expansive, deep and eroding mud flats, cut by river channels. Sediment exposed for more than a few months is soon colonized by tamarisk. Sediments carried by the Colorado River and the San Juan, Dirty Devil, and Escalante rivers are deposited near the inflow areas of Lake Powell, forming downstream-progressing deltas. These sediment deltas are considered a visual detraction, particularly as the reservoir elevation decreases and the deltas become more visible.

3.7.2 Glen Canyon Dam to Lake Mead

River trips down the Colorado River through Marble Canyon and the Grand Canyon are renowned for their visual character. The proposed federal action will not have any visual effects on this reach.

3.7.3 Lake Mead and Hoover Dam

3.7.3.1 Attraction Features

Hoover Dam is a major destination and a national landmark. In 1955, it was selected as one of the seven engineering wonders in the United States by the American Society of Civil Engineers. The dam is located in a narrow, steep-walled canyon. Only a small portion of Lake Mead within Black Canyon can be viewed from Hoover Dam and the adjacent visitor facilities.

3.7.3.2 Calcium Carbonate Rings

Lake Mead also has deposits of calcium carbonate on the surrounding reservoir walls that become visible as the reservoir is drawn down. At lower reservoir elevations the steep rock slopes, canyon walls, and islands show a white band of calcium carbonate deposit between the full reservoir elevation and the lower reservoir elevation, which changes the visual contrast of rock and water. The ring is primarily noticeable to travelers on U.S. Highway 93 between Boulder City, Nevada and Hoover Dam, and to boaters and hikers. The main viewshed affected is the 56 square mile Boulder Basin.

3.7.3.3 Sediment Deltas

Sediment deltas have built up at the confluence of the Virgin River and Muddy River at the upper Overton Arm and at upper Lake Mead (Iceberg Canyon, Pearce Basin, and lower Granite Gorge). Sediment deltas are visible primarily to water-based recreationists, though they can also be viewed by visitors of the Lake Mead National Recreation Area (NRA) at Overton Beach and Pearce Ferry.

3.8 Biological Resources

This section describes the existing conditions related to biological resources within the study area that could be affected by implementation of the proposed federal action, including vegetation, wildlife and special status species associated with the Colorado River, its mainstream reservoirs, and historic floodplain.

Water deliveries are made to the service areas of the CAP, SNWA, and MWD through a series of pumps, pipelines, diversions, and lined canals. Accordingly, the vegetation and wildlife habitat potential of this infrastructure is essentially absent. Therefore, no impacts to biological resources within these facilities are expected, and they are not analyzed in the Final EIS.

Furthermore, Reclamation does not have the authority to decide how these agencies will operate under a Shortage Condition. For example, Reclamation does not control, and cannot anticipate which specific agricultural acreages may be planted or fallowed as a result of changes in water deliveries due to the proposed federal action, nor are individual farm operator's response to various water delivery conditions predictable over the long-term given access to alternative sources of water, economic conditions, and other factors. While the Final EIS has identified the potential for fallowing agricultural lands, it cannot identify specific acreage which would be fallowed as a result of the proposed federal action. Therefore, the effect on any specific acreage is not reasonably certain to occur and it would be speculative to attempt to identify potential biological effects within the service areas. Thus these potential biological effects are not analyzed in this Final EIS.

Reclamation is involved with numerous ongoing activities aimed at reducing the impact its operations have on biological resources, particularly on endangered species. For example, Reclamation is implementing the Glen Canyon Dam Adaptive Management Program aimed at protecting and improving the environment downstream of Glen Canyon Dam, and the LCR MSCP aimed at enhancing habitat for several endangered species and providing comprehensive mitigation to offset impacts from a range of conditions downstream of Hoover Dam.

3.8.1 Vegetation

Plant communities in the study area can be broadly categorized as riparian. The riparian vegetation along the Colorado River is among the most important wildlife habitat in the region. Riparian habitats, or vegetated areas along streams and rivers, in the Western United States typically support a disproportionately large number of wildlife species.

Much of the information in this section comes from the Final Environmental Impact Statement on the Colorado River Interim Surplus Criteria (Reclamation 2000) and various LCR MSCP documents (Reclamation 2005b).

3.8.1.1 Lake Powell and Glen Canyon Dam

Riparian vegetation around Lake Powell is extremely restricted because of the desert terrain that extends directly to the water's edge, and the continuously fluctuating lake elevations. Salt cedar, also known as tamarisk (*Tamarix ramosissima*), a nonnative invasive shrub along the Lake Powell shoreline is still becoming established and has not yet formed stable communities. These communities may attain some level of importance as insect and wildlife (particularly bird) habitat in the future, and provide habitat for fish during high lake elevations when the plants are inundated.

Fluctuations in lake elevations may result in standing water in the side canyons of Lake Powell where riparian vegetation has become established. Dominant plants found in these canyons include Fremont cottonwood (*Populus fremontii*), salt cedar, and cattail (*Typha sp.*). The GCNRA has many springs, seeps that are common in alcoves along Glen Canyon walls, and waterpockets located in canyons and uplands. These areas are recognized for their significance as wetland habitats and as unique ecosystems within the desert. These seeps support hanging gardens which are a specialized vegetation community (Welsh et al. 1987). The water sources that support hanging gardens originate from natural springs and seeps within the Navajo Sandstone formation and are independent of Lake Powell. This plant community will not be affected by the proposed federal action and as such it is not considered further in the Final EIS.

3.8.1.2 Glen Canyon Dam to Lake Mead

There is a change in the composition of the riparian community in this reach from Intermountian flora to that of the southern Basin and Range. Total area associated with the riparian community measures at least 10 square miles (6,400 acres).

Today, salt cedar, arrowweed (*Pluchea sericea*), black willow or Gooding willow (*Salix goodingii*), coyote willow (*Salix exigua*), and Emory seepwillow (*Baccharis emeroyi*) are the primary phreatophytes in the riparian zone (taxonomy is after Welsh et al. 1987). Those species that are more adapted to dry conditions may also be found further upslope on the terraces. Terrace dominants including four-wing saltbush (*Atriplex canescens*), arrowweed (*Pluchea sericea*), rubber rabbitbrush (*Chrysothamnus nauseosus*), and netleaf hackberry (*Celtis reticulata*), may also be located closer to the riverbank.

Marshes composed of emergent aquatics such as common cattail (*Typha domingensis*), broad-leaved cattail (*Typha latifolia*), and bulrushes (*Scirpus spp.*) have become established in return-current channels (backwaters), channel margins, and mouths of tributary streams from Glen Canyon Dam downstream to Lake Mead. Stands of emergent marsh vegetation in the riparian zone tend to be dominated by a few species, depending on soil texture and drainage. A cattail (*Typha domingensis*) and common reed (*Phragmities australis*) association grows on fine-grained silty loams while a horseweed (*Conyza canadensis*), knotweed (*Polygonum aviculare*), and Bermuda grass (*Cynodon dactylon*) association grows on loamy sands.

Since 1995, there has been a modest increase in woody vegetation and an increase in marsh communities under modified Glen Canyon Dam operations (Gloss et al. 2005). However, the increase in woody vegetation is partially due to expansion of the non-native salt cedar and arrowweed into the riparian zone. The United States Geological Survey (USGS) has indicated that there has been a decrease in wet marsh and an increase in dry marsh (Gloss et al. 2005).

3.8.1.3 Lake Mead to SIB

The highest concentration of vegetated habitat associated with Lake Mead is found in the Lake Mead and Virgin River deltas. Fluctuating lake elevations limit the shoreline vegetation. Riparian vegetation that does develop within the range of Lake Mead elevation fluctuations is temporary as fluctuating lake elevations either dewater or inundate these areas through time. Linear riparian woodlands may be present along the shoreline of the Lake Mead delta following high water flows, and associated sediment deposition and exposure. The sediment deposition and the associated growth of riparian vegetation at the Lake Mead delta has occurred for decades. As lake elevations decline, vegetation in the Lake Mead and Virgin River deltas begins to establish on clay/silt deposits. The dynamic nature of fluctuating lake elevations and deposition of sediment in the Lake Mead delta is expressed as a change in plant species composition and relative abundance over time. An increase in sediment deposition in the deltas followed by lower lake elevations allows establishment of native riparian habitat if the lowering of the lake elevations is timed to match native seed dispersal.

Vegetation for this reach is categorized using the methodology outlined in the LCR MSCP. Detailed descriptions of the vegetation resources can be found in the LCR MSCP documents. A summary of the vegetation cover types, and their characteristics, found from Lake Mead to the SIB is provided in Table 3.8-1.

Table 3.8-1
Summary of Vegetation Cover Types from Lake Mead to the SIB

Vegetation Cover Type	Characteristics
Woody Riparian	
Cottonwood-willow (6 structural types)	Gooding willow and cottonwood at least 10 percent of total trees
Saltcedar (6 structural types)	Saltcedar species constituting 80 to 90 percent of total trees
Honey Mesquite (4 structural types)	Honey mesquite constituting 90 to 100 percent of trees
Saltcedar-honey mesquite (4 structural types)	Honey mesquite at least 10 percent of total trees (usually <40 percent)
Saltcedar-screwbean mesquite (5 structural types)	Screwbean mesquite at least 20 percent of total trees
Arrowweed	Arrowweed at least 90 to 100 percent of total vegetation
Atriplex	Saltbush species constituting 90 to 100 percent of total vegetation
Marsh (7 compositional types)	Cattail/bulrush, little common reed, trees and grasses, and open water
Aquatic	
River	Mainstream plus tributaries and natural/artificial channels
Reservoir	Lakes formed by dams with variable water levels
Backwater	Open water plus marsh, temporary to permanent
Desert Scrub	Adjacent to riparian and aquatic land cover types
Agriculture	Active or fallow, adjacent to riparian and aquatic land cover types
Developed	Buildings, roads, campgrounds, landscaped areas

Table 3.8-2 provides a summary of the vegetation cover type acreage by river sub-reach that was determined to be present for the LCR MSCP analysis. A detailed breakdown of the sub-categories of cover types is provided in Table 4-8 of the LCR MSCP BA.

Table 3.8-2
Summary of Vegetation Cover Types from Lake Mead to the NIB (acres)[a]

Type	Lake Mead and Hoover Dam	Hoover Dam to Davis Dam	Davis Dam to Parker Dam	Parker Dam to Cibola Gage	Cibola Gage to Imperial Dam	Imperial Dam to NIB
Cottonwood-willow	1,721	1	1,541	889	616	1,325
Saltcedar	2,254	838	13,647	26,923	5,581	6,257
Honey Mesquite	0	4	627	6,443	175	5
Saltcedar-Honey Mesquite	58	359	3,463	13,398	778	234
Saltcedar-Screwbean Mesquite	0	32	5,058	4,654	579	786
Marsh	137	22	4,358	2,091	3,762	1,414
Atriplex	0	0	19	582	0	177
Arrow weed	0	0	496	6,541	48	1,069
Desert Scrub	353	31	7,676	11,710	397	3,151
Agriculture	0	0	19,166	169,664	260	36,799
Undetermined Riparian	0	0	6,634	6,268	0	2,337

[a] *From LCR MSCP BA Table 4-8 (Reclamation 2004c).*

For reference, further description of the LCR MSCP vegetation types present in this reach are provided below. The vegetation is classified according to the Anderson and Ohmart system, which is further described in the LCR MSCP documents (Reclamation 2005b).

3.8.1.4 NIB to SIB

Riparian communities comprise approximately 6,974 acres of the land cover present below Morelos Diversion Dam; 3,638 acres of which is in the United States. Approximately 77 percent of these communities are dominated by non-native saltcedar. The types of riparian communities present in this reach are described in Table 3.8-1. Table 3.8-3 summarizes the extent of riparian communities in the United States below Morelos Diversion Dam, from the NIB to the SIB.

The Borderlands Task Force consisting of the BLM, the Border Patrol (Department of Homeland Security), the USACE, FWS, Reclamation, and the Cocopah Tribe of Arizona is planning a vegetation clearing project along this reach aimed at improving security along this section of the United States and Mexico border. BLM is the lead federal agency responsible for compliance on this proposed effort.

Table 3.8-3
Summary of Vegetation Cover Types in the United States from NIB to SIB[a]

Type	Acreage
Arrow weed	33
Atriplex	38
Cottonwood-Willow-I	14
Cottonwood-Willow-II	38
Cottonwood-Willow-III	212
Cottonwood-Willow-IV	165
Cottonwood-Willow-V	27
Subtotal	*527*
Marsh	50
Saltcedar	2,996
Saltcedar-screwbean mesquite	65
TOTAL	3,638

[a] *Reclamation, July-September 2005 surveys.*

3.8.2 Wildlife

The Colorado River and its associated riparian vegetation provide important habitat for a variety of wildlife. Table 3.8-4 lists the native and non-native fish species that occur in the study area. The study area extends from the northern tip of Lake Powell in Utah south to the SIB (RM 0.0).

3.8.2.1 Lake Powell and Glen Canyon Dam

Fifteen fish species reside in Lake Powell and include 14 non-native fish species and one native fish species (flannelmouth sucker).

Common fish species in Lake Powell include walleye, bluegill, green sunfish, carp and channel catfish. Species that occur in the reservoir, but that are mainly associated with tributaries and inflow areas, include fathead minnow, mosquitofish, red shiner and plains killifish (NPS 1996). Mueller and Horn (1999) reported large numbers of fish in the reservoir upstream of the dam, but Budy et al. (2005) found large seasonal variances in fish abundances with low numbers of striped bass, threadfin shad and gizzard shad present at Wahweap Bay in May and July.

Table 3.8-4
Native and Non-Native Fish Species Present in the Study Area by Reach

Species	Reach	Native/ Non-native
Black bullhead *(Ictalurus melas)*	All	Non-native
Black crappie *(Pomoxis nigromaculatus)*	All	Non-native
Bluegill *(Lepomis macrochirus)*	All	Non-native
*Bluehead sucker *(Catastomus discobolus)*	Glen Canyon Dam to Lake Mead	Native
*Bonytail *(Gila elegans)*	Lake Powell (rare), Hoover Dam to Imperial Dam	Native
Carp *(Cyprinus carpio)*	All	Non-native
Channel catfish*(Ictalurus punctatus)*	All	Non-native
*Colorado pikeminnow *(Ptychocheilus lucius)*	Lake Powell to Glen Canyon Dam (rare)	Native
Fathead minnow *(Pimephales promelas)*	All	Non-native
*Flannelmouth sucker *(Catostomus latipinnis)*	Lake Powell, Separation Canyon, Lake Mead, immediately downstream of Davis Dam	Native
Flathead catfish *(Pylodictis olivaris)*	Davis Dam to the NIB	Non-native
Green sunfish *(Lepomis cyanellus)*	Lake Powell to Glen Canyon Dam, Lake Mead to the SIB	Non-native
*Humpback chub *(Gila cypha)*	Lake Powell (rare) Glen Canyon Dam to Separation Canyon	Native
Largemouth bass *(Micropterus salmoides)*	Lake Powell to the NIB	Non-native
Mosquitofish *(Gambusia affinis)*	Glen Canyon Dam to the SIB	Non-native
Plains killifish *(Fundulus zebrinus)*	Glen Canyon Dam to Hoover Dam	Non-native
Rainbow trout *(Oncorhynchus mykiss)*	Glen Canyon Dam to Below Davis Dam	Non-native
*Razorback sucker *(Xyrauchen texanus)*	Lake Powell to Imperial Dam (rare upstream of Lake Mead)	Native
Red shiner *(Notropis lutrensis)*	All	Non-native
Shortfin mollies *(Poecilia mexicana)*	Lake Mead, Laguna Dam to the SIB	Non-native
Smallmouth bass *(Micropterus dolomieui)*	Lake Powell, Separation Canyon (rare), Lake Mead to Imperial Dam	Non-native
Speckled dace *(Rhinichthys osculus)*	Glen Canyon Dam to Lake Mead	Native
Striped bass *(Morone saxatilis)*	Lake Powell to the NIB	Non-native
Threadfin shad *(Dorosoma petenense)*	Lake Powell to the SIB	Non-native
Tilapia *(Oreochromis aureus)*	Lake Mead to the SIB	Non-native
Walleye *(Stizostedion vitreum)*	Lake Powell to Glen Canyon Dam	Non-native
Redear Sunfish *(Lepomis Microlophus)*	Davis Dam to the NIB	Non-Native
Warmouth *(Chaenobryttus gulosus)*	Parker Dam to the NIB	Non-Native
Sailfin Molly *(Poecillia latipinna)*	Palo Verde Diversion Dam to the SIB	Non-native
Striped Mullet *(Mugil cephalus)*	Laguna Dam to the SIB	Native
Goldfish *(Carassius auratus)*	Lake Mead to the SIB	Non-native
Yellow bullhead *(Ameiurus natalis)*	Lake Powell to the SIB	Non-native

Distribution Information from: CDFG 2000; Colorado Division of Wildlife no date; Fuller 2006; New Mexico Game and Fish 2004; NatureServe 2006; Pima County no date; Ptacek et al. 2005; Rees et al. 2005a; Rees et al. 2005b; FWSa no date; FWSb no date; FWSc no date; Valdez 2006.

**Note: These fish species are discussed further below under Special Status Species.*

Non-native fish species became established by intentional and unintentional introductions. Lake Powell was stocked with non-native sport and forage fish and movement of stocked non-native fish into the lake has also taken place. Largemouth bass and crappie populations were stocked initially and proliferated to provide the bulk of the sport fisheries. Both species have declined in recent years due to lack of habitat structure for young fish. Filling and fluctuation of the reservoir resulted in changing habitat that eliminated most of the vegetation favored by many species. The habitat change led to the introduction of smallmouth bass and striped bass, presently the two dominant predator species in the reservoir, with striped bass being the most dominant. Threadfin shad were introduced to provide an additional forage base and quickly became the predominant prey species (NPS 1996).

The sport fishery in Lake Powell is primarily based on striped bass. Other sport fish found in Lake Powell include largemouth bass, catfish and trout. Threadfin shad in Lake Powell exist in the northernmost portion of their range, and are the primary food source for striped bass.

July 2007 sampling in Lake Powell found three individual quagga and/or zebra mussel larvae near Wawheap Marina and near Glen Canyon Dam. The testing method is not able to determine whether these larvae are zebra or quagga mussels. Uncertainty remains as to whether there is an established population of zebra and/or quagga mussels in Lake Powell (Utah Division of Wildlife Resources 2007).

At least six species of amphibians are currently known to live in Glen Canyon National Recreation Area. The Canyon tree frog (*Hyla arenicolor*) is common along the shores of Lake Powell (Spence 1996). All other herpetofauna, including the declining northern leopard frog (*Rana pipiens*), are associated with side canyons off Lake Powell and are therefore outside the area of influence of the proposed federal action.

Common waterfowl of the Lake Powell area include American widgeon (*Anas americana*), northern pintail (*Anas acuta*), bufflehead (*Bucephala albeola*) common goldeneye (*Bucephala clangula*), common merganser (*Mergus merganser*), green-winged teal (*Anas crecca*), lesser scaup (*Aythya affini*), eared grebe (*Podiceps nigricollis*), and mallard (*Anas platyrhynchos*). The majority of these are winter residents or spring and fall migrants. Most shorebirds are summer residents. Common shorebird species include western sandpiper (*Calidris mauri*), least sandpiper (*Calidris minutilla*), American avocet (*Recurvirostra americana*), long-billed dowitcher (*Limnodromus scolopaceus*), snowy egret (*Egretta thula*), and great blue heron (*Ardrea herodias*). Ring-billed gulls (*Larus delarwarensis*) are common year-round residents.

Larger mammals inhabiting the study area include beavers, desert bighorn sheep, mule deer, coyotes, mountain lions, and bobcats (Reclamation 2004b). Mountain lions and bobcats are rare. Smaller mammals include ringtail and western spotted skunks and six bat species (Carothers and Brown 1991). Two skunk species are some of the most common mammals in the area.

3.8.2.2 Glen Canyon Dam to Lake Mead

A total of 18 non-native fish species have been reported between Glen Canyon Dam and Lake Mead during the period of 1957 through 2006 (Lauretta and Johnstone 2005; Lauretta and Seratto 2006; Trammell and Valdez 2003; Valdez and Ryel 1995). Non-native fish infrequently occurring in this reach include the golden shiner, redside shiner, striped bass, and threadfin shad.

The Glen Canyon Dam to Lake Mead reach supports six native fish species which include small numbers of the three non-ESA listed species: flannelmouth sucker, bluehead sucker, and speckled dace. The flannelmouth sucker spawns in the Colorado River (McIvor and Thieme 1999; Thieme 1998), although the water generally is too cold for survival of eggs and larvae. Populations of bluehead and flannelmouth suckers are protected under a multi-state cooperative agreement between Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming (Utah Department of Natural Resources 2004). Their populations appear to have remained relatively stable under the Modified Low Fluctuating Flows (MLFF) operating policy of Glen Canyon Dam.

The primary sport fish in the Colorado River between Glen Canyon Dam and Lake Mead inflow is rainbow trout. Natural reproduction of rainbow trout in the Grand Canyon is dependent on cool water temperatures, access to tributaries for spawning and continued availability of suitable mainstream habitat. These variables are directly related to patterns of flow releases from Lake Powell. McKinney and Speas (2001) conducted a study analyzing 658 rainbow trout around Lees Ferry to determine the predominant food sources. It was found that *Gammarus*, chironomids, and *Cladophora* constituted about 90 percent of the food by volume.

Humpback chub have also been reported to rely on *Gammarus* and chironomids, but also rely on larval simuliids, which become more common downstream of the Paria River (Gloss et al. 2005). *Cladophora, Oscillatoria spp* and terrestrial organic matter serve as key energy sources for aquatic invertebrates between Glen Canyon Dam and Lake Mead. *Cladophora and Oscillatoria* are also consumed by fish (Gloss et al. 2005).

Zebra and/or quagga mussels prefer slow moving water and are currently not known to exist in the Colorado River between Glen Canyon Dam and Lake Mead (Britton 2007, personal communication).

Over 27 species of herpetofauna have been documented in the riparian zone of Grand Canyon. Within this reach, herpetofauna densities are generally highest in the new high water zone of riparian vegetation that has developed since construction of Glen Canyon Dam. The old high water zone is situated higher in elevation, a result of pre-dam flooding. However, Carpenter (2006) found that, other than the resident frog species, all herpetofuana observed in the canyon utilized all three hydrologic zones - shoreline, the new high water zone and the old high water zone. Toads and tree lizards used the shoreline proportionally more than any of the other species and were observed more in the new, than in the old high water zone.

The most common lizards in the riparian zone are the side-blotched lizard (*Uta stansburiana*), the Western whiptail (*Cnemidophorus tigris*), the desert spiny lizard (*Sceloporus magister*), and the tree lizard (*Urosaurus ornatus*). The collared lizard (*Crotaphylus insularis*) and the chuckwalla (*Sauromalus obesus*) are less common in the riparian zone than in the old high water zone. Warren and Schwalbe (1986) reported lizard densities during June averaged 858 per hectare in the riparian zone versus 300 per hectare in the old high water zone. Kearsley et al. (2006) suggested that the high density of lizards in the riparian zone may be attributed to increased abundance of food resources (insects) and to some degree to organic debris left on popular camping beaches.

Snakes are common in the higher and drier elevations of the riparian zone and in the more xeric terraces and hillsides. Eight snake species have been documented within the riparian zone; the most common of these are the Grand Canyon rattlesnake (*Crotalus viridis abyssus*), the southwestern speckled rattlesnake (*C. mitchellii pyrrhus*) and the desert striped whipsnake (*Masticophis taeniatus*).

Recent surveys have found healthy populations of the Woodhouse's toad (*Bufo woodhousii*), the red-spotted toad, (*B. punctatus*), the canyon treefrog, and the tiger salamander (*Ambystoma tigrinum*) (Gloss et al. 2005).

The canyon tree frog is confined mostly to relatively steep side canyons while the two toad species are generally found in the active riparian zone in spring and fall but appear to favor the shore zone in summer (Kearsley et al. 2003). For riverside dwellers, egg deposition and larval development generally occurs in the backwaters or along the shallow waters at the boundary of the aquatic and riparian ecosystems.

Listed as a species of special concern in Arizona, the northern leopard frog is declining throughout its range. Leopard frogs have disappeared from 70 percent of the known sites upstream and downstream of Glen Canyon Dam and there appear to be declines among some of the remaining populations (Gloss et al. 2005). The only known remaining population downstream of Glen Canyon Dam is located between Glen Canyon Dam and the Paria River in a series of off-channel pools. Inundation at this site occurs at approximately 21,000 cfs. This population has experienced wide year-to-year fluctuations in numbers, but recent survey efforts indicate a sharp decline in population size with only two adult individuals found in 2004 (Drost 2004).

In 2004, a previously unknown small population of a second leopard frog species was found in Surprise Canyon. Although genetic studies are still in progress, the frogs appear to be an ever rarer species, the lowland leopard frog (*Rana yavapaiensis*). This small population is located well up the canyon and outside the influence of flows in the Colorado River (Drost 2005).

More than 30 bird species have been recorded breeding in the riparian zone along the Colorado River in Grand Canyon. Most of these bird species nest and forage for insects within the riparian zone and the adjacent upland area. Of the 15 most common riparian breeding bird species, 10 are neotropical migrants that breed in the study area but winter primarily south of the United States-Mexico border. The rest of the breeding birds that use the canyon are year-round residents or short-distance migrants that primarily winter in the region or in nearby southern Arizona (Brown et al. 1987).

Eleven of these nesting bird species are referred to as obligate riparian birds due to their complete dependence on the riparian zone. Obligate riparian birds nesting within the riparian zone include the neotropical migrants Lucy's warbler (*Vermivora luciae*) and Bell's vireo (*Vireo bellii*), two species identified as "high priority" under regional Partners-in-Flight bird plans and area state bird plans, Common yellowthroat (*Geothlypis trichas*), yellow warbler (*Dendroica petechia*), yellow-breasted chat (*Icteria virens*), black-chinned hummingbirds (*Archilochus alexandri*), the endangered Southwestern willow flycatcher (*Empidonax trailii extimus*), and Bewick's wren (*Thryomanes bewickii*), a sometimes permanent resident of Grand Canyon. Black Phoebe (*Sayornis nigricans*) is a common permanent resident of the canyon having a close association with water.

The riparian breeding bird community appears little changed since the riparian plant community stabilized in the 1970s and bird studies were initiated in the 1980s. Exceptions are Bell's vireo and song sparrow (*Melospiza melodia*), which appear to have expanded their breeding ranges, and Bullock's oriole (*Icterus bullockii*) and yellow warbler which have increased in number. The blue-gray gnatcatcher (*Polioptila caerulea*) has shown a steady decline in numbers (Brown et al. 1987; Spence 2004; Yard and Blake 2004).

Winter songbirds include ruby-crowned kinglet, white-crowned sparrow, dark-eyed junco, and song sparrow (Spence 2004). Spence (2004) found that winter species diversity increased below RM 205.

The aquatic bird community is almost exclusively made up of winter residents. Thirty-four species of wintering waterfowl along with loons, cormorants, grebes, herons, rails, and sandpipers utilize the Colorado River corridor. Increases in abundance and species richness have been attributed to the increased river clarity and productivity associated with the presence of Glen Canyon Dam (Spence 2004; Stevens et al. 1997a). The majority of waterfowl tends to concentrate above the Little Colorado River due to the greater primary productivity that benefits dabbling ducks and greater clarity for diving, piscivorous ducks. Common waterfowl species include American coot (*Fulica americana*), American widgeon, bufflehead, common goldeneye, common merganser, gadwall (*Anas strepera*), green-winged teal, lesser scaup (*Aythya affinis*), mallard, and ring-necked duck (*Aythya collaris*). Shorebirds other than great blue heron and spotted sandpiper (*Actitis macularia*) are rare in the action area. These species are fairly common winter and summer residents along the Colorado River.

The American peregrine falcon (*Falco peregrinus*) are uncommon year-round residents in the study area. In recent years, as many as twelve active eyries have been found in Glen Canyon. Nest sites are usually associated with water. In Grand Canyon, common prey items in summer include white-throated swift (*Aeronautes saxatalis*), swallows, other song birds, and bats (Brown 1991), many of which feed on invertebrate species (especially Diptera) that emerge out of the Colorado River (Stevens et al. 1997b). In winter, a common prey item is waterfowl.

The common bird species found in this reach (Gloss et al. 2005) are summarized in Table 3.8-5 and Table 3.8-6.

Table 3.8-5
The Fifteen Generally Most Common Terrestrial Breeding Bird Species Found in Riparian Habitats Along the Colorado River in Grand Canyon

Common Name	Scientific Name
Ash-throated flycatcher	*Myiarchus cinerascens*
Bell's vireo	*Vireo bellii*
Bewick's wren	*Thryomanes bewickii*
Black-chinned hummingbird	*Archilochus alexandri*
Blue grosbeak	*Passerina caerulea*
Blue-gray gnatcatcher	*Polioptila caerulea*
Bullock's oriole	*Icterus bullockii*
Common yellowthroat	*Geothlypis trichas*
House finch	*Carpodacus mexicanus*
Lesser goldfinch	*Carduelis psaltria*
Lucy's warbler	*Vermivora luciae*
Mourning dove	*Zenaida macroura*
Song sparrow	*Melospiza melodia*
Yellow warbler	*Dendroica petechia*
Yellow-breasted chat	*Icteria virens*

Table 3.8-6
The Ten Generally Most Common Overwintering Aquatic Bird Species Encountered During Surveys Along the Colorado River Downstream of Glen Canyon Dam

Common Name	Scientific Name
American coot	*Fulica Americana*
American wigeon	*Anas Americana*
Bufflehead	*Bucephala albeola*
Common goldeneye	*Bucephala clangula*
Common merganser	*Mergus merganser*
Gadwall	*Anas strepera*
Green-winged teal	*Anas crecca*
Lesser scaup	*Aythya affinis*
Mallard	*Anas platyrhynchos*
Ring-necked duck	*Aythya collaris*

Within the GCNRA and Grand Canyon National Park, 64 and 34 species of mammals, respectively, have been found (Carothers and Aitchison 1976; Warren and Schwable 1986; Frey 2003). Of these mammals only three can be considered obligate aquatic mammals - beaver (*Castor canadensis*), muskrat (*Ondatra canadensis*), and river otter (*Lutra canadensis*). Despite occasional reported sightings of river otters in Grand Canyon, river otters are classified as extirpated and muskrats are considered extremely rare.

An increase in the population size and distribution of beavers in Glen Canyon and Grand Canyon has occurred since the construction of Glen Canyon Dam, likely due to the increase in riparian vegetation and relatively stable flows. Beavers cut willows, cottonwoods, and shrubs for food and can significantly affect the riparian vegetation. Bats in Grand Canyon typically roost in desert uplands, but forage on abundant insects along Lake Powell, the Colorado River and its tributaries. The deer mouse (*Peromyscus maniculatus*) is restricted to the riparian zone. Larger mammals include coyotes (*Canis latrans*), bighorn sheep, mule deer (*Odocoileus rafinesque*), mountain lions (*Puma concolor*), and bobcats (*Lynx rufus*). Mountain lions and bobcats are rarely seen (Gloss et al. 2005).

3.8.2.3 Lake Mead and Hoover Dam

The sport fishery in Lake Mead is primarily for striped bass and largemouth bass. Other sport fish found in the lakes include catfish and hatchery reared rainbow trout (Reclamation 2000).

Native fishes in this reach include the razorback sucker, and the flannelmouth sucker. Non-native fishes inhabiting this reach include red shiner (*Cyprinella lutrensis*), common carp (*Cyprinus carpio*), and mosquitofish, among others (Reclamation 1982).

A large number of non-native fish species are present, predominantly downstream of the Warm Springs area on the Muddy River and continuing into Lake Mead (FWS 1995). Non-native species that co-occur with native fishes in spring-fed pools include shortfin mollies (*Poecilia mexicana*), mosquitofish, and tilapia (*Oreochromis aureus*) (Scoppettone et al. 1998).

The non-native quagga mussel (*Dreissena rostriformis bugensis*) was discovered at Lake Mead in early January 2007 (FWS 2007). Monitoring is ongoing to determine their extent.

The herpetofauna and their habitat use of upper Lake Mead is an extension of the more common species and habitat use described above for the Glen Canyon Dam to Lake Mead reach. The two relict leopard frog (*Rana onca*) populations within LMNRA are associated with isolated springs and are outside the area of influence of the proposed federal action. The spiny soft-shelled turtle (*Trionyx spiniferus*) has also been introduced and it is present in Lake Mead (Allan and Roden 1978).

Avifauna for upper Lake Mead is similar to that discussed for the previous river reaches. Songbird species are similar to those of the canyons upstream with greater diversity than in Glen Canyon and Grand Canyon. Waterfowl species are similar to those described above for Lake Powell. Waterfowl use of Lake Mead is highest in winter months.

Mammalian use of this reach is similar to that discussed for the previous reaches.

3.8.2.4 Hoover Dam to NIB

This section of the lower Colorado River supports several hundred species of wildlife (birds, mammals, fish, reptiles, and amphibians), including both resident species and migratory visitors, that use the land cover types described above. Common mammals include mule deer (*Odocoileus hemionus*), burro (*Equus asinus*) (a non-native mammal), coyote (*Canis latrans*), bobcat (*Felis rufus*), Audubon cottontail (*Sylvilagus audubonii*), several species of rodents and bats, striped skunk (*Mephitis mephitis*), and raccoon (*Procyon lotor*) (Anderson and Ohmart 1984). Reptiles and amphibians are represented by several species of lizards, snakes, toads, and frogs, many of which are native to the area. Most of these use upland and riparian areas, but the amphibians require water for reproduction. The spiny soft-shelled turtle (*Trionyx spiniferus*) has also been introduced in Lake Mohave (Allan and Roden 1978). A variety of aquatic invertebrates inhabit the reservoirs and river. Fourteen species of zooplankton have been reported in Lake Mead and Lake Mohave as well as mollusks, crustaceans, aquatic and terrestrial insects, and a freshwater jellyfish (Allan and Roden 1978).

The non-native quagga mussel was recently discovered in Lake Mohave and Lake Havasu (FWS 2007). Monitoring is ongoing to determine their extent.

The Colorado River corridor provides important habitat for migratory birds, both neotropical songbirds and waterfowl and other wetland dependent species, as well as habitat for resident species. These migratory species include such songbirds as humming birds, cuckoos, flycatchers, vireos, warblers, tanagers, orioles, buntings, waterfowl and wetland birds such as geese, ducks, cranes, rail, killdeer and other plovers, stilts, avocets, yellowlegs, dowitchers, and sandpipers. Woody riparian vegetation and wetlands provide habitat for a variety of raptors that include sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), rough-legged hawk (*Buteo lagopus johannis*), common black hawk (*Buteogallus anthracinus*), Harris' hawk (*Parabuteo unicinctus*), bald eagle (*Haliaeetus luecocephalus*), golden eagle (*Aquila chrysaetos*), white-tailed kite (*Elanus leucurus*), American kestrel (*Falco sparverius*), peregrine falcon (*Falco peregrinus*), and osprey (Pandion haliaetus). Other common birds include egrets, herons, and woodpeckers. Backwaters and reservoirs provide resting and foraging habitat for waterfowl and shorebirds.

3.8.2.5 NIB to SIB

Aquatic habitats within this reach are supplied by surface water present in the lower Colorado River channel and in backwaters maintained by subsurface lower Colorado River flow. Approximately 205 acres of open water were present in this reach in 2005. These open water areas and associated emergent vegetation provide habitat for a variety of waterfowl, wading birds (e.g., herons), water birds (e.g., grebes), and shorebirds. Huerta et al. (2003) recorded 13 species of water-associated bird species using aquatic habitats of the limitrophe in 2003. Permanent fish habitats are limited to the upstream portions of the limitrophe that maintain surface water throughout the year. Fish present in the limitrophe are primarily introduced species (e.g., catfish and other sport fishes). As identified in Table 3.8-4, sixteen species of fish, primarily non-native, may be found in this reach. Native species historically occurring in this reach included the following marine or brackish water species: spotted sleeper (*Eleotris picta*), machete (*Elops affinis*), longjaw mudsucker (*Gillichthys mirabilis*), and striped mullet (*Mugil cephalus*) (Reclamation 2004d).

Woody riparian vegetation provides habitat for common mammals such as coyote, bobcat (*Felis rufus*), Audubon cottontail, several species of rodents and bats, muskrat (*Ondatra zibheticus*), beaver (*Castor canadensis*), and raccoon (*Procyon lotor*) (Huerta et al. 2003). Common birds associated with riparian habitats include mourning dove, ash-throated flycatcher, Crissal thrasher, Bullock's oriole, brown-headed cowbird, Abert's towhee, and verdin. Reptiles and amphibians known to occur include Woodhouse's toad (*Bufo woodhousii*), bullfrog (*Rana catesbeiana*), the non-native spiny softshell (*Trionyx spiniferus*), tree lizard (*Urosaurus ornatus*), and bullsnake (*Pituophis catenifer sayi*) (Huerta et al. 2003). The lower Colorado River also serves as a migration corridor for numerous neotropical migrant birds and riparian vegetation present in this reach provides stopover habitat for these species during migration.

3.8.3 Special Status Species

Special status species are species that are listed, or those that are proposed for listing as threatened or endangered under the ESA that may be present in the study area, and include species of special concern to states and other entities responsible for management of resources within the study area. This includes special status species and their habitat from Lake Powell to the SIB that may be affected by the proposed federal action. Special status species not associated with the Colorado River, or which otherwise are not likely to be affected, are not described in this EIS.

Reclamation is consulting with the FWS to meet its responsibilities under Section 7 of the ESA on the potential effects of the proposed federal action to ESA-listed species. A considerable amount of information pertinent to this analysis is available from various recent documents prepared by Reclamation and the FWS under NEPA and/or the ESA. These documents were relied upon for much of the information for this section.

Reclamation prepared a BA on the ISG and the Secretarial Implementation Agreement (SIA), which analyzed the potential effects on special status species, including ESA-listed species which may occur in the study area from the full pool elevation of Lake Powell to the SIB (Reclamation 2000).

More recently, Reclamation completed consultation under ESA for various current and projected federal and non-federal activities covered by the LCR MSCP. The purpose of the LCR MSCP was to provide for conservation of several federally listed species and many non-listed species, while allowing the federal and non-federal MSCP partners to continue their ongoing and future operations below Lake Mead. The geographic scope of the LCR MSCP includes the full pool elevation of Lake Mead and the floodplain downstream to the SIB. Among the activities covered by the consultation were future water delivery reductions under shortage conditions.

Reclamation is consulting with the FWS to meet its responsibilities under Section 7 of the ESA on potential effects of the proposed federal action to federally listed species beyond the LCR MSCP coverage (Appendix R). This includes: 1) Lake Powell to Lake Mead (outside LCR MSCP coverage); 2) the full length of the Muddy River in Nevada, and the Virgin River from the Mesquite Diversion near Mesquite, Nevada to Lake Mead; and 3) incremental effects beyond the LCR MSCP coverage, if any, from Lake Mead to the SIB.

Table 3.8-7 lists those special status species potentially affected by the proposed federal action. Further description of special status species is available in several existing documents including the LCR MSCP (Reclamation 2004a-e, 2005b) and the Colorado River Interim Surplus Criteria Final EIS (Reclamation 2000).

Table 3.8-7
Special Status Species Potentially Affected by the Proposed Federal Action

Common Name	Scientific Name	Listing Status	Location		
			Lake Powell	GCD to Lake Mead	Lake Mead to SIB
Fish					
Colorado pikeminnow	Ptychocheilus lucius	FE CH CA E UT SP AZ SC	X		
Flannelmouth sucker	Catostomus latipinnis	AZ SC BLM S UT CS	X	X	X
Humpback chub	Gila cypha	FE CH UT State Protected AZ SC	X	X	
Bonytail	Gila elegans	FE CH AZ SC CA E	X		X
Speckled dace	Rhinichthys osculus	BLM S		X	
Razorback sucker	Xyrauchen texanus	FE CH CA E UT SP AZ SC	X	X	X
Bluehead sucker	Catostomus discobolus	FC AZ SC UT CS		X	
Birds					
California Condor	Gymnogyps californianus	FE EX AZ SC CA E	X	X	
Bald eagle	Haliaeetus leucocephalus	FT - PDL AZ SC CA E NV SP	X	X	X
Osprey	Pandion haliaetus	AZ SC CA SC	X	X	X
Belted kingfisher	Ceryle alcyon	AZ SC NV SP	X	X	X
American peregrine falcon	Falco peregrinus	FSC AZ SC CA E (fully protected) NV E	X	X	X

Table 3.8-7
Special Status Species Potentially Affected by the Proposed Federal Action

Common Name	Scientific Name	Listing Status	Location		
			Lake Powell	GCD to Lake Mead	Lake Mead to SIB
Southwestern willow flycatcher	Empidonax traillii extimus	FE CH AZ SC CA E NV SP		X	X
Clark's grebe	Aechmophorus clarkia	AZ SC	X	X	X
Snowy egret	Egretta thula	AZ SC		X	X
Yuma clapper rail	Rallus longirostris yumaniensis	FE AZ SC CA T			X
Western yellow-billed cuckoo	Coccyzus americanus	FC AZ SC CA E NV SP		X	X
California black rail	Laterallus jamaicensis coturniculus	FSC AZ SC CA T			X
Elf owl	Micrathene whitneyi	CA E			X
Gilded flicker	Colaptes chrysoides	CA E			X
Gila woodpecker	Melanerpes uropygialis	CA E			X
Vermillion flycatcher	Pyrocephalus rubinus	CA SC			X
Arizona Bell's vireo	Vireo bellii arizonae	CA E			X
Sonoran yellow warbler	Dendroica petechia sonorana	CA SC			X
Summer tanager	Piranga rubra	CA SC			X
American white pelican	Pelecanus erythrorhynchos	CA SC NV SP UT SC			X
Double-crested cormorant	Phalacrocorax auritus	CA SC			X
Western least bittern	Ixobrychus exilis hesperis	FSC CA SC			X
American bittern	Botaurus lentiginosus	AZ SC			X
Great egret	Ardea alba	AZ SC			X
Black-crowned night-heron	Nycticorax nycticorax	CA SC			X
White-faced ibis	Plegadis chihi	FSC CA SC NV SP			X
Black tern	Chlidonias niger	CA SC			X
Greater sandhill crane	Grus canadensis tabida	CA T			X

Table 3.8-7
Special Status Species Potentially Affected by the Proposed Federal Action

Common Name	Scientific Name	Listing Status	Location		
			Lake Powell	GCD to Lake Mead	Lake Mead to SIB
Long-eared owl	Asio otus	CA SC NV SP			X
Brown-crested flycatcher	Myiarchis tyrannulus	CA SC			X
Crissal thrasher	Toxostoma crissale	CA SC			X
Lucy's warbler	Vermivora luciae	CA SC			X
Yellow-breasted chat	Icteria virens	CA SC			X
Yellow-headed blackbird	Xanthocephalus xanthocephalus	CA SC			X
Northern cardinal	Cardinalis cardinalis	CA SC			X
Northern harrier	Circus cyaneus	CA SC NV SP			X
Cooper's hawk	Accipiter cooperii	CA SC NV SP			X
American kestrel	Falco sparverius	NV SP			X
Mammals					
Townsend's big-eared bat	Corynorhinus townsendii	UT SC BLM S CA SC	X	X	X
Pale Townsend's Big-Eared Bat	Corynorhinus townsendii pallescens	FSC AZ SC	X	X	X
Spotted Bat	Euderma maculatum	FSC CA SC AZ SC UT SC	X	X	X
Allen's Big-eared Bat	Idionycteris (=Plecotus) phyllotis	UT SC BLM S	X	X	X
Western Red Bat	Lasiurus blossevillii	AZ SC	X	X	X
Yuma myotis	Myotis yumanensis	FSC BLM S	X	X	X
Western Yellow Bat	Lasiurus xanthinus	AZ SC			X
Colorado River Cotton Rat	Sigmodon arizonae plenus	FSC CSC			X
Yuma Hispid Cotton Rat	Sigmodon hispidus eremicus	FSC CA SC			X
Occult little brown bat	Myotis lucifugus occultus	FSC CA SC AZ SC	X	X	X

Table 3.8-7
Special Status Species Potentially Affected by the Proposed Federal Action

Common Name	Scientific Name	Listing Status	Location		
			Lake Powell	GCD to Lake Mead	Lake Mead to SIB
Cave Myotis	Myotis velifer	FSC CA SC			X
Greater Western Mastiff Bat	Eumops perotis californicus	FSC CA SC		X	X
Small-footed myotis	Myotis ciliolabrum	BLM S		X	X
Amphibians					
Colorado River Toad	Bufo alvarius	CA SC			X
Relict Leopard Frog	Rana onca	FC NV SP AZ SC CA SC			X
Lowland leopard frog	Rana yavapaiensis	FSC AZ SC CA SC		X	X
Northern leopard frog	Rana pipens	AZ SC CA SC	X	X	
Plants					
Grand Canyon evening primrose	Camissonia specuicola	FSC		X	
Sticky buckwheat	Eriogonum viscidulum	FSC			X
Geyer's milkvetch	Astragalus geyeri var triquetrus	NV CE			X
Las Vegas Bear Poppy	Arctomecon californica	NV CE			X
Invertebrates					
Kanab ambersnail	Oxyloma haydeni kanabensis	FE AZ SC		X	
MacNeill's sooty-winged skipper	Hesperopsis gracielae	FSC BLM S			X
Niobrara ambersnail	Oxyloma haydeni haydeni	BLM S		X	

Listing Status Legend

FT – Federally threatened under Endangered Species Act (ESA)

FT PDL – Federally threatened under ESA, proposed for de-listing

FE – Federally endangered under ESA

FE CH – Federally endangered under ESA with designated Critical Habitat (CH)

FE EX – Federally endangered under ESA, experimental population

FC – Federal candidate for listing under ESA

FSC – Federal Species of Concern (non-ESA)

BLM S – Bureau of Land Management Sensitive

NV E – Nevada Endangered

NV CE – Nevada Critically Endangered

NV SP – Nevada State Protected

AZ SC – Arizona Wildlife of Special Concern

CA T – California Threatened

CA E – California Endangered

CA SC – California Species of Special Concern

UT CS – Utah special management under Conservation Agreement to preclude the need for Federal listing

UT SC – Utah Species of Concern

UT SP – Utah State Protected

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3.9 Cultural Resources

This section describes the cultural resources that may be affected by the proposed federal action. The cultural resources include historic and prehistoric buildings, structures, sites, and objects, including Indian sacred sites and traditional cultural properties. Historic properties are the subset of cultural resources that are either listed or determined eligible for listing on the National Register of Historic Places (NRHP). Eligibility to the NRHP is determined by the ability of a property to convey its significance or importance in American history, prehistory, culture, or engineering, and by its integrity, essentially its preservation (36 C.F.R. pt. 60.4).

Section 106 of the National Historic Preservation Act of 1966 (NHPA), as amended, and its implementing regulations (36 C.F.R. pt. 800) require federal agencies to take into account the effects of their actions (undertakings) on historic properties and to allow the Advisory Council on Historic Preservation (ACHP) an opportunity to comment. Executive Order (Exec. Order) No. 13007 requires consultation with Indian tribes regarding Indian sacred sites. Executive Memorandum from the White House of April 29, 1994 requires government-to-government consultation on other issues of Tribal concern. These concerns may also involve cultural resources. Reclamation has initiated consultation with concerned Indian tribes, State Historic Preservation Officers (SHPO), Tribal Historic Preservation Officers (THPO), and other interested parties regarding cultural resources.

3.9.1 Undertaking Determination

Reclamation has determined that the proposed federal action is an undertaking subject to compliance with Section 106 of the NHPA. This is because it adds a new element to the existing program of on-going operations of the Colorado River that could lead to changes in the manner in which Lake Powell and Lake Mead have been operated historically. Specifically, the alternatives address operation of these two reservoirs at low elevations that might result in the emergence of cultural resources that have been submerged since the creation of the reservoirs. A reduction in the amount of water to be delivered downstream of Lake Mead could result in lower river elevations, which could lead to changes in stream dynamics and patterns of deposition and erosion that could potentially affect cultural resources.

3.9.2 Definition of the Area of Potential Effects and Identification Efforts

The area of potential effects (APE) of an undertaking is defined at 36 C.F.R. pt. 800.16(d) as “the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist.” This section goes on to state that “the APE is influenced by the scale of the undertaking and may be different for different kinds of effects caused by the undertaking.” Reclamation defines the APE to be the reaches of the Colorado River from Lake Powell downstream to Imperial Dam. In the reach from Davis Dam to Imperial Dam, the APE is further defined as the Colorado River channel from bank to bank, and the lateral extent of backwaters, lakes, and marshes directly connected to it.

Reclamation has compiled all available information about previously documented cultural resources in the APE. This information will form the basis of consultation with the SHPO and THPO, as required by 36 C.F.R. pt. 800.

3.9.3 Lake Powell and Glen Canyon Dam

The NPS database indicates that 518 historic properties were recorded within the full reservoir pool of Lake Powell (elevation 3,700 feet msl) during the Upper Colorado River Basin Archaeological Salvage Project (more commonly referred to as the Glen Canyon Project [Jennings 1966]) between 1956 and 1963. All were inundated by 1980 when Lake Powell reached full pool elevation. The Glen Canyon Project was completed prior to the enactment of the NHPA; hence none of the sites were evaluated for eligibility to the NRHP. Of the 518 sites, 61 were excavated and 10 tested for significance under the Historic Sites Act of 1935. This left 447 sites for which documentation was the only form of mitigation.

It is not known whether any of the inundated sites would retain integrity should they be exposed through the lowering of Lake Powell elevation. Inundation studies conducted by the NPS and the USACE (Dunn 1996; Lenihan et al. 1981; Ware 1989) concluded that cultural resources located within the deep-water zone of reservoirs are least susceptible to impacts of inundation and reservoir operations, while cultural resources within the operational zones of reservoirs are subject to adverse impacts from wave action and the alternating effects of wetting and drying related to fluctuating reservoir elevations. Cultural resources located immediately above the full pool elevation have generally been disturbed and damaged by recreation and visitation.

Indian sacred sites and other resources of Tribal concern have been documented in this reach.

3.9.4 Glen Canyon Dam to Lake Mead

The first 15 miles of this reach is within the GCNRA. The remainder of the reach is within the Grand Canyon National Park, the Navajo Indian Reservation and the Hualapai Indian Reservation. An intensive archaeological survey of this reach was conducted during 1991 and 1992 by NPS and the Department of Anthropology, Northern Arizona University (NAU) through funding provided by Reclamation. In all, 475 sites were recorded, 336 of which were potentially subject to impacts from dam operations. Of the 336 sites, 313 were determined NRHP-eligible, 14 not eligible, and nine were recommended for testing (Fairley et al. 1994). A programmatic agreement was developed to address the possible impacts to cultural resources resultant from the operation of Glen Canyon Dam (Reclamation 1994b). Currently, Reclamation in conjunction with the NPS, Navajo Nation Archaeological Department (NNAD), Utah State University (USU), the Zuni Cultural Resource Enterprise (ZCRE), and Museum of Northern Arizona is developing a treatment plan for mitigation of adverse effects to 160 historic properties. Additional long term monitoring and resource protection is afforded by the Grand Canyon Protection Act of 1992.

The Navajo Nation, Pueblo of Zuni, Hopi Tribe, Hualapai Indian Tribe, Kaibab Band of Paiute Indians, and Paiute Indian Tribe of Utah have been actively monitoring Grand Canyon natural resources, as well as resources of traditional religious and cultural significance. These tribes are currently developing culturally specific long-term monitoring protocols.

In addition, the Pueblo of Zuni has completed a NRHP eligibility nomination for selected historic properties or Traditional Cultural Properties (TCP) as defined by National Register Bulletin 38. The Navajo Nation, Hopi Tribe, and Hualapai Indian Tribe are currently developing TCP nominations. Indian sacred sites and other resources of Tribal concern have been documented in this reach.

3.9.5 Lake Mead and Hoover Dam

Most of the prehistoric cultural resources in this reach were documented by Harrington and the Civilian Conservation Corps in the 1920s and 1930s (Harrington 1925a, b, 1926, 1927; Harrington et al. 1930), while those of historic and architectural value are compiled in WESTEC Services Inc. (1980). Property types include: mines, ferry and steamboat landings, roads, ranches, farms, buildings, and sites of historical towns of Kaolin, St. Thomas, Rioville, and Callville Bay. Notable ethnographic resources include a Southern Paiute farm observed by Jedediah Smith in 1827, a village site, and the Salt Song Trail, the general location of which is shown in the map that serves as the frontispiece to Laird's work on the Chemehuevi (Laird 1976). Two resources are listed on the NRHP: Lost City/Pueblo Grande de Nevada, and Hoover Dam. Hoover Dam is further distinguished by its status as a National Historic Landmark. Most of these resources have been submerged since 1937 when Lake Mead rose above elevation 1,083 feet msl to an elevation of 1,102 feet msl.

Since its initial filling in the late 1930s, Lake Mead elevations have fluctuated from a high of 1,226 feet msl in 1983 to a low of 1,083 feet msl in 1956. Based on the results of the National Reservoir Inundation Study (Lenihan et al. 1981; Ware 1989) it is anticipated that most cultural resources located within the historical operational zone of Lake Mead (between the 1,225 foot msl and 1,083 foot msl elevation contours) have lost integrity as a result of repeated, periodic exposure at the margin of the reservoir where they would have been subject to mechanical erosion by wave action. Although some sites in the historical operational zone such as St. Thomas (Wyskup 2006) may continue to retain integrity, the National Reservoir Inundation Study and other reservoir specific studies (Labadie 2001) indicate only cultural resources submerged at depth since initial inundation are likely to retain integrity. Recent sidescan sonar and high-resolution seismic-reflection studies performed at Lake Mead (Harper et al. 2005; Twichell et al. 1999, 2003) appear to confirm this finding and suggest that cultural resources submerged in Lake Mead since it reached historic operational elevations in 1937 could retain sufficient integrity for listing on the NRHP.

Though some 156 resources appear in agency records, documentary sources, and inventory reports, this analysis concentrates on 108 sites previously identified in agency and repository records. Of these 108 sites it is likely that as many as 73 sites within the operational zone of Lake Mead, between elevations 1,226 feet msl and 1,083 feet msl, are likely to have been completely destroyed or damaged to the point where they would not qualify for listing on the NRHP. The remaining 35 sites below elevation 1,083 feet msl may retain sufficient integrity to qualify for listing. Examples of submerged resources in excellent condition are the B-29 bomber that went down in Lake Mead in the 1950s, and features associated with the aggregate classification plant located in Boulder Basin, which was used for the construction of Hoover Dam (Harper et al. 2005).

Previously undocumented cultural resources in the operational zone of Lake Mead will likely have been impacted to varying degrees and some will probably retain sufficient integrity to qualify for listing on the NRHP. However, the excellent condition of the B-29 bomber and the features associated with the aggregate classification plant located in Boulder Basin suggest there is a good chance that previously undocumented cultural resources that have been submerged since 1937, at depths below elevation 1,083 feet msl, could retain sufficient integrity to be considered for listing. Examples of the kinds of cultural resources that are likely to retain some information potential include historic sites with structural remains and archaeological sites with subsurface deposits and features. Information from sidescan sonar studies conducted in Boulder Basin and other areas of Lake Mead indicate deposition of sediment has been greatest in the area of the delta, and along the old channels of the Colorado River and Virgin River, and the major washes that feed into them. Undocumented cultural resources in these areas are likely buried beneath considerable thickness of sediment or, as is the case with St. Thomas, cultural resources may be covered by a mantle of silt several to tens of inches thick (Wyskup 2006).

3.9.6 Lake Mohave and Davis Dam

Most of the prehistoric cultural resources in this reach were documented by Baldwin (1943, 1948). WESTEC Services, Inc. (1980) reported on historic and architectural resources. Though 196 previously recorded prehistoric and historic period cultural resources are known or suspected to be located in or immediately adjacent to the Lake Mohave and Davis Dam reach, many of the resources documented by Baldwin prior to the construction of Davis Dam (Baldwin 1943, 1948) are features, rather than sites. When Baldwin's clusters are treated as single sites, the total number of sites suspected to be located in and immediately adjacent to the Lake Mohave and Davis Dam reach is reduced to 89.

Types of historic sites include mines, ranches, buildings and structures, ferry and steamboat landings, roads, trails, campsites, and a railroad (the Quartette Mining Company line). One traditional cultural property of importance to several tribes that is listed on the NRHP is located in this reach. Prehistoric property types documented in this reach include pit houses, rock art, rock shelters, lithic and ceramic scatters, rock circles, rock alignments, and rock piles.

With respect to the probable condition of documented and undocumented sites submerged in Lake Mohave, it can be anticipated that the portions of resources located between the 647-foot msl elevation contour and the 628-foot msl elevation contour will have lost integrity as a result of wave action. The results of a recent sidescan sonar and seismic-reflection study (Foster et al. 2004) suggest portions of sites located below the 628-foot msl elevation contour may retain sufficient integrity to qualify them for consideration for listing on the NRHP.

3.9.7 Davis Dam to Parker Dam

The environment in which cultural resources exist is different in fluvial and lacustrine systems. For this reason, the highly channelized river reach from Davis Dam to Upper Lake Havasu is treated separately from that of the Lake Havasu and Parker Dam reach.

3.9.7.1 Davis Dam to Upper Lake Havasu

The 39-mile reach of the Colorado River from Davis Dam to Upper Lake Havasu is one of its most highly modified and controlled stretches. Within this part of the reach, the Colorado River elevations will likely fall rather than rise from a decrease in water deliveries when shortages are declared. For this reason, the APE for this reach is the Colorado River channel from bank to bank, and the lateral extent of backwaters, lakes, and marshy areas directly connected to it.

Information contained in WESTEC Services, Inc. (1980) indicates that at least 22 historic period cultural resources may be present in or located in the immediate vicinity of the Davis Dam to Upper Lake Havasu reach. Property types located in this reach include river crossings, ferry and steamboat landings, town sites or camps, buildings, structures, trails, roads, highways, railroads, bridges, and the suspected site of the Rose-Brown massacre. This information also indicates that a number of these resources had already been significantly impacted by the 1970s by residential and commercial development, historic flood events, or destroyed during the 1950's when portions of this stretch was confined within levees, channelized, and stabilized with rip-rap. The Arch Bridge/ 1916 Colorado River Highway Bridge, a part of a multiple property listing on the NRHP, is in this reach. Prehistoric sites include caves and rockshelters, lithic and ceramic scatters, rock alignments, and petroglyphs.

3.9.7.2 Lake Havasu and Parker Dam

This part of the APE includes Lake Havasu from RM 237 downstream to Parker Dam. Information contained in WESTEC Services, Inc. (1980) and other sources provide a brief description of eight cultural resources submerged beneath Lake Havasu. These are primarily river landings associated with mills, and commercial and residential structures established to support several local mines active from 1860 to the turn of the century. Historic records indicate that several historic-period Chemehuevi Indian villages were located along both sides of the Colorado River at the upper end of the Chemehuevi Valley. An additional 20 cultural resources appear in repository records as being located at the margin of Lake Havasu or on small islands or peninsulas extending into the reservoir. Prehistoric types include lithic and ceramic scatters, rock alignments, trails, bedrock mortars, petroglyphs, and intaglios. Due to limited information currently available, it is not possible to know the condition of the submerged resources or how much post-impoundment sedimentation has occurred.

Any cultural resources located within the current operational zone of the reservoir (between elevations 450.5 feet msl and 445.8 feet msl), or within the historic operational zone (between elevations 451 feet msl and 444 feet msl), will likely have been impacted. Sites located in these zones will likely not be considered as eligible properties. However, it is possible based on results of recent findings in Lake Mead and Lake Mohave that cultural resources consistently submerged beneath Lake Havasu since its creation may retain sufficient integrity to be eligible for the NRHP.

3.9.8 Parker Dam to Imperial Dam

This reach extends from Parker Dam to Imperial Dam and covers the 143 miles of river channel (from bank to bank) and the lateral extent of backwaters, lakes, and marshy areas having a direct connection to the river.

Minimal cultural resources inventory taking has been conducted in this portion of the APE. Possible cultural resources within the limits of the APE are described in the Implementation Agreement FEIS (Reclamation 2002a). The information provided in this document suggests that numerous historic resources may be present in and around this reach. Twelve sites have been recorded proximate to the boundary of the APE. These consist of a segment of a railway where it crosses the Colorado River, a ceramic scatter, heat altered rock, intaglios, historic mining/milling features, bedrock mortar depressions, a natural cavern used as a jail for the historic gold milling community of Picacho, a lithic scatter, a trail segment, mining cairns, rock art, and cleared circles. Only one of the twelve sites, a prehistoric habitation site, is listed on the National Register and is near the edge of the APE. Only three recorded sites are known to exist within the APE. These are Parker Dam, Imperial Dam, and a portion of the "Old Parker Road" alignment. Parker Dam is a contributing element to the Parker Dam Historic District, which is eligible for listing on the National Register. Imperial Dam is potentially eligible for individual listing on the National Register and is a contributing element to the AAC.

Though cultural inventories of areas within the historic floodplain of this river reach are extremely limited, it appears that historic site distribution along the Colorado River corridor is more random then on the uplands bordering the historic floodplain. Also, prior to construction of Hoover Dam in the 1930s, river flows were extremely dynamic, its course meandering and altering across the floodplain. Trench evaluations reveal that sediments within the floodplain have been laid down under high-energy fluvial conditions, under which it is extremely unlikely to expect *in situ* cultural remains.

3.9.9 Imperial Dam to SIB

There is little to no data relative to the existence of historic properties within the Imperial Dam to the SIB reach. Nevertheless, any known or as yet undiscovered cultural resources within this reach of the Colorado River will not be affected by the proposed federal action because the existing river operations will continue into the future. This also applies to sites listed on the NRHP. One of these sites is the Ocean to Ocean Bridge, constructed in 1915 for U.S. Highway 80 in Yuma, Arizona which is the first highway bridge to be constructed across the Colorado River. Another site is Yuma Crossing and associated sites, which has been designated as a National Historic Landmark. The landmark boundaries straddle the Colorado River from the St. Thomas Yuma Indian Mission on the north and the Quartermaster Depot and Yuma Territorial Prison on the south.

3.10 Indian Trust Assets

This section discusses the Indian Trust Assets (ITAs) that may be affected by the proposed federal action. ITAs are "…'legal interests' in 'assets' held in 'trust' by the federal government for federally recognized Indian tribes or individual Indians" (Reclamation 1994a). The United States, as trustee, is responsible for protecting rights reserved by, or granted to, Indian tribes or individual Indians by treaties, statutes, executive and secretarial orders, and other federal actions. The Department's policy is that when a proposed federal action appears likely to adversely affect an ITA, the action agency should seek ways to minimize or avoid the adverse effect; if adverse effects cannot be avoided, then the action agency should provide appropriate mitigation or compensation. While most ITAs are located on reservation lands, they can also be located off-reservation. Examples of ITAs include, but are not limited to, water rights, land, minerals, and rights to hunt and fish.

Reclamation consulted with potentially affected tribes (Chapter 6) whose reservations are located along the mainstream Colorado River from Lake Powell to the SIB, as well as with those tribes who have a water service contract to identify ITAs and to assess potential effects of the proposed federal action on these ITAs. Reclamation has determined that no tribes or reservations located upstream of Lake Powell will be affected by the proposed federal action.

The trust assets that might potentially be impacted as a result of implementing the proposed federal action are described and discussed below. Impacts to the ITAs are discussed and analyzed in Chapter 4, and cumulative effects are discussed in Chapter 5.

3.10.1 Water Rights and Trust Lands

For this analysis, the Indian water rights and land assets considered include:

- federally reserved Indian rights to Colorado River water including rights established pursuant to *Arizona v. California;*
- Colorado River water Tribal delivery contracts where such contracts are part of a congressionally approved water rights settlement; and
- Indian reservations.

Indian trust lands are areas for which the United States holds title in trust for the benefit of the tribe (Tribal trust land) or for an individual Indian (individual trust land). Trust lands may be located on or off a reservation. While Indian reservations are not technically synonymous with trust lands, the exterior boundaries of Indian reservations are used to define the trust assets for purposes of this NEPA analysis. The BIA and United States Census Bureau identified and provided the data on size and location of reservations analyzed here.

3.10.1.1 Indian Trust Assets Determined under Arizona v. California: Fort Mojave, Chemehuevi, Colorado River Indian, Fort Yuma Indian, and Cocopah Indian Reservations

The March 9, 1964 *Arizona v. California* Decree and several supplemental decrees (consolidated in 2006 into the Consolidated Decree) quantified the Indian reserved water rights of the Fort Mojave, Chemehuevi, Colorado River Indian, Fort Yuma Indian, and Cocopah Indian Reservations. The amounts of water (diversion entitlements), priority dates for these water rights, net acres of irrigated land, and the states where the water rights are perfected for these Indian reservations are listed in Table 3.10-1, and discussed below.

Table 3.10-1
Colorado River Mainstream Diversion Entitlement (Water Rights) in Favor of Indian Reservations

Reservation	State	Diversion Entitlement (Water Right) (afy)[1]	Net Acres[1]	Present Perfected Right Number[1]	Priority Within State	Priority Date[1]
FORT MOJAVE RESERVATION	Arizona	27,969	4,327	3	1	Sept.18,1890
		75,566	11,691			Feb 2, 1911
	California	16,720	2,587	25	1	Sept. 18, 1890
	Nevada	12,534	1,939	81	1	Sept. 18, 1890
Total	--	132,789	--	--	--	
CHEMEHUEVI RESERVATION	California	11,340	1,900	22	1	Feb. 2, 1907
Total	--	11,340	--	--	--	
COLORADO RIVER INDIAN RESERVATION	Arizona	358,400	53,768	2	1	Mar. 3, 1865
		252,016	37,808			Nov. 22, 1873
		51,986	7,799			Nov. 16, 1874
	California	10,745	1,612	24	1	Nov. 22, 1873
		40,241	6,037			Nov. 16, 1874
		5,860	879			May 15, 1876
Total	--	719,248	--	--	--	
FORT YUMA INDIAN RESERVATION	Arizona	6,350	952	3a	1	Jan. 9, 1884
	California	71,616	10,742	23	1	Jan. 9, 1884
Total	--	77,966	--	--	--	
COCOPAH INDIAN RESERVATION	Arizona	1,140	190	8	1	1915
		7,681	1,206	1		Sept. 27, 1917
		2,026	318	--	4	June 24, 1974
Total	--	10,847	--	--	--	
Arizona Total	--	783,134	--	--	--	
California Total	--	156,522	--	--	--	
Nevada Total	--	12,534	--	--	--	

1 *Source: Consolidated Decree of March 27, 2006. The quantity of water in each instance is measured by (i) diversions or (ii) consumptive use required for irrigation of the respective acreage and for satisfaction of related uses, whichever of (i) or (ii) is less.*

Fort Mojave Reservation (Fort Mojave Indian Tribe of Arizona, California and Nevada). The Fort Mojave Reservation is located in the Lower Basin where Arizona, California, and Nevada meet. The Fort Mojave Reservation possesses present perfected federal reserved water rights from the Colorado River in all three of these states that contain reservation land pursuant to the Consolidated Decree.

As a result of recent changes made to the Fort Mojave Reservation's water rights resulting from a boundary adjustment, the reservation has the right to divert up to 103,535 afy in Arizona (2004 diversion was 69,103 af)[1], up to 16,720 afy in California (2004 diversion was 16,019 af), and up to 12,534 afy in Nevada (2004 diversion was 3,870 af).

Chemehuevi Reservation (Chemehuevi Indian Tribe of the Chemehuevi Reservation, California). The Chemehuevi Reservation is located in southern California, near Lake Havasu. The Chemehuevi Reservation holds present perfected federal reserved water rights from the mainstream Colorado River pursuant to the Consolidated Decree. The lands of the Chemehuevi Reservation are mostly on the plateau above the shoreline of Lake Havasu. Present agricultural water use is limited. The Chemehuevi Reservation has a right to divert up to 11,340 afy in California; the 2004 reported diversion was 1,444 af.

Colorado River Indian Reservation (Colorado River Indian Tribes of the Colorado River Indian Reservation, Arizona and California). The Colorado River Indian Reservation is located in Arizona and California. The Colorado River provides 90 miles of shoreline for the Colorado River Indian Reservation. The reservation economy centers around agriculture, recreation, and light industry. The Colorado River Indian Reservation was established on March 3, 1865. The Colorado River Indian Reservation's diversion right in Arizona is 662,402 afy (2004 diversion was 585,534 af) and the reservation's diversion right in California is 56,846 afy (2004 diversion was 6,231 af).

Fort Yuma Indian Reservation (Quechan Tribe of the Fort Yuma Indian Reservation, California and Arizona). The Fort Yuma Indian Reservation is located in southwestern Arizona and southern California, near Yuma, Arizona. The Consolidated Decree provided additional water rights to the Fort Yuma Indian Reservation in both Arizona and California. The Fort Yuma Indian Reservation has the right to divert up to 6,350 afy in Arizona (2004 diversion was 1,279 af) and up to 71,616 afy in California (2004 diversion was 46,259 af).

Water for the Fort Yuma Indian Reservation is diverted from the Colorado River at Imperial Dam and delivered through the Yuma Project Reservation Division - Indian Unit. The Fort Yuma Indian Reservation has other uses of small amounts of water at homestead sites south of Yuma, Arizona. The current water uses shown in Table 3.10-1 include only uses within the Fort Yuma Indian Reservation.

[1] 2004 diversions are provided in this section to indicate approximate use of the entitlements for each Indian tribe.

Cocopah Indian Reservation (Cocopah Tribe of Arizona). The Cocopah Indian Reservation is located in southwestern Arizona. The western boundary of the reservation is bordered by Mexico and portions of the Colorado River. The Cocopah Indian Reservation was established through Exec. Order No. 2711 on September 27, 1917, but additional acres were added to the reservation through 1974. The Cocopah Indian Reservation economy is centered on agriculture. The Cocopah Indian Reservation's present perfected federal reserved water rights provide for the diversion of up to 10,847 afy in Arizona. The 2004 reported diversion was 3,878 af.

The 1974 decreed right for the Cocopah Indian Reservation is unique because of its more recent priority date (i.e., post-1968). The 1984 Supplemental Decree in *Arizona v. California* recognized the decreed right for the Cocopah Indian Reservation dated June 24, 1974 and amended paragraph 2 of Article II (D) of the 1964 Decree to reflect this 1974 right.

3.10.1.2 Seven Central Arizona Indian Tribes

The CAP makes Colorado River water available to Indian tribes located in central Arizona in addition to the ITA entitlements discussed above. Over the years, there have been several Secretarial decisions allocating water to ten Indian tribes in central Arizona. All of these Indian tribes, with the exception of the Gila River Reservation, signed CAP water delivery contracts in 1980. The Gila River Reservation, with the largest allocation of CAP water, signed its CAP water delivery contract in 1992. Each of the CAP water delivery contracts contained a provision that the Indian tribes' CAP water would be credited against their Winters right (*Winters v. United States*, 207 U.S. 564 [1908]), if and when such rights were finally determined. Over the years, water rights settlements have been implemented for seven of these ten Indian tribes. Under these settlements, the seven Indian tribes generally have a right to lease their CAP water within Arizona; the CAP water does not have to have a history of use in order for the water to be leased. A listing of the major water rights settlement legislation for these seven Indian tribes in chronological order follows:

- ♦ Settlement of Ak-Chin Indian Community Water Rights Claims of July 28, 1978 (92 Stat. 409) and the Ak-Chin Indian Community Water Rights Settlement Act of October 19, 1984 (96 Stat. 2698)
- ♦ Southern Arizona Water Rights Settlement Act of October 12, 1982 (Title III of Public Law 97-293) and Title III of the Arizona Water Settlements Act of December 10, 2004 (118 Stat. 3536)
- ♦ Salt River Pima-Maricopa Indian Community Water Rights Settlement Act of 1988 (102 Stat. 2549)
- ♦ Fort McDowell Indian Community Water Rights Settlement Act of 1990 (104 Stat. 4469)

- San Carlos Apache Tribe Water Rights Settlement Act of 1992 (Title XXVII of the Reclamation Projects Authorization and Adjustment Act of 1992 (106 Stat. 4600)

- Yavapai-Prescott Indian Tribe Water Rights Settlement Act of 1994 (108 Stat. 4526) (Indian tribes' CAP water permanently assigned to Scottsdale)

- Gila River Indian Community Water Rights Settlement Act (Title II of the Arizona Water Settlements Act of December 10, 2004 (118 Stat. 3499)

Table 3.10-2 lists the CAP Tribal water entitlements for the seven Indian tribes discussed above. These entitlements and their priorities are further discussed below.

An understanding of the CAP priority system is necessary to discern how shortages can potentially impact the different priorities of CAP water and CAP water users, including Indian tribes. Within CAP, shortages reduce water deliveries to CAP water users in the following order: CAP 5 Bank; CAP 4 Excess Agricultural Users; CAP 3 NIA Priority Water; equally CAP 2 M&I Priority and Indian Priority Water; and finally CAP 1 Arizona Priority 2 and 3. A detailed explanation of the CAP water priority rights is included in Appendix G. Modeled reductions are based on what would be available to a user under its entitlement in that year based on higher priority use.

Ak-Chin Indian Community of the Maricopa (Ak-Chin) Indian Reservation. In 1912, President Taft created a reservation at Ak-Chin comprised of 21,840 acres. In 1961, the Ak-Chin Tribal Council was formally recognized under the Indian Reorganization Act of 1934. The Ak-Chin Indian Reservation is located in Pinal County 50 miles south of Phoenix. Farming (Ak-Chin Farms) is a major part of the economy of the reservation.

Ak-Chin Reservation's water rights settlement of 1978 was the first of a series of Indian water rights settlements in central Arizona. The 1978 Settlement Act was amended in 1984. Under the 1984 water rights settlement, the Ak-Chin Indian Reservation has the right to receive up to 75,000 afy of water at the southeastern corner of the reservation. When excess water is available in the CAP canal, the United States may deliver up to an additional 10,000 afy of water to the Ak-Chin Indian Reservation (maximum of 85,000 afy). In years of shortage on the Colorado River, the United States must pay damages if less than 72,000 afy is delivered to the Ak-Chin Indian Reservation. The United States acquired 50,000 afy of Colorado River water entitlement from the Yuma Mesa Division of the Gila Project to partially meet the requirement to deliver required quantities to the Ak-Chin Indian Reservation. After losses, 47,500 afy is delivered to the Ak-Chin Indian Community with a priority date that precedes the date of enactment of the CRBPA, and therefore has a higher priority during times of shortage than other CAP water.

The Ak-Chin Indian Reservation was provided with the right to lease some of its CAP water supplies within Arizona, and the Ak-Chin Indian Reservation has leased a portion of its water to the Del Webb Corporation. The Ak-Chin Indian Reservation's water infrastructure is in place, and with the exception of water that the Ak-Chin Indian Reservation leased, the community is using all of its CAP water for farming purposes.

Table 3.10-2
Central Arizona Project Indian Tribal Diversion Entitlements (Water Rights)

Reservation	Diversion Entitlement (Water Right) (afy)	Land Area (square miles)[1]	Arizona Priority	CAP Priority[2]
Ak-Chin Indian Community of the Maricopa Indian Reservation	47,500	--	2	CAP 1
	27,500[3]	--	4	CAP 2 (Indian)
Ak-Chin Indian Community Total	*75,000*	*32.9*		
Tohono O'odham Nation of Arizona - San Xavier District	27,000	--	4	CAP 2 (Indian)
	23,000[4]	--	4	CAP 3
Tohono O'odham Nation - San Xavier District Total	*50,000*	*111.4*		
Tohono O'odham Nation of Arizona – Schuk Toak District	10,800	--	4	CAP 2 (Indian)
	5,200[4]	--	4	CAP 3
Tohono O'odham Nation - Schuk Toak District Total	*16,000*	*4,342.0*		
Salt River Reservation	13,300	--	4	CAP 2 (Indian)
Salt River Reservation Total	*13,300*	*80.0*		
Fort McDowell Reservation		--		
Contracted in 1980	4,300	--	4	CAP 2 (Indian)
Acquired from HVID	13,933	--	4	CAP 2 (Indian)
Fort McDowell Reservation Total	*18,233*	*38.6*		
San Carlos Reservation	12,700	--	4	CAP 2 (Indian)
M&I Reassignment	18,145	--	4	CAP 2 (M&I)
Ak–Chin Settlement[5]	30,800	--	4	CAP 2 (Indian)
San Carlos Reservation Total	*61,645*	*2,910.6*		
Gila River Reservation	191,200	--	4	CAP 2 (Indian)
	120,600[6]	--	4	CAP 3
Gila River Reservation Total	*311,800*	*583.9*		

1 *Source is www.census.gov\geo\wvw\ezstate\airpov.pdf, accessed December 10, 2006*

2 *CAP Priority Definitions:*

CAP 1: Arizona Priority 2 and Arizona Priority 3 Water
CAP 2: M&I Priority and Indian Priority Water
CAP 3: NIA Priority Water
CAP 4: Excess Agricultural Users
CAP 5: Excess Water for Bank

3 *When excess water is available in the CAP canal, Ak-Chin Indian Community is entitled to the excess water up to 10,000 af annually in addition to the 75,000 afy.*

4 *Firmed by the United States to the M&I Priority of CAP 2 for a period of 100 years.*

5 *After the Secretary has met the water delivery obligation to the Ak-Chin Indian Community under the Ak-Chin Water Rights Settlement, any excess water under the Ak-Chin Indian Community's CAP water delivery contract is available for delivery to the San Carlos Apache Tribe. Estimated delivery losses of six percent on the Santa Rosa Canal, incurred in the delivery of water to the Ak-Chin Indian Community, are charged to the Community's CAP water delivery contract.*

6 *15,000 afy are firmed for a period of 100 years by the State of Arizona to CAP 2 M&I Priority Water.*

Tohono O'odham Nation of Arizona. The Tohono O'odham Nation sits in the heart of the Sonoran Desert, sixty miles west of Tucson, Arizona. The Tohono O'odham Nation is divided into multiple districts totaling more than 4,342 square miles. Under the Tohono O'odham Nation's 1982 water rights settlement, as subsequently amended, the nation's water rights are specific to two of Tohono O'odham Nation's districts, the San Xavier District, and the Schuk Toak District.

The San Xavier District has the right to receive a total of 50,000 afy of water, consisting of 27,000 afy of CAP 2 Indian Priority Water, and 23,000 afy of CAP 3 NIA Priority Water (Table 3.10-2). CAP 3 NIA Priority Water is the most vulnerable portion of the CAP water supply, and the United States is required to firm (i.e., provide a backup water supply) the delivery of this water to M&I Priority Water of CAP 2 during the next 100 years.

The Schuk Toak District has the right to receive a total of 16,000 afy of water, consisting of 10,800 afy of CAP 2 Indian Priority Water, and 5,200 afy of CAP 3 NIA Priority Water. The United States is required to firm the delivery of CAP 3 NIA Priority Water to M&I Priority of CAP 2 during the next 100 years as in the case with the San Xavier District.

Yet another Tohono O'odham Nation's district, the Chui-Chu District, has a CAP water delivery contract with the Secretary to receive up to 8,000 afy of CAP 2 Indian Priority Water. As this water is not presently part of a water rights settlement, it is not considered an ITA.

Construction of the works necessary for the Tohono O'odham Nation to take delivery of its water under the 1982 Settlement Act is ongoing. The works necessary to deliver water to the Schuk Toak and San Xavier Districts have been completed. The Schuk Toak District is currently using a portion of the water provided under this settlement. The San Xavier District has initiated water deliveries and will expand these deliveries upon completion of the rehabilitation of its existing cooperative farm, which is ongoing.

Salt River Reservation (Salt River Pima-Maricopa Indian Community). The Salt River Reservation is located in Arizona, aside the boundaries of Mesa, Tempe, Scottsdale, Fountain Hills, and metropolitan Phoenix. The reservation was created in 1879. The Salt River Reservation is occupied by two tribes, the Pima and the Maricopa; and the combined enrolled population exceeds 7,000. The Salt River Reservation consists of 53,600 acres and maintains 19,000 acres as a natural preserve. Approximately 12,000 acres are under cultivation with cotton, melons, onions, broccoli, and carrots being the major crops.

Under its water rights settlement, the United States obtained the rights to 22,000 afy of Colorado River water entitlement from the Wellton-Mohawk Irrigation and Drainage District, near Yuma, Arizona. This right is senior to CAP. Pursuant to the settlement, this water was contracted by the Secretary to several Phoenix area cities and the tribe agreed to accept delivery of an equivalent amount of Salt River Project (SRP) water. The SRP water deliveries to the tribe will not be affected by the proposed federal action.

The Salt River Reservation has the right to receive up to 13,300 afy of CAP 2 Indian Priority Water. The Salt River Reservation has the right to lease its CAP water under the settlement within Arizona and has leased all of its CAP water to the City of Phoenix for a 100-year period. This water supply is considered an ITA.

Fort McDowell Reservation (Fort McDowell Yavapai Nation). The Fort McDowell Reservation is located in Maricopa County, Arizona about 23 miles northeast of Phoenix. The Verde River flows north to south through the reservation. The Fort McDowell Reservation was created by executive order in 1903 for the Yavapai, Mojave, and Apache Indian tribes. The 38.6 square-mile Fort McDowell Reservation is home to 600 community members, while another 300 members live off the reservation.

Under its water rights settlement, the Fort McDowell Reservation received a combination of water resources from both the SRP and the CAP. With respect to the Colorado River supplies, the Fort McDowell Reservation received the rights to delivery of up to 18,233 afy of water. This consisted of 4,300 afy of CAP water that the Fort McDowell Reservation had contracted for in 1980, plus an additional 13,933 afy of CAP water that the United States acquired from the Harquahala Valley Irrigation District (HVID). The acquired HVID water was converted from its CAP 3 NIA Priority Water to CAP 2 Indian Priority Water through this settlement. The Fort McDowell Reservation has leased 4,300 afy of its CAP water to the City of Phoenix for a 100-year period, and the reservation is presently not using the remaining 13,933 afy of CAP water.

San Carlos Reservation (San Carlos Apache Tribe). The San Carlos Reservation is located in southeastern Arizona. The reservation was established by executive order in 1871 and covers 2,910.6 square miles. Approximately one-third of the San Carlos Apache Tribe's land is forested or wooded. San Carlos Lake is a hub of recreational activity, especially for fishing.

Under its water rights settlement, the San Carlos Reservation has the rights to delivery of 12,700 afy of CAP 2 Indian Priority Water, 18,145 afy of CAP 2 M&I Priority Water (previously allocated to Phelps Dodge and the town of Globe), and excess water made available by the Ak-Chin Indian Community Water Rights Settlement Act of 1984. The excess Ak-Chin water is unquantified in the settlement and estimated to be 30,800 afy before losses. The tribe's right to receive the excess Ak-Chin water is subordinate to the Secretary's obligation to deliver water to the southeast corner of the Ak-Chin Indian Reservation under that community's water right settlement. Given that the San Carlos Reservation is not able to physically divert CAP water, the tribe would need to implement a water exchange to benefit from its CAP water supplies. The San Carlos Reservation has the right to lease CAP water under its 1992 settlement, and has leased up to 14,000 afy to Phelps Dodge through an exchange with the SRP. The San Carlos Reservation has also entered into a lease with the City of Scottsdale for 12,500 afy of CAP 2 M&I Priority Water.

Yavapai Reservation (Yavapai-Prescott Tribe of the Yavapai Reservation). Under its 1994 settlement, the Yavapai Reservation permanently assigned and transferred its CAP contractual right of 500 afy to the city of Scottsdale, Arizona, in return for funds to develop alternative water supplies. Since the Yavapai Reservation no longer has a right to CAP water, no trust asset is attributable to the Yavapai Reservation.

Gila River Reservation (Gila River Indian Community). The Gila River Reservation was established by an act of Congress in 1859 for Pima and Maricopa Indians. The 583.9 square mile reservation is located in Maricopa and Pinal Counties, 35 miles south of the Phoenix metropolitan area. The Gila River Reservation is bounded by the San Tan and Sacaton Mountains to the east, the Estrella Mountains to the west, and the South Mountains to the north. The Gila River Indian Community established Gila River Farms during the late 1960s, with approximately 16,000 acres in production. The Gila River Reservation is the homeland for two distinct tribes, the Pima and the Maricopa.

The 2004 Gila River Indian Community Water Rights Settlement Act provides the community with 311,800 afy of CAP water, consisting of 120,600 afy of CAP 3 NIA Priority Water and 191,200 afy of CAP 2 Indian Priority Water. Under the 2004 Settlement Act, the state of Arizona is required to firm 15,000 afy of the CAP 3 NIA Priority Water so that it has a reliability equivalent to CAP 2 Indian Priority and M&I Priority Water over a 100-year period. Construction of the infrastructure to deliver CAP water to the Gila River Reservation for farming purposes is ongoing. Under the 2004 settlement, the Gila River Reservation has the right to lease its CAP water within Arizona for a term of up to 99 years. Approximately 40,000 afy of the Gila River Reservation’s CAP water has already been leased to Phoenix area cities, subject to implementation of the Gila River Indian Community water rights settlement. In addition, the Gila River Reservation has entered into effluent exchange agreements with surrounding municipalities, Chandler and Mesa, whereby the Gila River Reservation exchanges some of its CAP water for a larger quantity of treated effluent.

3.10.2 Hydroelectric Power Generation and Distribution

Headgate Rock Dam and Powerplant are owned and operated by the BIA, which supplies energy generated at the Headgate Rock Powerplant to the Colorado River Indian Tribes of the Colorado River Indian Reservation, Arizona and California (CRIT) and other Indian tribes. Western markets any excess power produced at Headgate Rock Powerplant on the open market. Headgate Rock Powerplant is a run-of-the-river hydroelectric powerplant, which means it is dependent on Colorado River flow to generate power. For this reason Headgate Rock Dam is unable to store water in excess of the amount that can flow through its generator turbines or through CRIT’s diversion facilities. Any water that is not diverted by CRIT or used by the Headgate Rock Powerplant generators is spilled downstream. Chapter 4 of the Final EIS provides a more detailed description of hydroelectric power generation. Reclamation has determined that water appropriated to non-CRIT entities that flows through Headgate Rock Dam and generates power is not an ITA.

3.10.3 Cultural Resources

Cultural resources located on Indian trust lands are often the property of the tribe or individual Indians beneficially owning those lands; these resources may be ITAs (Reclamation 1994a). During consultation, the Hualapai Tribe identified historic and traditional cultural properties, archaeological resources and sacred sites in Grand Canyon and on the Hualapai Reservation as Tribal trust resources that should be addressed in this EIS. None of the tribes identified cultural resources on- or off-reservation lands that should be considered ITAs for the purposes of this analysis.

3.10.4 Biological Resources

During consultation on this proposed federal action, none of the tribes identified fishing or hunting rights. The Hualapai Indian Tribe raised a concern with fish and wildlife, wildlife habitat, and culturally significant vegetation located throughout Grand Canyon and on the Hualapai Reservation.

3.10.5 Other Potentially Affected Tribes Asserting Colorado River Water Rights

Reclamation has determined that no quantified water right trust assets are located within the study area upstream of Lake Mead. However, the following tribes have asserted that they have unquantified water right trust assets and other ITAs that will be affected by the proposed federal action.

3.10.5.1 Navajo Indian Reservation (Navajo Nation, Arizona, New Mexico and Utah)

The Navajo Nation is a federally recognized Indian tribe whose 12.5 million-acre reservation was initially established by treaty in 1868 and expanded by a series of executive orders in 1884, 1900, and 1930. The Navajo Nation economy is historically based on livestock herding, dry farming, and mining. Under the Winters doctrine established by the United States Supreme Court, the United States implicitly reserved water in an amount necessary to fulfill the purposes of an Indian reservation. The existence of a federally reserved right for the Navajo Nation to mainstream Colorado River water has not been judicially determined at this time. Unquantified water rights of the Navajo Nation are considered an ITA.

During consultation on this proposed federal action, the Navajo Nation wrote Reclamation a letter dated August 21, 2006 identifying a water budget of 76,732 afy that the Navajo Nation believes must be satisfied out of the Colorado River mainstream. The water budget of the Navajo Nation is premised on the use of 63,000 afy from the Little Colorado River which would otherwise contribute to the supply available in Lake Mead. In addition, the Navajo Nation asked Reclamation to consider the effects of the proposed federal action on 6,411 afy of CAP 3 NIA Priority Water identified for use by the Navajo Nation in the Arizona Water Settlements Act of 2004. This water is included in the 76,732 afy that the Navajo Nation believes must be satisfied out of the Colorado River mainstream. Overall, the Navajo Nation has asked the Secretary to account for the needs of the Navajo Nation as the Secretary undertakes the difficult task of developing guidelines to deal with Lake Powell and Lake Mead in time of shortage (Navajo Nation letter dated August 21, 2006).

3.10.5.2 Hualapai Indian Reservation (Hualapai Indian Tribe)

The 992,463-acre Hualapai Indian Reservation is located in northwestern Arizona. The reservation was established by executive order on January 4, 1883. Under the Winters doctrine established by the United States Supreme Court, the United States implicitly reserved water in an amount necessary to fulfill the purposes of an Indian reservation. The existence of a federally reserved right for the Hualapai Indian Tribe to mainstream Colorado River water has not been judicially determined at this time. Unquantified water rights of the Hualapai Indian Tribe are considered an ITA.

During consultation on this proposed federal action, the Hualapai Indian Tribe has asserted in a letter to Reclamation dated August 28, 2006 that it has Tribal trust resources and other Tribal assets in Grand Canyon and on the Hualapai Indian Reservation that may be adversely affected by the proposed federal action. The Hualapai Indian Tribe's claimed resources include:

> "…tribal lands, the Tribe's senior, federal reserved water rights to the use and flows of the Colorado River, historic and traditional cultural properties, archaeological resources and sacred sites, fish and wildlife habitat, sensitive beaches, and culturally significant plants located throughout the Grand Canyon and on the Hualapai Reservation" (Hualapai Indian Tribe letter dated August 28, 2006).

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3.11 Electrical Power Resources

This section provides an overview of electrical power (i.e., hydropower) generation, power marketing, and the Colorado River Basin power funds used to manage electrical power revenues and expenditure requirements for mainstream Colorado River dams. A description of potentially affected electrical power generation facilities and energy dependent infrastructure within the study area is provided below. The electrical power resources that could potentially be affected by implementation of the proposed federal action include:

- amount of electrical power generated;
- available generation capacity;
- economic value of electrical power produced;
- electrical power related revenues and contributions to the different Colorado River Basin power funds and programs supported by these funds; and
- electrical costs for entities that pump water directly from Lake Powell and Lake Mead.

3.11.1 Overview

The primary electrical power resources that could be affected by the proposed federal action include the Glen Canyon Powerplant, Hoover Powerplant, Parker-Davis Project (P-DP) generation systems, and the Headgate Rock Powerplant. Reclamation operates and maintains the Glen Canyon, Hoover, and P-DP power generation facilities. Western is responsible for marketing and transmitting the power. The Headgate Rock Powerplant is operated by the BIA.

3.11.1.1 Hydropower Generation

Hydropower generation is directly related to the net effective head on the generating units and the quantity of water flowing through the turbines. The net effective head is the difference between the elevation of the forebay behind a dam and in the tail water below the dam. The head influences the maximum power output capability of the powerplant, measured in megawatts (MW). In general, the powerplant capability increases as a function of increasing head. However, turbine capacities or other equipment limitations, such as switches or transformer ratings, limit maximum powerplant output levels.

The turbines at a powerplant are designed to produce maximum efficiency at a design head. At design head, the powerplant can produce the maximum capacity and the most energy per acre-foot of water passing through the turbine. As the net effective head on the powerplant is reduced from the design head because of reduced forebay (upstream reservoir) elevation, the power output of the turbine, the electrical capacity of the generator attached to the turbine, and the efficiency of the turbine are all reduced. This reduction continues as net effective head decreases until, below the minimum elevation for power generation, the turbines cannot be operated safely and must be bypassed for downstream water deliveries. Minimum power elevation generally occurs at a point where cavitation within the turbine causes extremely rough operation, air becomes entrained in the water, and/or vortices appear in the forebay. Excessive cavitation can lead to turbine damage and is avoided.

Ramping is the change in water release from the reservoir to meet the electrical load. Both scheduled and unscheduled ramping are crucial in load following, ancillary services, emergency situations, and variations in real time (what actually happens compared to what was scheduled) operations. North American Electric Reliability Council (NERC) and Western Electricity Coordinating Council (WECC) operating criteria require Western and Reclamation to meet scheduled load changes by ramping the generators up or down beginning at ten minutes before the hour and ending at ten minutes after the hour.

Hydropower generation can react instantaneously to the load (or power demand) - a pattern called load following. By comparison, coal- and nuclear-based resources have a relatively slow response time; consequently, they generally are not used for load following in the WECC.

As a control area operator, Western regulates the transmission system within a prescribed geographic area. Western is required to react to moment-by-moment changes in electrical demand within this area, adjusting the electrical power output of hydroelectric generators within the area in response to changes in the generation and transmission system to maintain the scheduled level of generation in accordance with prescribed NERC criteria. Automatic Generation Control (AGC) is a process whereby the control system automates the water releases in a manner that follows the power system’s actual dynamic demands on a moment-to-moment (typically a four-second-interval) basis.

Regulation depends on being able to ramp releases up or down quickly in response to system conditions. In addition, each utility is required to have sufficient generating capacity, in varying forms of readiness, to continue serving its customer load, even if the utility loses all or part of its own largest generating unit or largest capacity transmission line. This reserve capacity ensures electrical service reliability and an uninterrupted power supply.

Generating capacity that is in excess of the load on the system is called spinning reserve. Spinning reserves are used to quickly replace lost electrical generation resulting from a forced outage, such as the sudden loss of a major transmission line or generating unit. Additional off-line generating units are also used to replace generation shortages, but they cannot replace lost generation capacity as quickly as spinning reserves.

3.11.1.2 Power Marketing and Customers

Western markets the power and administers the power contracts for power generated from Reclamation-owned and operated hydropower facilities (i.e., Glen Canyon, Hoover, P-DP, and the smaller generation facilities).

Marketing of electricity is based on two concepts: capacity and energy. In power marketing, capacity is the rate of delivery or demand of electricity and is measured in kilowatts (kW) or megawatts. Electricity must be available the instant consumers need it. Capacity is important for meeting consumers' instantaneous demand as they turn on lights, appliances, and motors. Energy is the amount of electricity delivered over time and is measured in kilowatt-hours (kWh) or megawatt-hours (MWh). One kilowatt-hour of energy delivered over one hour requires one kilowatt of capacity. Energy is important for meeting consumers' continuing need for electricity. With the delivery of electricity, capacity and energy are both present; however, they can be marketed and billed separately. Power rates usually include individual charges for capacity and energy.

Power is marketed in terms of firm and nonfirm power. Firm power is capacity and energy that is guaranteed to be available. A sufficient portion of the generation capacity is held in reserve to enable continued delivery of firm power even if an outage occurs at a powerplant. The amount of power that is held in reserve is established by various power pooling agreements and reliability criteria.

Nonfirm power is sold to power contractors that would rather purchase nonfirm energy that is less expensive than the cost of their own generation or cost of alternative sources of supply. Nonfirm energy is usually sold with the requirement that the sale can be stopped on short notice and the buyer must have the resource available to meet its own load. Rates for nonfirm energy only include a charge for the energy delivered, since the customer has the capacity to meet its loads, if necessary.

Any power surplus or deficit affects all WECC power customers since the WECC region is one large interconnected system. However, customers most affected are those that have an allocation of hydropower resources sold by Western through various contractual arrangements.

The contracts for power from Glen Canyon Dam terminate in 2025, from Hoover Dam in 2017, and from the P-DP in 2008. After these dates, the identity of the recipients of power from these resources is not known. Recognizing that contracts for power will exist in some form in the future, an analysis of the effects of the action alternatives compared with those of the No Action Alternative consider the general effects in the overall areas served by the power facilities.

The states that could be potentially affected by changes in energy production and capacity changes at Glen Canyon and Hoover Powerplants are Arizona, California, Colorado, Nevada, Utah, Wyoming, and New Mexico. These states make up the Rocky Mountain, Arizona-New Mexico-Southern Nevada, and California-Mexico areas of the WECC. Electrical energy produced in each of these areas is derived from a variety of sources including Glen Canyon and Hoover Powerplants. The total generation capability of the areas as of January 1, 1999, is 86,348 MW. The generation capability of each WECC area is listed in Table 3.11-1.

Table 3.11-1
Generation Capability in WECC Areas

WECC Area	Available Capacity (MW)
Rocky Mountain	10,584
Arizona-New Mexico-Southern Nevada	22,272
California-Mexico	53,492

The capacity of Glen Canyon and Hoover powerplants represents approximately 3.6 percent of the total generating capability of these three areas of WECC (WECC 1999).

3.11.2 Lake Powell and Glen Canyon Dam

Glen Canyon Powerplant has eight generators with a maximum combined capacity of 1,320 MW when the reservoir elevation is 3,700 feet msl. The maximum combined discharge capacity of the eight turbines is approximately 31,500 cfs. Due to environmental restrictions, the maximum release is limited to 25,000 cfs except for extreme hydrologic or emergency conditions, limiting Glen Canyon Dam power generation capacity to approximately 1,000 MW, depending on reservoir elevation. The generators require a minimum Lake Powell elevation of 3,490 feet msl to operate. At this elevation, Glen Canyon Powerplant has a maximum capacity of about 630 MW. The annual gross generation has averaged approximately 4,951,918 MWh for the last 25 years and has averaged approximately 3,453,806 MWh over the past 5 years.

Glen Canyon Powerplant is part of the Salt Lake City Area Integrated Projects (SLCA/IP), which is a group of hydroelectric facilities marketed by Western. The SLCA/IP consists of hydroelectric facilities of Colorado River Storage Project (CRSP), Rio Grande Project, and Collbran Project.

Changes to reservoir elevations or releases could affect electrical power generation at Glen Canyon Dam.

3.11.3 Lake Mead and Hoover Dam

Hoover Powerplant is located at the toe of Hoover Dam, and extends downstream 650 feet along each canyon wall of the Colorado River. The turbines are designed to operate at heads ranging from 420 to 590 feet. The minimum reservoir elevation for efficient power generation is currently estimated to be approximately 1,050 feet msl. The final generating unit, N-8, was installed at Hoover Dam in 1961, giving the Hoover Powerplant a total of 17 commercial generating units with a rated capacity of 1,850,000 horsepower. Two station-service units, rated at 3,500 horsepower each, increased the powerplant total rated capacity to 1,344.8 MW.

Between 1982 and 1993, the 17 commercial generating units were uprated with new turbines, and new transformers and breakers were installed, raising the Hoover Powerplant's maximum capacity to 2,074 MW. The annual gross generation has averaged approximately 4,819,524 MWh for the last 25 years and has averaged approximately 4,014,655 MWh over the past 5 years.

Western markets the power to 15 customers in three states (Arizona, California, and Nevada); these are non-firm contracts. Any excess energy generated at the Hoover Powerplant is distributed to Hoover Powerplant contractors in accordance with their contracts.

Changes to reservoir elevations or releases could affect electrical power generation at Hoover Powerplant.

3.11.4 Parker-Davis Projects

The Davis Powerplant has five generators and a 256 MW maximum operating capacity. Between 1987 and 2005, the average annual net energy generated at the Davis Powerplant was 1,166,286 MWh.

Parker Powerplant has four generators and a 108 MW maximum operating capacity. Between 1987 and 2005, the average annual net energy generated at the Parker Powerplant was 487,649 MWh. MWD has a perpetual contract right to 50 percent of the electric power generated at the Parker Powerplant. Reclamation's 50 percent share of power generated at the Parker Powerplant is part of the P-DP.

The P-DP was formed in 1954 by consolidating the Parker Dam power project and the Davis Dam power project. Western markets the power generated by the P-DP. The P-DP supplies power to five Priority Use Projects (PUP) customers and 25 firm electric service contractors. The P-DP has 283 MW of capacity under contract to PUP and to firm electric service customers. The total annual energy committed to the five PUP and 25 firm electric service customers is 1,345,800 MWh (the PUP commitment is 195,266 MWh and the firm commitment is 1,150,534 MWh). The contracted capacity and energy for the P-DP, including system losses and reserves, is based on Davis Powerplant capacity and energy and Reclamation's half of Parker Powerplant's capacity and energy. The current P-DP firm electric service commitments are in effect until September 30, 2008. Western is close to concluding the process of finalizing the contractual commitments through September 30, 2028.

Under the existing P-DP firm electric service contracts, the amount of power per month and per season are guaranteed. This means that if the power is not available, Western would need to purchase the additional power required to fulfill the contracts.

Power generated at the P-DP, over and above what has been guaranteed to PUP and preference customers having firm electric service contracts, is referred to as surplus energy. A portion of the surplus energy, referred to as excess energy, is offered to P-DP customers for purchase at an “at cost” rate or for “banking” of energy up to the limit of the contractor’s contract rate of delivery. Any remaining surplus energy may be sold at market rates to interested parties or may be banked for future use.

Changes to dam releases could affect electrical power generation at the P-DP.

3.11.5 Other Small Hydropower Facilities

Headgate Rock Dam and Powerplant, which is owned and operated by the BIA and located downstream of Parker Dam, is a run-of-the-river powerplant that generates power through three turbines with a total capacity of 19.5 MW. Between 2001 through 2005, the average net energy generated annually at Headgate Rock Powerplant was 76,157 MWh. Changes to downstream water demand could affect electrical power generation at Headgate Rock Powerplant.

There are other small hydropower facilities located below Parker Dam. These facilities include Senator Wash, Siphon Drop, and Pilot Knob. In addition, there are several hydropower facilities owned by IID located at various drop structures along the AAC and on various other canals. These other small hydropower facilities will not be affected by the proposed federal action.

3.11.6 Basin Power Funds

3.11.6.1 Upper Colorado River Basin Fund

The Upper Colorado River Basin Fund (Basin Fund) was established under Section 5 of the CRSP Act. The CRSP Act “authorized a separate fund in the Treasury of the United States to be known as the Upper Colorado River Basin Fund for carrying out provisions of this Act other than Section 8”. Money appropriated for construction of CRSP facilities and Section 8 funding is credited in the Basin Fund. Revenues derived from operation of the CRSP and participating projects are deposited in the Basin Fund. Most of the revenues come from sales of hydroelectric power and transmission services. The Basin Fund also receives revenues from M&I water service sales, rents, salinity control funds from the Colorado River Lower Basin (as a pass-through for the Colorado River Basin Salinity Control Program), and miscellaneous revenues collected in connection with the operation of the CRSP and participating projects.

Basin Fund revenues must first be used to repay costs associated with the operation and maintenance of the CRSP units and used to repay the United States Treasury Department the reimbursable investment costs previously spent on construction of the CRSP units and costs allocated to the irrigation investment above the irrigator’s ability to pay. The Basin Fund is managed by Western. Approximately $175 million is needed each year to fund Reclamation and Western operation and maintenance needs. Of this amount, approximately $20 million is used to support environmental programs. Reclamation’s allocation of its portion of the Basin Fund, approximately $62 million, is shown in parentheses below.

- ♦ Reclamation and Western's costs associated with the operation, maintenance, equipment replacements, and emergency expenditures for all facilities of the CRSP and participating projects, provided that with respect to each participating project, such costs shall be paid from revenues received from each such project (Reclamation - $42.9 million);
- ♦ cost sharing for Colorado River Basin Salinity Control Program (Reclamation - $2 million);
- ♦ the major portion of the cost of the Glen Canyon Adaptive Management Program (Reclamation - $9 million);
- ♦ cost sharing for Upper Colorado River Endangered Fish Recovery Program (Reclamation - $7 million);
- ♦ water quality studies (Reclamation - $0.8 million); and
- ♦ consumptive use studies (Reclamation - $0.3 million).

Basin Fund revenues may not be appropriated and used for construction projects. Also, they may not be used for construction, operation and maintenance of public recreational facilities or facilities to mitigate losses of and improve conditions for the propagation of fish and wildlife (Section 8 of the CRSP Act authorizes Congressional appropriations for these purposes).

Western is responsible for transmission and marketing of CRSP power, collecting payment for the power, and transfer of revenues for repayment to the United States Treasury Department. A change in the amount of available capacity or energy could potentially affect the revenue derived from the sale of energy and the contributions to the Basin Fund, or rates charged to power customers.

3.11.6.2 Lower Colorado River Basin Funds

Currently there are three funds that are used to manage revenue and expenditure requirements of Lower Colorado Region power projects for the CAP, Boulder Canyon Project (Hoover) and the P-DP. Two are legislated funds and one is an account fund. A change in the amount of available capacity or energy could potentially affect the revenue derived from the sale of energy and the contributions to these funds, or rates charged to power customers.

The Lower Colorado River Basin Development Fund (Development Fund) was established by the CRBPA. The Colorado River Dam Fund (Dam Fund) was established by the BCPA. The Parker-Davis Account was established to enable the P-DP to fund in advance capital improvements and other expenses.

Lower Colorado River Basin Development Fund. In a manner similar to the Basin Fund, the Development Fund defrays costs of operation, maintenance and replacements of all project facilities, salinity control programs, repayment of CAP construction, and, as amended by the Arizona Water Settlements Act, of certain Tribal projects. It also reimburses water users in Arizona for losses sustained as a result of diminution of the production of hydroelectric power at Coolidge Dam, Arizona, resulting from exchanges of water between users in Arizona and New Mexico. The Development Fund is composed of revenue deposited from:

- surplus power sales of the United States entitlement of the Navajo Generating Station;
- CAP surcharge revenues from the Boulder Canyon and P-DP; and
- certain other CAP revenue receipts.

Colorado River Dam Fund. The Dam Fund is utilized to fund operation and maintenance (O&M) of Hoover Dam, payments to states, visitor services, up-rating program, replacements, investment repayment, and interest expenses of the Boulder Canyon Project (BCP). The Dam Fund is composed of:

- power revenues collected from the BCP power contractors;
- revenues collected from the BCP Visitor Center; and
- revenues from other BCP revenue receipts.

The BCP annual revenue requirement, base charge and rates, are determined annually to provide sufficient revenue to pay all annual costs, including interest expense and to repay investments, within the allowable period.

Parker-Davis Account. The Parker-Davis Account is utilized to advance-fund the costs of the P-DP, including operation, maintenance, and capital improvements. The funds are drawn from the customers' account into Reclamation on a monthly basis throughout the year. The advances are reconciled to the actual expenditures and the customers get credit for any remaining balance in the following period.

3.11.7 Water Supply System

3.11.7.1 Navajo Generating Station

The Navajo Generating Station (NGS) is a 2,250 MW coal-fired powerplant located on the Navajo Indian Reservation near Page, Arizona, and serves electric customers in Arizona, California and Nevada. The coal-fired powerplant is jointly owned by Reclamation, SRP, Los Angeles Department of Water and Power, Arizona Public Service Company, Nevada Power Company, and the Tucson Electric Power Company. The SRP operates the plant. The station supplies energy to pump water through the CAP. NGS was constructed near Lake Powell to ensure it had a dependable supply of cooling water for its three generators.

When NGS was constructed, it received an annual allotment of 34,100 af of water, and the intakes that pump water from Lake Powell to the powerplant were installed at an approximate elevation of 3,470 feet msl, or 230 feet below the lake's full pool elevation of 3,700 feet msl. A decrease in Lake Powell elevation could result in an increase in pumping costs for the NGS due to the increase in the required pumping lift.

To ensure that cooling water will be available for the continued operation of NGS, a proposal is being advanced to modify the water intake system of NGS by installing new intake structures at an elevation below that of the current intakes. The planning for this proposal is ongoing.

3.11.7.2 City of Page Water Supply Intake

The City of Page provides municipal water to approximately 7,800 residents from Lake Powell. The intake pump station is operated by Reclamation using power produced at the Glen Canyon Powerplant. Municipal water use in the City of Page is dominated by residential use with substantial residential landscape irrigation. The average annual use of water by the City of Page in recent years has been about 2,650 af. Under contract with Reclamation, the City of Page pays energy costs associated with pumping the water plus costs associated with operation and maintenance of the pump station by Reclamation. Annual energy usage has averaged around 3,900,000 kWh per year over the past 10 years. At the current rate of $0.03286 per kWh, the annual cost of energy for pumping the water is approximately $130,000 per year. Changes in CRSP power generation or drops in the elevation of Lake Powell could cause an increase in the cost of power for the City of Page's intake pump station.

3.11.7.3 SNWA Lake Mead Intake

The largest diverter of Colorado River water in Nevada is the SNWA. It diverts most of its allocation of Colorado River water from Lake Mead through the SNWA pumping plant located at Saddle Island within Lake Mead. The power-consuming features of this system are the pumping plants that are used to pump water from Lake Mead to the water treatment facility that is also owned and operated by SNWA.

The minimum required Lake Mead elevations necessary to operate the pumping units for SNWA's upper and lower intakes are 1,050 and 1,000 feet msl, respectively. A decrease in Lake Mead elevation could result in an increase in pumping costs for the SNWA due to an increase in the required pumping lift.

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3.12 Recreation

Key recreation resources or issues include reservoir or riverine recreational activities or facilities that might be affected by changes in reservoir elevation or river flow. The affected environment for recreation resources includes:

- shoreline public use;
- reservoir boating;
- river and whitewater boating; and
- sport fishing.

Information in this section was compiled after review of published and unpublished sources and through personal communications with Reclamation, NPS, and resource specialists. Key published sources of information used in the preparation of this section include:

- Lake Mead National Recreation Area, General Management Plan Amendment/EA (NPS 2005a);
- Grand Canyon National Park Final EIS, Colorado River Management Plan, Volume I (NPS 2005b);
- Glen Canyon National Recreation Area Final EIS, Personal Watercraft Rulemaking, Volume I (NPS 2003);
- Lower Colorado River Multi-Species Conservation Program, Final PEIS/EIR (Reclamation 2004a);
- Colorado River Interim Surplus Criteria Final EIS (Reclamation 2000); and
- Operation of Glen Canyon Dam Final EIS (Reclamation 1995).

3.12.1 Shoreline Public Use

The following sections describe shoreline public use associated with boating facilities (marinas, boat docks, and boat launch ramps), access to points of interest, and other opportunities within each Colorado River reach. Where available, the number and type of facilities at each marina, boat dock, and boat launch ramp are included for major shoreline access points. Recreational boating in the study area is dependent on these major shoreline access points. Fluctuation in pool elevations is a normal aspect of reservoir operations, and facilities have been designed and operated to accommodate these fluctuations. However, changes in pool elevations or increased variations or rates in pool elevation fluctuation could result in changes in operation costs and temporary closures.

Representative threshold pool elevations and river flows were selected for the boating facilities, at or below which certain facilities may be rendered inoperable or relocation of facilities could be required to maintain their operation. These thresholds were chosen based on either information provided in studies or communications with NPS personnel.

3.12.1.1 Lake Powell and Glen Canyon Dam

Lake Powell is located entirely within the GCNRA, which receives approximately two million visitors each year (NPS 2006d). Table 3.12-1 summarizes visitation to GCNRA for the most recent six years. The data indicate a gradual decrease in the number of visitors.

Table 3.12-1
Glen Canyon National Recreation Area Recreational Visitors

Year	Recreational Visitors
2000	2,568,111
2001	2,340,031
2002	2,106,896
2003	1,876,984
2004	1,841,845
2005	1,908,726

Source: NPS, 2006f.

Table 3.12-2 summarizes the total number of visits to GNCRA by visitor segment for 2003, the most recent year for which data are available.

Table 3.12-2
Glen Canyon National Recreation Area Visits by Visitor Segment for 2003

	Local Day Trips	Non-Local Day Trips	Hotel	Camp	Total
Number of Recreational Visits	187,698	656,944	218,548	750,794	1,876,984
Percent Segment Shares in Recreational Visits	10	35	15	40	100
Party Days[1]	81,608	252,671	196,886	870,804	1,415,939

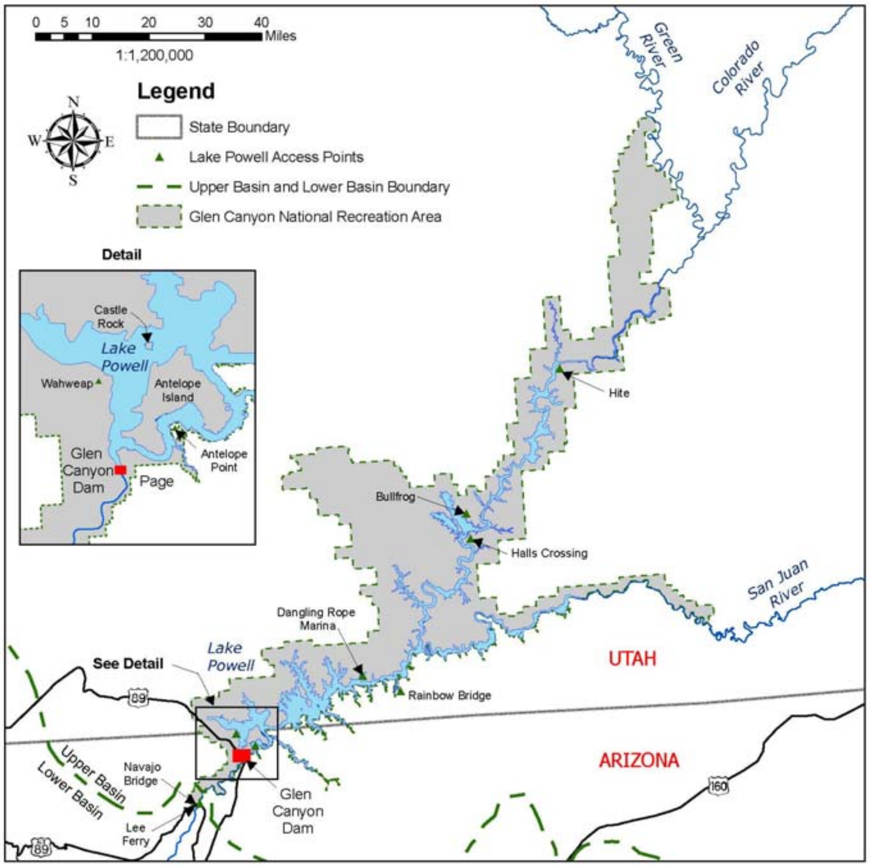
Source: NPS 2006b.

1 *Party days equal the number of days each visitor party spends in the local region. Party days are estimated by converting recreation visits using estimates of the average party size, length of stay in the area, and number of park entries per trip (re-entry rate).*

Lake Powell, its many side canyons, and related natural, cultural, and geologic resources are the primary recreation features of GCNRA. Recreation activities that occur at Lake Powell include swimming and sunbathing, power boating, waterskiing, fishing, off-beach activities associated with boat trips (such as hiking and exploring ruins), house boating, personal water craft use, canoeing, kayaking, sailing, wildlife viewing, photography, sightseeing, and other activities. Visitors can enjoy camping opportunities ranging from remote and undeveloped campsites to fully developed campgrounds. Visitors can also see archeologically and culturally important sites throughout the recreation area.

Boating Facilities. Recreation boating is the most important recreational activity on Lake Powell, with more than 831,000 boater days in 2001 (NPS 2003). Specific boating facilities, and reservoir elevations important to their operation, are discussed in the following sections. Figure 3.12-1 shows Lake Powell and the locations of its shoreline access points.

Figure 3.12-1
Lake Powell Shoreline Access Points



Water-based recreational facilities at Lake Powell are located at Wahweap, Dangling Rope, Halls Crossing, Bullfrog, Hite, and Antelope Point marinas. Table 3.12-3 lists critical lake elevations, identified by the NPS for Lake Powell, below which marinas, boat docks, or boat launch ramps become inoperable. Dangling Rope Marina is only accessible by boat, and it is used primarily for accessing Rainbow Bridge National Monument. There are no known reservoir elevations that would impair operation of Dangling Rope Marina.

Table 3.12-3
Critical Elevations for Lake Powell by Boating Facility

Lake Elevation (feet msl)	Impact and Facility
3,700	Full pool
3,620	Castle Rock Cut closed; Hite Marina and Public Launch Ramp closed
3,588	Antelope Point Public Launch Ramp closed
3,580	Main Bullfrog Launch Ramp closed
3,560	Wahweap and Stateline Public Launch Ramps closed; Bullfrog Low Water Alternative Launch Ramp closed; Halls Crossing Public Launch Ramps closed
3,555	Wahweap Marina closed; Antelope Point Marina closed; Bullfrog Marina closed; Halls Crossing Marina closed

Source: Henderson 2006

Access to Points of Interest. The facilities at Rainbow Bridge National Monument include courtesy docks, restrooms, a floating walkway, and a floating interpretive platform. Trails from the dock lead to viewing areas. One viewing area is used when Lake Powell is at the full pool elevation of 3,700 feet msl, and the other is used when the reservoir is below full pool elevation. The docks and trail system are designed to accommodate Lake Powell elevation fluctuations from 3,490 feet msl to 3,700 feet msl (NPS 1993). Boat tours to the Rainbow Bridge National Monument originate at Dangling Rope Marina.

When Lake Powell elevations fall below 3,650 feet msl, the floating walkway and interpretive platforms would be removed and stored, dock facilities would be moved to a lower elevation, dock facilities would be connected to the trail with a short walkway, and the old land trail through Bridge Canyon (submerged at full pool elevation) would be exposed, hardened, and used for access (NPS 1990).

3.12.1.2 Glen Canyon Dam to Lake Mead

The 15.5-mile river reach downstream of Glen Canyon Dam to Lees Ferry is managed by GCNRA and is used by anglers; campers; and commercial float trip operators, kayakers, and other boaters. Fishing opportunities (with an Arizona state non-native fishing license and a trout stamp) for rainbow and brown trout also occur downstream of this reach.

Grand Canyon National Park begins at Lees Ferry and the NPS manages most of the reach, except where it is bordered on the east by the Navajo Indian Reservation and the south by the Hualapai Indian Reservation. The Grand Canyon National Park regulates visitor use of the Colorado River in accordance with the Colorado River Management Plan (NPS 2005b).

The Lees Ferry to Diamond Creek reach has relatively low use densities and levels of development, providing opportunities for solitude on the Colorado River and at many camps and attraction sites. This section of the Colorado River is where the majority of whitewater boating occurs. Take-outs are located at Diamond Creek and Pearce Ferry, and the reach downstream of Diamond Creek offers different recreation opportunities than the river reach upstream as it transitions to a more populated and developed setting. The Pearce Bay take-out is closed at elevation 1,175 feet msl. Whitewater boating trips become intermingled with very high levels of general boating and recreation use in the Quartermaster Area.

Several helicopter operations transport people into the Grand Canyon and connect with motorized pontoon boats that give 20-minute tours of the immediate area. These same helicopters serve a dual service in flying out boaters who have traveled from Diamond Creek on commercial motor day trips.

Camping also occurs in the Grand Canyon National Park on undeveloped beaches along the river. The important variable is the number and quality of high-water versus low-water campsites.

The Hualapai Indian Reservation offers camping, fishing, hiking, and big game hunting. A Tribal enterprise operates a river rafting company that offers rafting trips on the section of the Colorado River from Diamond Creek to Quartermaster Canyon.

Boating Facilities. There are few boating facilities in Grand Canyon National Park, except for major launch facilities that include Lees Ferry, Phantom Ranch, Whitmore, Diamond Creek, and the Quartermaster Area. Brief descriptions of each facility are provided below.

Lees Ferry. The primary put-in at the start of a Grand Canyon river trip, Lees Ferry has a large ramp, parking, a camping area, and an information kiosk where pre-trip logistics and information sessions are conducted.

Phantom Ranch. Phantom Ranch is a collection of cabins, a small store, an NPS ranger station, and campground. River trips are prohibited from camping at Phantom Ranch, but it is a popular exchange location.

Whitmore. The Whitmore exchange point consists of a helicopter landing pad on Hualapai Indian Reservation and a boat tie-up and camping area. The Whitmore area is used by commercial trips as an exchange point for passengers to begin or end their river trip; nearly all of those passengers arrive at or depart from the area via a helicopter flight.

Diamond Creek. The Diamond Creek take-out and launch is operated by both the NPS and the Hualapai Indian Tribe. The tribe charges fees to use Diamond Creek. The Hualapai River Runners (HRR) manage take-out and launch operations in addition to conducting guided whitewater trips that put-in at Diamond Creek, and floating trips that put-in at Quartermaster Canyon. All of these trips take out at Pearce Ferry. There is a gravel ramp area and a limited parking lot.

Quartermaster Area. There are 15 helipads, 2 docks, and other facilities in the Quartermaster Area. While all of the pads offer access for look-and-leave flights, a few pads are also used to transport HRR and pontoon trip passengers out of the canyon.

Camping. Sandbars form the camping beaches used by river runners. Camping is possible in only a limited number of locations along the Colorado River between Glen Canyon Dam and Lake Mead because most of the shoreline is unsuitable. At a given time, however, campable area depends on the local stage (height) of the river, which is determined by the magnitude of releases and local topography.

There are three general categories for camp sizes: small (one to 12 people); medium (13 to 24 people); and large (25 to 36 people), that are further divided into high-water and low-water camps (Kearsley and Warren 1993). High-water camps are available at flows above 15,000 cfs, generally on terraces. Low-water camps are available only at flows below 15,000 cfs. Thirty-seven favorable sites that become available at discharges of 15,000 cfs or less were identified by Kearsley and Warren (1993). Table 3.12-4 lists the number of small, medium, and large camps, as well as the number of high- and low-water camps.

Table 3.12-4
Number of Camping Beaches by Camp Size for High- and Low-Water Camps

High- and Low-Water Camping Beaches	Small (1 to 12 people)	Medium (13 to 24 people)	Large (25 to 36 people)	Total
Camping beaches at high water (15,000 cfs or greater)	47	102	90	239
Additional camping beaches available at low water only (15,000 cfs or less)	27	10	*	37

*Source: Kearsley and Warren 1992, 1993; * not measured.*

3.12.1.3 Lake Mead and Hoover Dam

LMNRA contains 1.5 million acres and encompasses the 110-mile-long Lake Mead, 67-mile-long Lake Mohave, the surrounding desert, and the isolated Shivwits Plateau in Arizona.

The Virgin River flows into upper Lake Mead from the north. Recreational activities such as camping, boating, fishing, and hiking occur on upper Lake Mead. The Overton Wildlife Management Area provides opportunities for wildlife viewing and photography, waterfowl and upland game bird hunting, hiking, and fishing. The Overton Wildlife Management Area has an average of 5,300 annual visitor use days (Nevada Department of Wildlife 2006).

LMNRA extends along the lower Colorado River from the western border of Grand Canyon National Park (with the dividing line at the Grand Wash Cliff, RM 276.5) to Davis Dam. Primary recreational activities on Lake Mead by percentage of users include cruising/sailing 41.4 percent, personal watercraft usage 17.5 percent, waterskiing

16.9 percent, fishing 14.2 percent, swimming 6.7 percent, and other 3.3 percent (NPS 2002). A number of campgrounds and picnic areas provide additional recreational opportunities and include Boulder Beach, Calville Bay, Echo Beach, Las Vegas Bay, and Temple Bar. The LMNRA has approximately six million visitor use days per year (NPS 2001).

Table 3.12-5 summarizes recreational visits to LMNRA for the last six years.

Table 3.12-5
Lake Mead National Recreation Area Recreational Visitors

Year	Recreational Visitors
2000	8,755,005
2001	8,465,547
2002	7,550,284
2003	7,915,581
2004	7,819,984
2005	7,692,438

Source: NPS 2006c.

Table 3.12-6 summarizes the total number of visits to LMNRA by visitor segment for 2003, the most recent year for which data are available.

Table 3.12-6
Lake Mead National Recreation Area Visits by Visitor Segment for 2003

	Local Day Trips	Non-Local Day Trips	Hotel	Camp	Total
Number of Recreational Visits	2,374,674	2,374,674	791,558	2,374,674	7,915,581
Percent Segment Shares in Recreational Visits	30	30	10	30	100
Party Days[1]	719,598	719,598	263,853	668,482	2,415,452

Source: NPS 2006d.

1 *Party days equal the number of days each visitor party spends in the local region. Party days are estimated by converting recreational visits using estimates of the average party size, length of stay in the area, and number of park entries per trip (re-entry rate).*

Boating Facilities. The LMNRA is considered one of the premier water-based recreation areas in the nation. Most visitors are involved in water-based recreational activities, primarily between May and September. These recreational activities are supported by marina and launch ramp facilities developed along the Lake Mead shoreline. On average, the majority of boats are personal watercraft. There may be as many as 6,000 boats on Lake Mead and Lake Mohave during a peak recreation use weekend. The Boulder Beach developed area, which is one of the most heavily visited portions of the recreation area located near the urbanized area of Las Vegas and surrounding communities, includes special use areas for sailing, recreational diving, and personal watercraft use.

Water-based recreational facilities at Lake Mead are located at Boulder Beach, Las Vegas Bay, Callville Bay, Echo Bay, Overton Beach, and Temple Bar marinas, and Hemenway, Government Wash, South Cove, and Pearce Ferry boat ramps. Pearce Ferry is used as a take-out by Colorado River boaters. Table 3.12-7 shows critical elevations, identified by the NPS for Lake Mead, below which marinas, boat docks, or boat launch ramps become inoperable. The Pearce Bay launch ramp, a take-out point for rafts and whitewater boats, is closed at elevation 1,175 feet msl. This results in rafts and other whitewater boats having to continue downstream to South Cove, an additional 16 miles.

Table 3.12-7
Critical Elevations for Lake Mead by Recreational Facility

Lake Elevation (feet msl)	Impact and Facility
1,221	Full Pool
1,175	Pearce Bay Launch Ramp closed
1,150	Las Vegas Bay and Government Wash Public Launch Ramps closed
1,125	Overton Beach Marina, Callville Ramp and South Cove Ramp closed
1,112	Lake Mead Marina – Relocation of "C Dock" to Hemenway
1,110	Overton Public Launch Ramps closed
1,100	Lake Mead Marina must relocate out of protected harbor
1,080	Lake Mead Marina public launch ramp closed; Hemenway public launch ramp closed; Temple Bar Public Launch Ramp closed
1,050	Echo Bay Public Launch Ramp closed

Source: Henderson 2006.

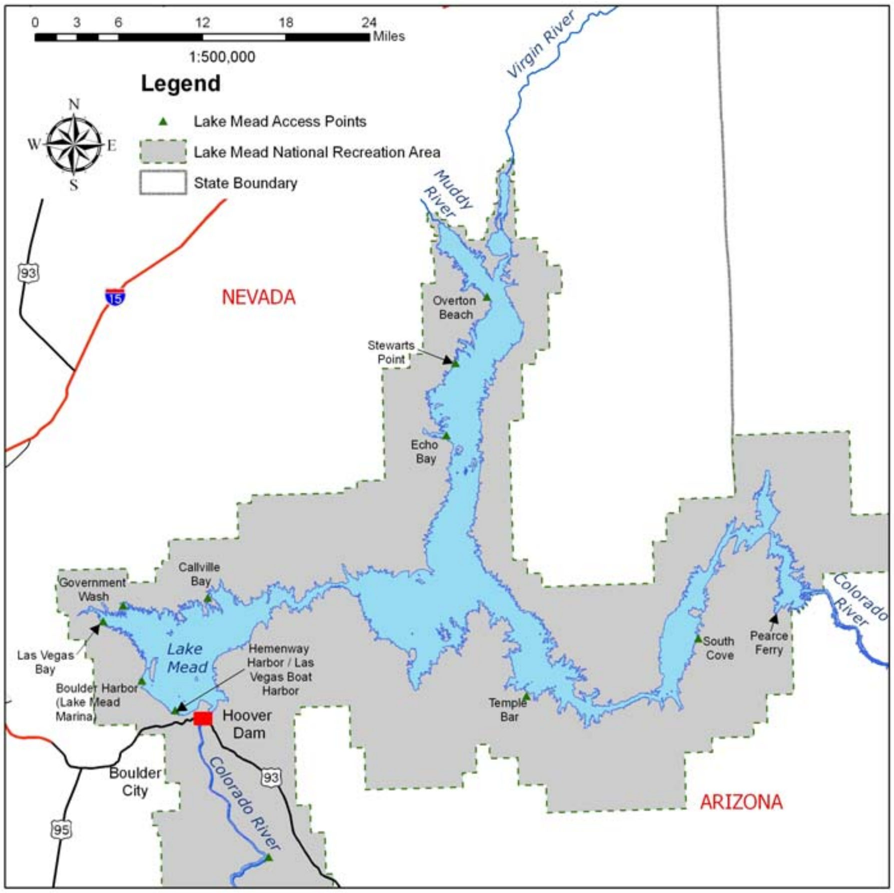
Shoreline public use facilities on Lake Mead are shown on Figure 3.12-2 and described on the following pages.

Pearce Ferry. Pearce Ferry includes a primitive public launch ramp used by Grand Canyon raft tour companies as their take-out. The ramp is located in a cove off of the river and operable when Lake Mead is at an elevation above 1,175 feet msl. Below that elevation, the cove becomes isolated from the river by a large sand bar separating the cove and graded ramp from the main flow of the Colorado River (NPS 2006e).

When Pearce Ferry is inaccessible due to low flows, boaters must continue downstream to South Cove, an additional 16 miles. This costs river runners fuel (for motorized craft), time (one to two more hours on the river), and possible safety problems (due to fatigue).

South Cove. The facilities at South Cove provide access to one of the best sand beach areas. There is one courtesy dock, public launch ramp, picnic facilities, and unpaved parking (Henderson 2000). The public launch ramp is constructed of asphalt and concrete and extends to an elevation of 1,125 feet msl. Other public facilities include a picnic area and restrooms. In addition, there is an airstrip approximately four miles from the facilities at South Cove (Henderson 2000).

Figure 3.12-2
Lake Mead Shoreline Access Points



Temple Bar. Temple Bar Marina includes a public launch ramp, boat, houseboat, and personal watercraft rentals, slip rentals, and fuel. Other facilities and services include a restaurant/lounge, motel, cabin rentals, trailer village, recreational vehicle sites, dry boat storage, store, shower/laundry, boat/motor repairs, and auto/boat gas.

Overton Beach. The facilities at Overton Beach Marina include two public launch ramps. The marina is closed at elevation 1,125 feet msl and the public launch ramps are closed at elevation 1,110 feet msl.

Additional available facilities and services at the Overton Beach Marina include covered rental slips, boat and personal watercraft rentals, small boat repair, fuel dock, and snack bar. Land based facilities include a store, shower/laundry, recreational vehicle campground, a trailer village, and dry boat storage.

Stewart's Point. Stewart's Point has an unpaved launch ramp (River Lakes Host 2006). The shoreline at Stewart's Point is a popular summertime weekend destination. The area is also a vacation cabin site area. The 2003 Lake Management Plan approved the future construction of a public boat launch at this location.

Echo Bay. The Echo Bay Marina includes boat, houseboat, and personal watercraft rentals, slip rentals, and fuel. Other facilities and services include a restaurant, motel, trailer village, recreational vehicle sites, dry boat storage, store, shower/laundry, boat/motor repairs, and auto/boat gas.

Callville Bay. The Callville Bay Marina includes rental slips; boat, houseboat, and personal watercraft rentals; and fuel. Other facilities and services include boat and motor repair, a trailer village, recreational vehicle sites, cafe/lounge, shower/laundry, auto/boat gas, dry boat storage, and a general store.

Government Wash. The facilities at Government Wash include one courtesy dock, public launch ramp, and a parking area. These facilities are closed at elevation 1,150 feet msl.

Las Vegas Bay. The facilities at Las Vegas Bay Marina include two public launch ramps, dry boat storage, and fuel service and maintenance area. The public launch ramps close at elevation 1,150 feet msl.

Las Vegas Boat Harbor. The facilities at Las Vegas Boat Harbor Marina are located next to Hemenway Harbor, and include rental slips, boat and personal watercraft rentals, floating gas dock, boat/motor repairs, store, and restaurant.

Hemenway Harbor. The facilities at Hemenway Harbor include one courtesy dock, public launch ramp, campgrounds, and a parking area. It also serves as the departure point for Lake Mead Cruises that provides sightseeing tour boat service to and from Hoover Dam, breakfast and dinner cruises, and charter boat service.

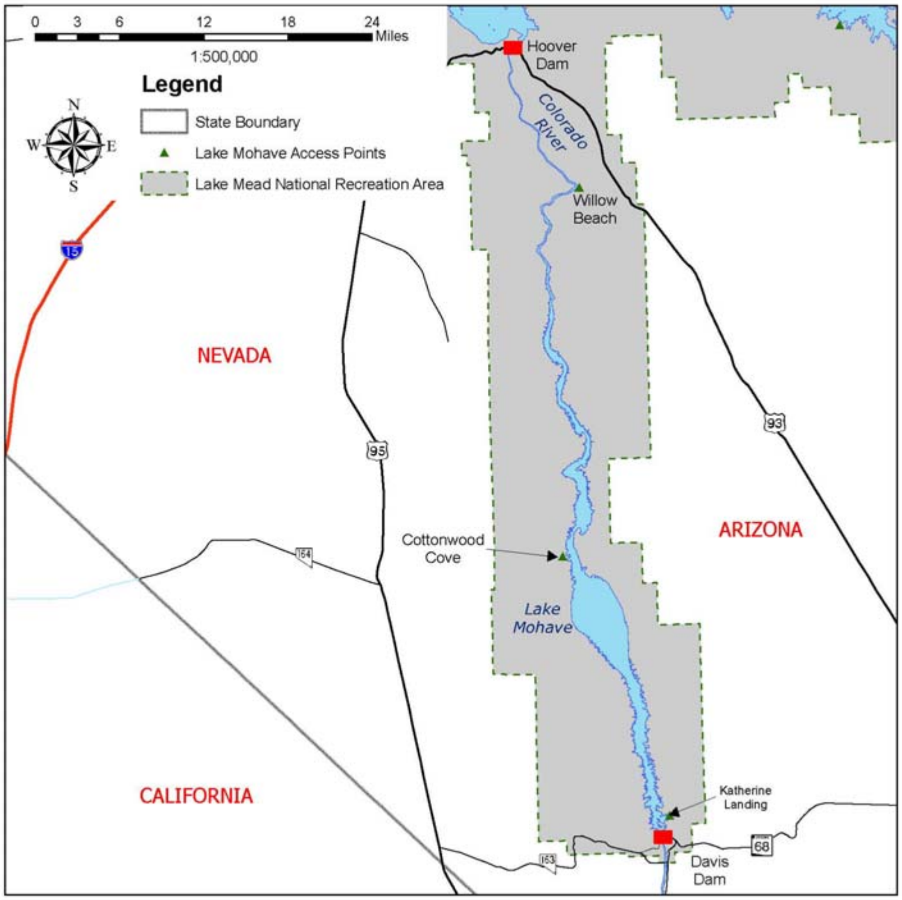
Boulder Harbor. The facilities at Boulder Harbor include two public launch ramps at Boulder Beach.

3.12.1.4 Hoover Dam to Davis Dam

Lake Mohave, formed by Davis Dam, provides a multitude of recreational opportunities. Activities include boating, canoeing on northern parts of the lake, camping, exploring, fishing, photography, picnicking, swimming, parasailing, two locations for cliff diving, and water skiing. There are also hundreds of beaches that can only be accessed by boat.

The main shoreline access points for Lake Mohave are Katherine Landing, Cottonwood Cove, and Willow Beach (Figure 3.12-3). Facilities for public use and boat launching are located at Katherine's Landing in Arizona near Davis Dam, and at Cottonwood Cove, east of Searchlight, Nevada. Boats and jet skis can be rented at both locations. Public campgrounds are available at both locations where concessionaires provide trailer parks, restaurants, lodging, docking facilities, boat and fishing tackle equipment, and fishing licenses. Facilities for public use and boat launching are also located at Willow Beach, 31 miles upstream on the Arizona shore.

Figure 3.12-3
Lake Mohave Shoreline Access Points



3.12.1.5 Davis Dam to Parker Dam

Recreational Areas. The Davis Dam to Parker Dam reach includes several recreational areas along the Colorado River including Laughlin, Bullhead City, Davis Camp, Needles, Havasu NWR, Lake Havasu State Park, and Bill Williams River NWR. Relevant recreational areas are briefly described in the following sections.

Davis Camp. Located near Bullhead City, Davis Camp, a campground and day use area, has boat launching facilities, picnic areas, numerous campsites, and recreational vehicle hookups. Davis Camp offers many river-oriented recreational opportunities, including fishing and water sports.

Havasu National Wildlife Refuge. The Havasu NWR, managed by the FWS, covers 30 river miles (300 miles of shoreline) from Lake Havasu City, Arizona to Needles, California, and includes one of the last remaining natural stretches of the lower Colorado River, which flows through the 20-mile-long Topock Gorge (FWS 2002). Typical activities include canoeing, fishing, boating through the scenic Topock Gorge, and hiking in the Havasu Wilderness Area. Each year, thousands of visitors explore the 4,000-acre Topock Marsh, which offers excellent canoeing, fishing, and water-bird watching. Other activities offered by the Havasu NWR include camping and hunting.

Lake Havasu State Park. Lake Havasu, formed by Parker Dam, contains a number of coves and inlets, and it is a popular spot for fishing. The waters of Lake Havasu also are used for canoeing, house boating, jet-skiing, kayaking, sailing, and speed-boating, swimming, and water-skiing. Camping and hiking also occur along the more than 400 miles of the lake's shoreline. Additional visitor opportunities include viewing the London Bridge. Lake Havasu is a popular spring break and family vacation destination.

Lake Havasu is the premier attraction area within the Davis Dam to Parker Dam reach. Visitation at Arizona's Lake Havasu and Cattail Cove State Parks is listed in Table 3.12-8.

Table 3.12-8
Visitation at Arizona's Lake Havasu and Cattail Cove State Parks

State Park	Visitation (1995-1996)	Visitation (2000-2001)	Percent Change
Lake Havasu	371,700	345,590	-7.0
Cattail Cove	96,459	106,939	10.9
Totals	468,159	451,983	-3.4

Source: Northern Arizona University 2002.

Bill Williams River National Wildlife Refuge. The Bill Williams River NWR, managed by the FWS, is located along the Bill Williams River near its confluence outlet into Lake Havasu. The refuge offers a variety of recreational opportunities, including hiking and bird watching (as well as other wildlife viewing), with opportunities to view Yuma clapper rails and southwestern willow flycatchers, among other species. Hunting is permitted for dove, cottontail, quail, and desert bighorn sheep. Other activities include boating and fishing.

Boating Facilities. The Davis Dam to Parker Dam reach includes shoreline public use facilities at Laughlin, Nevada; Bullhead City, Arizona; Davis Camp, near Bullhead City; Needles, California; Havasu NWR, covering 30 river miles (300 miles of shoreline) from Lake Havasu City, Arizona to Needles, California; Lake Havasu State Park, Arizona; and Bill Williams River NWR, Arizona. Recreational activities within this reach include canoeing, fishing, houseboating, jet-skiing, kayaking, sailing, speed-boating, swimming, and water-skiing.

3.12.1.6 Parker Dam to Cibola Gage

Recreational Areas. The Parker Dam to Cibola Gage reach includes several recreational areas including Parker Strip Recreation Area, Palo Verde Diversion Dam, Blythe, and Cibola NWR. Brief descriptions of relevant recreational areas located on this reach follow.

Parker Strip Recreation Area. The Parker Strip Recreation Area includes an 11-mile road along the Colorado River. Recreational activities include boating, camping, fishing, hiking, rock hounding, swimming, and wildlife viewing.

Palo Verde Diversion Dam. There are approximately 95 miles of navigable waters between Imperial Dam downstream of Yuma and Palo Verde Diversion Dam upstream of Blythe. Activities include canoeing, fishing, hunting, power boating, and other water sports.

Cibola National Wildlife Refuge. The Cibola NWR, including Cibola Lake, managed by the FWS is located about 15 miles south of Blythe. The largest concentration of Canada geese and sandhill cranes on the lower Colorado River winter at this refuge. Visitors to the refuge engage in canoeing, fishing, hiking, hunting, photography, and wildlife observation.

Boating Facilities. The Parker Dam to Cibola Gage reach includes shoreline public use facilities at Parker Strip Recreation Area, Arizona; Palo Verde Diversion Dam, Arizona; Blythe, California; and Cibola NWR, Arizona. Typical water activities within this reach include canoeing, power boating, fishing, swimming, and other water sports.

3.12.1.7 Cibola Gage to Imperial Dam

Recreational Areas. The Cibola Gage to Imperial Dam reach includes a few recreational areas including Picacho State Recreation Area (SRA), Imperial NWR, and Martinez Lake. Brief descriptions of these recreational areas follow.

Picacho State Recreation Area. Picacho SRA is a popular area for camping, desert exploring, river running, and sport fishing. It receives approximately 60,000 visitors annually (Picacho State Recreation Area 2006), and has a group boat-in area, three individual boat-in camp areas, and large group camping areas. Bird watching and small game hunting for doves, ducks, and quail are among other recreational opportunities.

Imperial National Wildlife Refuge. Recreational opportunities at the Imperial NWR include canoeing, fishing, and hunting. The refuge is valued by boaters for its remote scenery.

Martinez Lake. Martinez Lake, which adjoins the Imperial NWR, encompasses 300 to 500 acres and it is an attraction catering to anglers, birdwatchers, boaters, fishers, hunters, nature lovers, rock hounds, sightseers, and water skiers. Martinez Lake has a large variety of birds year around that can be viewed from boats on the Colorado River as well as the many side lakes along the river.

Boating Facilities. Cibola Gage to Imperial Dam reach includes shoreline public use facilities at Picacho SRA, California; Imperial NWR, Arizona; and Martinez Lake, Arizona. Picacho SRA has a group boat-in area and three individual boat-in camp areas. Typical water activities within this reach include river running, boating, canoeing, water-skiing, and sport fishing.

3.12.1.8 Imperial Dam to NIB

Recreational Areas. The Imperial Dam to the NIB reach includes a few recreational areas along the Colorado River, including Betty's Kitchen and Mittry Lake Wildlife Area. Brief descriptions of these recreational areas follow.

Betty's Kitchen. Betty's Kitchen, a 10-acre wildlife interpretive area, provides bird watching and fishing opportunities.

Mittry Lake Wildlife Area. Mittry Lake, within the Mittry Lake Wildlife Area, covers approximately 600 acres and it is an ideal location for small game hunting and sportfishing. There is a three-lane boat launch ramp for motorized boating on the lake. The area is also popular for birdwatching and nature study.

Boating Facilities. The Imperial Dam to the NIB reach includes shoreline public use facilities such as a public fishing pier (National Recreation Trails Program 2006) at Betty's Kitchen, Arizona and a three-lane boat launch ramp for motorized boating and fishing jetties at Mittry Lake Wildlife Area, Arizona (AZBLM 2006). Typical water activities within this reach include boating, swimming, and sport fishing.

3.12.1.9 NIB to SIB

The NIB to the SIB reach includes shoreline public use facilities in the City of Yuma, Arizona. Located on the edge of the historic floodplain to the east of the Colorado River, typical water activities within this reach include boating, swimming, and sport fishing.

3.12.2 Reservoir Boating

Reservoir boating is affected by fluctuating reservoir elevations, specifically causing changes in exposure to boating navigation hazards and changes in safe boating capacities. Hazards such as exposed rocks may become more evident and changes in navigation patterns may be necessary as reservoir elevations decline. At low-pool elevations, special buoys or markers may be placed within reservoirs to warn boaters of navigational hazards. In addition, signs may be placed in areas that are deemed unsuitable for navigation.

3.12.2.1 Lake Powell

Safe Boating Navigation. In 1986, the GCNRA developed an Aids to Navigation Plan for Lake Powell that identified boating safety issues on the reservoir and low-pool elevations that could affect boating (NPS 1986). The navigation system uses regulatory buoys and other marking devices to warn boat operators of hazardous conditions associated with subsurface obstructions or changes in subsurface conditions that could be hazardous for safe passage. Placement of many of these marking devices is dependent on the lake elevation.

At pool elevations below 3,680 feet msl, there are several places that remain passable, although buoys are placed for safe navigation. At elevations 3,626 feet msl and 3,620 feet msl, there are two areas on the reservoir that are closed to commercial tour boats and recreational boats, respectively, because of hazardous obstructions to navigation. One of these areas is around Castle Rock (elevation 3,620 feet msl), just east of the Wahweap Marina, and the other is around Gregory Butte, which is about midway to Dangling Rope Marina from Wahweap (Figure 3.12-1). At elevation 3,626 feet msl commercial tour boats leaving the Wahweap Marina heading up reservoir (east) must detour 8.5 miles around the southern end of Antelope Island. At elevation 3,626 feet msl, commercial tour boats must detour 4.5 miles around Padre and Gregory Buttes (NPS 1986). The added mileage and increased travel time makes the more popular half-day trips to the area infeasible for commercial tour boat operators. In addition, the added mileage may influence recreational boaters to remain in the area of Wahweap Bay, which can result in congestion (Henderson 2000).

In addition to buoys marking obstructions, the Aids to Navigation Plan also established a marked travel corridor to guide boat travel on Lake Powell. This primary travel corridor is the main channel of the Colorado River and it is marked with buoys along the entire length of the reservoir. Except for the reservoir mouth, there are no known pool elevations at which boat passage along this main travel corridor becomes restricted and affects boating.

Near Hite a delta has formed that can affect river boaters coming into Lake Powell at low-pool elevations. River boaters from the Colorado River row or motor through Lake Powell to a location where a boat transports them 20 to 25 miles (depending on the pick-up location) to the Hite Marina. At low elevations, the river boaters must travel further downstream to reach a location accessible to the transport company’s boat. Although this results in more miles to the take-out, there is usually enough current in the river to carry the boats. At lower elevations, additional rapids are exposed in Cataract Canyon (Hyde 2000), benefiting river runners; however, lower Lake Powell elevations result in the possibility of additional navigational hazards due to restricted channel widths, and subsurface conditions.

As listed in Table 3.12-9, watercraft use in the GCNRA peaks in the months of June through August.

Table 3.12-9
Estimates of Watercraft Use in Glen Canyon National Recreation Area by Month and Annually in 2001

Month	Other Watercraft		Personal Watercraft		All Watercraft	
	Boat Days	Monthly Use (percentage)	Boat Days	Monthly Use (percentage)	Boat Days	Annual Use (percentage)
January	747	96	30	4	777	<1
February	1,059	97	33	3	1,092	<1
March	8,995	97	261	3	9,256	1
April	18,686	94	1,122	6	19,808	2
May	68,444	81	15,771	19	84,215	10
June	137,675	74	47,985	26	185,660	22
July	113,984	70	48,600	30	162,584	20
August	126,628	72	49,491	28	176,119	21
September	80,045	62	49,883	38	129,928	16
October	37,658	86	6,336	14	43,994	5
November	11,946	96	445	4	12,391	2
December	5,189	99	67	1	5,256	1
Total	611,056	74	220,023	26	831,079	100

Source: NPS 2003.

Safe Boating Capacity. Recreational boating is the most frequent type of boating activity on Lake Powell, with an estimated 1.5 million boaters per year. One of the most popular activities at Lake Powell is to take houseboats and motorboats for multiple day excursions to explore the reservoir.

At full pool elevation for Lake Powell (3,700 feet msl), its operating surface area is 160,782 acres. Using nine surface acres per boat, Lake Powell’s safe boating capacity at full pool elevation is approximately 17,865 boats at one time. As pool elevation decreases, the surface area available for boats also decreases.

3.12.2.2 Lake Mead

Safe Boating Navigation. Regulatory buoys and other marking devices are used on Lake Mead to warn boat operators of dangers, obstructions, and changes in subsurface conditions in the main channel or side channels.

The main channel of the Colorado River forms the primary travel corridor on Lake Mead and it is marked along its entire length with buoys for boating guidance. In addition, regulatory buoys are placed in areas where there may be a danger for safe passage.

Excursions from Lake Mead into the Grand Canyon are a popular activity. Boats entering the Grand Canyon usually launch at Pearce Ferry, South Cove, or Temple Bar (Figure 3.12-2). In addition to sightseeing being a popular activity, many boaters include overnight camping on these excursions.

The upper arms and inflow areas of Lake Mead may be difficult to navigate due to shifting subsurface sediments. In the main channel of the reservoir, the Grand Wash Cliffs area is the beginning of dangerous navigation conditions and no houseboats are allowed beyond this point (NPS 2005a).

Over the years, sediment has built up in the section of the reservoir between Grand Wash and Pearce Ferry. When Lake Mead elevations drop below 1,170 feet msl, the sediment is exposed as mud flats and there is no well-defined river channel. As a result, the area is too shallow for motor boats to navigate upstream and into the lower reaches of the Grand Canyon. With fluctuating flows, even smaller crafts may have a difficult time accessing the area because of the shifting channel (Reclamation 1995). Based on this information, elevation 1,170 feet msl is considered a threshold elevation for safe boating navigation for the upper end of Lake Mead.

While the area around Pearce Ferry is an issue for navigation at elevation 1,170 feet msl, the Pearce Bay launch ramp is inaccessible as a take-out for boaters at elevation 1,175 feet msl and boaters must paddle an additional 16 miles to South Cove (Henderson 2006).

Safe Boating Capacity. At full pool elevation, Lake Mead’s operating surface area is 153,235 acres. Using the safe boating density of nine surface acres per boat, Lake Mead’s safe boating capacity at full pool elevation is approximately 17,000 boats. As pool elevation decreases, the safe boating capacity also decreases.

3.12.2.3 Lake Mohave and Lake Havasu

Because Lake Mohave and Lake Havasu will continue to be operated to meet monthly target elevations, reservoir boating safe navigation and capacity in these reaches will not be impacted by the proposed federal action.

3.12.3 River and Whitewater Boating

Whitewater boating is the key recreational activity in Grand Canyon from Lees Ferry to the Diamond Creek or Pearce Ferry take-outs. Other reaches are not predominately whitewater localities and so they are not covered here.

3.12.3.1 Glen Canyon Dam to Lake Mead

Most Grand Canyon river trips begin at Lees Ferry and take-out at Diamond Creek or Pearce Ferry when Lake Mead elevations are higher than 1,175 feet msl, or at South Cove when Lake Mead elevations are below 1,175 feet msl (Figure 3.12-2). Boating is regulated by the NPS through its Colorado River Management Plan (NPS 2005b). The number of permits or boaters will not change as a result of this proposed federal action; the key issue is whether the visitor experience could change as a result of potential changes in Glen Canyon Dam releases. The total number of river users is approximately

22,800 per year. Use is expected to increase to 28,000 per year as indicated in the Grand Canyon National Park Colorado River Management Plan. There are seasonal differences in the number of river users, with the winter season having the lowest daily and monthly uses.

Motorized boats travel up and down river from Glen Canyon Dam to Lees Ferry and in the upper end of Lake Mead. Limited camps in the latter area discourages overnight use.

3.12.3.2 Hoover Dam to SIB

Fluctuations in river flows between Hoover Dam and the SIB under each alternative are expected to be within the range of historic operations for the Colorado River and would not deviate from historic highs and lows. Between Hoover Dam and the SIB, river and whitewater boating are not expected to be adversely affected by the proposed federal action.

3.12.4 Sport Fishing

This discussion is based on the GCNRA Fish Management Plan (NPS 1996) for Lake Powell, and the Desert Lake View Newspaper, Fall/Winter 1999 for Lake Mead. In addition, creel information and angler fishing data have been obtained from state agencies in Arizona, Nevada, and Utah responsible for managing the fisheries resources at Lake Mead, Lake Powell, Lake Mohave, and on the Colorado River.

There are no specific reservoir elevation thresholds or river stages related to sport fishing identified from the literature reviewed. Catch rates for reservoir fishing are assumed to be directly related to reservoir habitat. Fishing satisfaction is assumed to be directly related to the general recreation issues of boating access to water via shoreline facilities, and boating navigation potential for hazards or reservoir detours due to low reservoir elevations. Catch rates are not expected to be affected by fluctuations in reservoir elevations.

3.12.4.1 Lake Powell and Glen Canyon Dam

Lake Powell supports a popular warm water sport fishery comprised mainly of striped and smallmouth bass. The striped bass depend on threadfin shad, a mid-water forage species, for a significant portion of their diet. The threadfin shad in Lake Powell are at the northernmost portion of their range and are sensitive to fluctuations of water temperature. Gizzard shad, which were inadvertently released recently and made their way to Lake Powell, may become an important striped bass forage fish. In addition to striped and smallmouth bass, Lake Powell supports largemouth bass, walleye, channel catfish, bluegill, and black crappie. There are two million angler hours per year in pursuit of sport fish. Due to the drought and declining visitation, angler use in 2003 was the lowest it has been since 1985 (Blommer et al. 2004).

3.12.4.2 Glen Canyon Dam to Lake Mead

The rainbow trout in the 15.5-mile river reach downstream of Glen Canyon Dam attract large numbers of local and international anglers. In 2003, angler use was approximately 14,000 user days. The fishery is managed as a blue ribbon rainbow trout fishery by the Arizona Game and Fish Department and GCNRA. The intention of blue ribbon management is to provide a quality fishing opportunity where anglers can catch larger than average trout, at a relatively high catch rate, in a unique recreational setting. Most fishing occurs from boats, but some anglers wade in the area around Lees Ferry. Downstream of this area the native fishery is emphasized. Whirling disease was discovered in Lees Ferry trout in June of 2007, which is the first documented case of the disease in wild fish in public waters in Arizona (Arizona Game and Fish 2007).

3.12.4.3 Lake Mead and Hoover Dam
Lake Mead has an excellent warm water sport fishery comprised of largemouth bass, striped bass, channel catfish, rainbow trout, bullhead catfish, sunfish, crappie, and bluegill. Eighty-six percent of the catch consists of striped bass. Fishing is generally better in the fall months of September, October, and November. Larger fish are caught by deep water trolling in spring from March through May.

3.12.4.4 Hoover Dam to Davis Dam
Lake Mohave's fishery is similar to Lake Mead's fishery. In Lake Mohave there are largemouth bass, striped bass, channel catfish, rainbow trout, bullhead catfish, sunfish, crappie, and bluegill. Largemouth and striped bass are in deep water in the winter and move into shallow water to spawn in the spring. Fishing is open year round, but the best fishing generally occurs in September, October, and November. For deep water trolling, March through May is best.

3.12.4.5 Davis Dam to Parker Dam
Striped bass is the dominant sport fish in Lake Havasu. They can be caught throughout the year, but best fishing locations change with seasons and with water temperature. The largemouth bass population supports tournaments nearly every weekend from September through May. The smallmouth bass population has experienced an increase in numbers over the past couple of years adding a needed resource for tournament anglers. Channel catfish are abundant and average two to four pounds in size. Flathead catfish grow to large sizes in Lake Havasu. Only a limited number of anglers fish specifically for catfish. Black crappie numbers are limited due to over-harvesting and lack of habitat. The lake also contains some very large bluegill and redear sunfish; many weigh well over a pound (Lake Havasu Fishing 2006).

3.12.4.6 Parker Dam to SIB
Fishing in Cibola NWR is limited to certain times of the year. Cibola NWR is managed to protect wintering waterfowl that use Cibola Lake. The lake is closed to fishing from Labor Day to March 15. Sport fishing in Cibola Lake includes largemouth, smallmouth, and striped bass, channel and flathead catfish, crappie, sunfish, tilapia, and common carp (FWS 2006a).

The Imperial NWR is managed as a refuge and breeding area for migratory birds and other wildlife (FWS 2006b). Hunting and fishing are permitted in some areas, according to state regulations, and fishing is allowed in the mainstream Colorado River any time of the year by boat. Fluctuations in flows between Parker Dam and the SIB under the alternatives are expected to be within the historic operating range of the Colorado River.

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3.13 Transportation

Transportation refers to the movement of people and vehicles on existing road networks and on ferries that cross the Colorado River. While there are other transportation services, only the ferry services have the potential to be impacted by the proposed federal action.

3.13.1 Ferry Service

Three ferry services transport people and vehicles across the Colorado River and its reservoirs. These services are:

- Lake Powell ferry service;
- Laughlin river taxis and tour boats; and
- Lake Havasu ferry service.

3.13.1.1 Lake Powell Ferry Service

The John Atlantic Burr Ferry on Lake Powell is located 95 miles upstream from Glen Canyon Dam and connects Bullfrog and Hall Crossing marinas on Lake Powell (Figure 3.13-1). The State of Utah operates this ferry service year round. This ferry saves approximately 130 miles of driving and the cost is $39.50 plus tax for a one-way trip. The ferry becomes inoperable when Lake Powell elevation falls below 3,550 feet msl (Aramark 2006).

3.13.1.2 Laughlin River Taxis and Tour Boats

Privately owned river taxis and tour boats operate on the Colorado River approximately 2.5 miles downstream of Davis Dam in Laughlin, Nevada (California Department of Boating and Waterways 2006) (Figure 3.13-2). The river taxis provide transportation between the casinos located along the Colorado River in Laughlin. The tour boats offer services ranging from air-conditioned cabins, open-air top decks, wedding chapels, and full service bars. The operation of these river taxis and tour boats depends upon the Colorado River elevations that result from releases of water from Davis Dam. Many operations, especially the larger tour boats with paddle wheels, require releases of two units (approximately 9,200 cfs) from Davis Dam to operate. Although some of the river taxi operations that operate smaller boats can get by with 0.5 units (approximately 2,300 cfs), most prefer at least one unit (approximately 4,600 cfs) (Fitch 2006, personal communication).

3.13.1.3 Lake Havasu Ferry Service

The Dreamcatcher Ferry transports people between Havasu Landing Casino on the Chemehuevi Indian Reservation, California and a point near the London Bridge in Lake Havasu City, Arizona (California Department of Boating and Waterways 2006) (Figure 3.13-3). This ferry carries approximately 400,000 people per year but does not carry vehicles (Arizona State Parks 2006). Lake Havasu will continue to be operated to meet monthly elevation targets; as such, the proposed federal action is not anticipated to affect the operation of the Lake Havasu ferry service.

Figure 3.13-1
John Atlantic Burr Ferry Route – Lake Powell

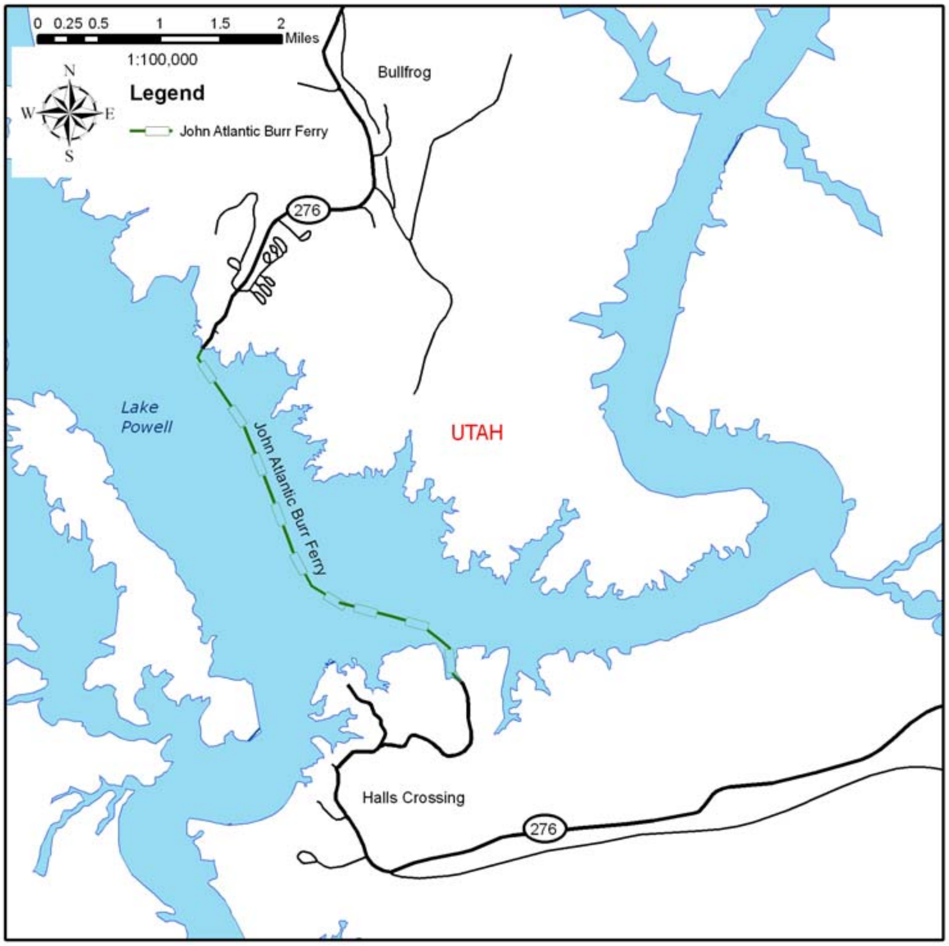


Figure 3.13-2
Laughlin River Taxi and Tour Boat Crossing

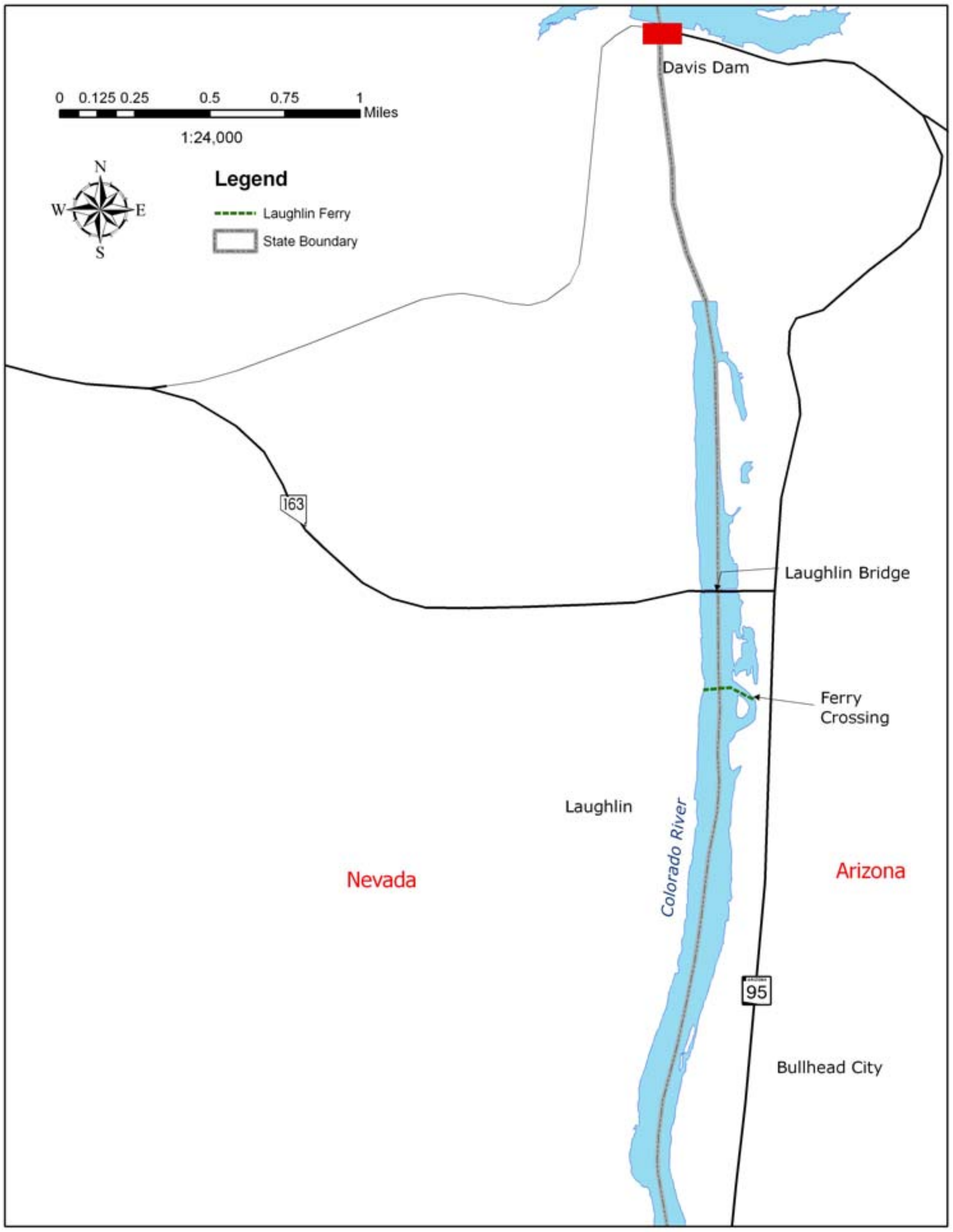
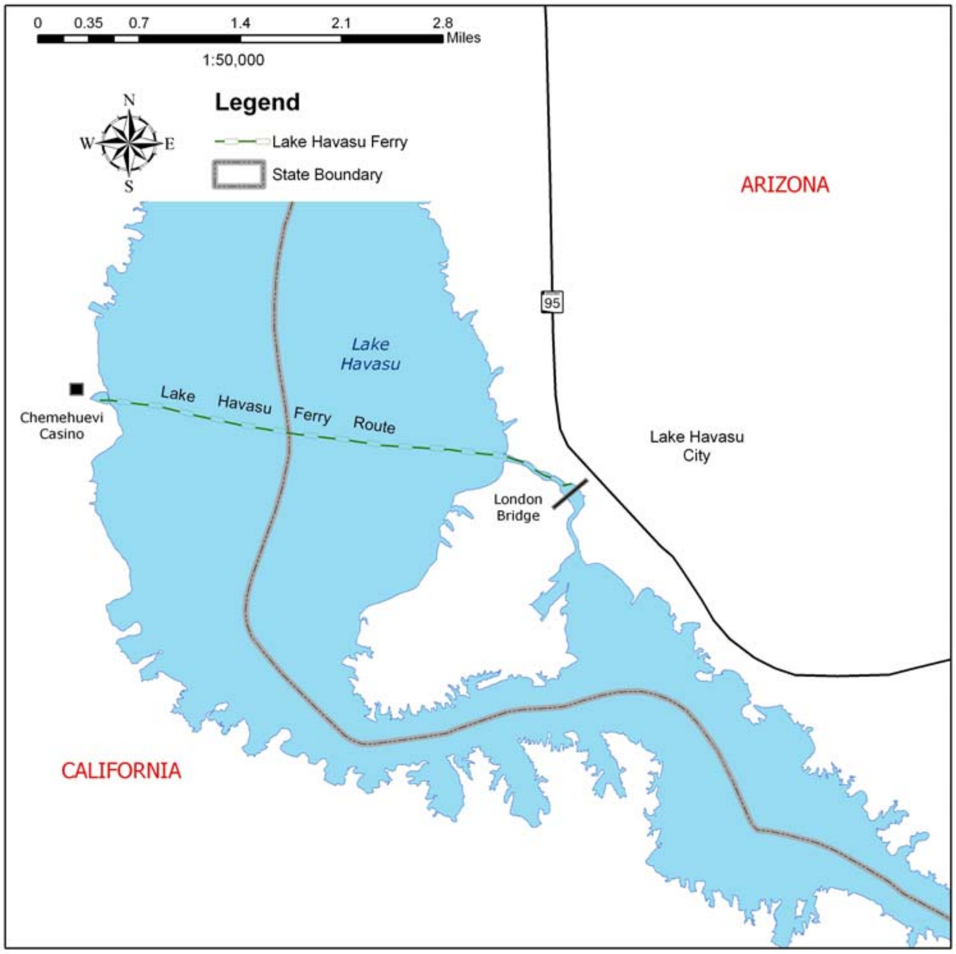


Figure 3.13-3
Lake Havasu Ferry Route



3.14 Socioeconomics

This section provides an overview of socioeconomic conditions within the states that could be affected by the proposed federal action. The potentially affected socioeconomic issues addressed in this section include:

- agricultural production and resulting changes in employment, income, and tax revenues;
- municipal and industrial uses and resulting changes in economic activity; and
- reservoir-related and river-related recreation activity and resulting changes in employment and income.

No long-term permanent changes in land uses are expected to be caused by the proposed federal action because only agricultural lands would be directly affected during a shortage and generally these lands would be fallowed and not permanently removed from production. In addition, the proposed federal action would not change apportionment or entitlements and changes in water deliveries would be temporary in nature. The proposed federal action will not result in permanent conversion of prime or unique farmlands pursuant to the Farmlands Protection Policy Act of 1978. Any changes in land uses are likely to be short-term and the proposed federal action would not result in or encourage the conversion of agricultural lands to other uses.

Information regarding the value of agricultural production was limited to the counties falling within the CAP service area and within Arizona along the mainstream of the Colorado River. Specific information regarding the value of agricultural production has not been included for California or Nevada. The value of agricultural production in Nevada is small relative to the sectors that drive the state and local economy. Agricultural production in California is not expected to be adversely affected because the potentially affected areas within California are almost all urbanized. Economic activity related to recreation is included in the information provided for Lake Powell, Lake Mead, and the Colorado River downstream of Lake Mead.

3.14.1 Study Area

The study area for the socioeconomics assessment was based on the states and counties in which a shortage may occur or in which changes in reservoir storage or river flow would result in a change in recreation opportunities or use. A county-level analysis was selected because information on employment and income is typically reported at the county level. The study area consists of counties in Arizona, California, Nevada, and Utah.

The Arizona study area is comprised of Coconino, La Paz, Mohave, Pima, Pinal, Yuma, and Maricopa counties. These counties were selected because they are either located directly adjacent to Lake Powell, Lake Mead, or the Colorado River, or they are counties in which shortages would likely occur. The counties in which measurable shortages could potentially occur, resulting in reduction in agricultural production or reduced municipal/industrial deliveries are Maricopa, Pinal, Pima, Mohave, La Paz, and Yuma. Although Coconino County would not experience a water shortage attributable to the proposed federal action, it is included in the study area because it is located adjacent to the Colorado River and may be affected by changes in recreation-related economic activity as a result of changes in river flows.

The California study area is comprised of Imperial, Los Angeles, Orange, Riverside, San Bernardino, and San Diego counties. These counties were selected because they are either located directly adjacent to the lower Colorado River, or they are within the MWD service area. Although Ventura County is also in MWD's service area, it does not receive any water from the Colorado River and therefore it is not included in the study area.

The Nevada study area is comprised of Clark County. The study area was limited to Clark County because it is located adjacent to Lake Mead and encompasses the service area of the SNWA. Shortages in Nevada would be limited to the SNWA service area.

The Utah study area is comprised of Garfield, Kane, and San Juan counties. Although Utah will not experience shortages under any of the alternatives, changes in storage at Lake Powell could result in changes in recreation-related expenditures made in these counties.

3.14.2 Water Use

This section provides an overview of the economic activity within Arizona, California, and Nevada that may be directly affected by water shortages occurring in the M&I and/or agricultural sectors.

3.14.2.1 State of Arizona

Agriculture. The total market value of agricultural production in Arizona was a little over $2.4 billion in 2002. The market value of agricultural production occurring within the Arizona study area accounted for nearly 90 percent of the statewide production value. In 2002, production values ranged from a low of approximately $16 million in Mohave County to a high of $802 million in Yuma County (USDA 2002).

Agricultural lands receiving water for irrigation from the CAP are located generally within Pinal, Maricopa, and Pima Counties. A list of irrigation districts and Indian communities receiving water from the CAP is provided in Appendix H.

The three counties account for approximately 53 percent of statewide irrigated and harvested cropland. These three counties also account for approximately 71 percent of Arizona's harvested cotton acreage, 18 percent of the state's vegetable crops, and approximately 48 percent of irrigated wheat cultivation (USDA 2004). Table 3.14-1 provides a summary of irrigated agricultural lands within these three counties.

Table 3.14-1
Central Arizona Irrigated Agricultural Lands in 2002

Area	Total Land in Irrigated Farms (acres)	Total Land Area (acres)	Land in Irrigated Farms as a Percentage of Total Land in 3-County Area
CAP Counties	829,957	15,205,760	5.5
Western Arizona Counties	536,152	14,928,438	3.6

Source: USDA 2004.

Agricultural resources in western Arizona are located in Mohave, La Paz, and Yuma Counties. Agricultural lands are located primarily along the Colorado River and in Yuma County along the Gila River Valley. A list of the potentially affected water agencies in these counties are provided in Appendix H.

These three western Arizona counties account for approximately 75 percent of the state's production of vegetable crops, 49 percent of irrigated wheat cultivation, and 38 percent of orchard lands (USDA 2004). Table 3.14-1 provides a summary of irrigated agricultural lands within these western Arizona counties.

Municipal and Industrial Uses. Municipalities potentially affected by the proposed federal action include the cities of Phoenix, Tucson, Scottsdale, and other Arizona towns and cities served by CAP, as well as Arizona municipalities along the Colorado River, such as Lake Havasu City, who have post-1968 Colorado River water delivery contracts. Industrial land uses located in Arizona on the Colorado River include the major power facilities of Glen Canyon Dam and Navajo Generating Station in Coconino County and Parker Dam in La Paz County (and San Bernardino County, California).

Employment. Full- and part-time employment in Arizona totaled 3,047,543 jobs in 2004, an increase of approximately 477,000 jobs from 1994 levels. Employment in the private sector represented nearly 85 percent of total employment in 2004 (United States Department of Commerce, Bureau of Economic Analysis 2006a). In 2004, employment in the arts, entertainment, and recreation sector totaled 59,022 jobs or approximately two percent of total employment in Arizona. Farm employment totaled 23,315 jobs in 2004 and accounted for less than one percent of total employment in the state.

Full- and part-time employment in La Paz, Mohave, Pima, Pinal, Maricopa, and Yuma Counties totaled 2,742,854 jobs in 2004, an increase of approximately 844,103 jobs from 1994. Total employment in the six counties represents approximately 89 percent of total employment in Arizona. Employment in the agricultural sector in the six counties totaled 17,170 jobs in 2004 and represented less than one percent of total employment in the six counties. (United States Department of Commerce, Bureau of Economic Analysis, 2006a).

Income. Total personal income in Arizona totaled just over $164.1 billion in 2004. This represents a substantial increase from the 1994 level of $81.5 billion. Statewide per capita income increased from approximately $19,000 in 1994 to approximately $29,000 in 2004 (United States Department of Commerce, Bureau of Economic Analysis, 2006b).

Among the six counties, average per capita income ranged from a low of approximately $19,815 per year in La Paz County to a high of $31,523 per year in Maricopa County. The total personal income generated in the six counties represents nearly 90 percent of the state total (United States Department of Commerce, Bureau of Economic Analysis 2006b).

3.14.2.2 State of California

The California study area is comprised of Imperial, Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties. These counties were identified because they are located within the service area of the MWD, which receives a portion of its water supply from the Colorado River.

Agriculture. Table 3.14-2 presents a summary of the amount of agricultural land present in the California counties served by the IID, the CVWD, the MWD, and the San Diego County Water Authority (SDCWA), and the percentage of land in the counties that is in agricultural use. These counties include Imperial, Los Angeles, Orange, Riverside, San Bernardino, and San Diego. The categories included in Table 3.14-3 are used by the California Department of Conservation and are based on the Important Farmland maps for California. These maps are compiled from United States Department of Agriculture (USDA) Natural Resources Conservation Service soil surveys and current land use information.

Table 3.14-2
Southern California Agricultural Land in the Six-County Study Area in 2004

Important Farmland in the Six-County area[1] (acres)	Grazing Land in the Six-County Area (acres)	Total Agricultural Land in the Six-County Area[2] (acres)	Total Six-County Area (acres)	Agricultural Land as a Percentage of Total Land in the Six-County Area (percent)
1,315,048	1,403,602	2,718,650	26,160,439	10.4

Source: California Department of Conservation 2004.

Notes:

1. *Important Farmland includes Prime Farmland, Farmland of Statewide Importance, Unique Farmland and Farmland of Local Importance.*
2. *This category includes both Important Farmland and Grazing Land.*
3. *Counties are Imperial, Los Angeles, Orange, Riverside, San Bernardino, and San Diego.*

Municipal and Industrial. Municipalities potentially affected by the proposed federal action include some 88 cities in Los Angeles County, 34 cities in Orange County, 24 cities in Riverside County, 31 cities in San Bernardino County, and 18 cities in San Diego County.

Employment. Full- and part-time employment in California totaled 20 million jobs in 2004, an increase of approximately 3.5 million jobs from 1994 levels. Employment in the private sector represented nearly 85 percent of total employment in 2004 (United States Department of Commerce, Bureau of Economic Analysis 2006c).

Full- and part-time employment in the six county study area totaled 11 million jobs in 2004, representing 55 percent of total California employment. Full- and part-time employment in the government sector was higher than the California average (13 percent) in four counties (Imperial, 24 percent; Riverside, 14 percent; San Diego, 18 percent; and San Bernardino, 15 percent) and lower in two counties (Los Angeles, 11 percent; and Orange, eight percent) (United States Department of Commerce, Bureau of Economic Analysis, 2006c).

Income. Total personal income in California totaled just over $1.2 trillion in 2004. This represents a substantial increase of $497 billion from 1994. Statewide per capita income increased from approximately $23,000 in 1994 to approximately $35,000 in 2004 (United States Department of Commerce, Bureau of Economic Analysis, 2006d).

In 2004, total personal income ranged from a low of approximately $3.3 billion in Imperial County to a high of $329 billion in Los Angeles County. When combined, the total personal income of the six counties represents 44 percent of the state total. Per capita income ranged from a low of approximately $22,000 in Imperial County to a high of approximately $42,000 in Orange County (United States Department of Commerce, Bureau of Economic Analysis 2006d).

3.14.2.3 State of Nevada

The potentially affected area within Nevada is Clark County, which is adjacent to the Colorado River.

Agriculture. Agricultural production in Clark County is very small compared to other farming areas in the study area. Table 3.14-3 provides a summary of agricultural land in this county. A small proportion of this land is used for cropland, most of which is irrigated. Cropland is used primarily for producing forage crops. Livestock and poultry are also produced in Clark County.

Table 3.14-3
Southern Nevada (Clark County) Agricultural Land in 2002

Total Land in Irrigated Farms (acres)	Total County Land (acres)	Land in Irrigated Farms as a Percentage of Total County Land (percent)
65,206	5,062,614	1.3

Source: USDA 2002.

Municipal and Industrial Uses. Municipalities potentially affected by the proposed federal action include Boulder City, Henderson, Las Vegas, and North Las Vegas due to their reliance on Colorado River water supplied by SNWA. These municipalities support urban, commercial, and industrial land uses that could be potentially affected by the proposed federal action.

Employment. Full- and part-time employment in Nevada totaled 1,430,370 jobs in 2004, an increase of approximately 521,000 jobs from 1994 levels. Employment in the private sector represented nearly 89 percent of total employment in 2004 (United States. Department of Commerce, Bureau of Economic Analysis 2006e). In 2004, employment in the arts, entertainment, and recreation sector totaled 46,137 jobs or approximately three percent of total employment in the state. Employment in the accommodations and food service sector totaled 293,157 jobs. This is the largest employment sector in Nevada, accounting for approximately 24 percent of total employment.

Full- and part-time employment in Clark County totaled 998,000 jobs in 2004, an increase of approximately 422,000 jobs from 1994. Total employment in Clark County represents almost 70 percent of total employment in Nevada. Full- and part-time employment in the Clark County government sector was lower than the Nevada average (United States Department of Commerce, Bureau of Economic Analysis 2006e). In 2004, employment in the arts, entertainment, and recreation sector totaled 30,391 jobs or approximately three percent of total employment in the county. Similar to statewide totals, the accommodations and food service sector was the largest employment sector in the county, totaling 235,632 jobs in 2004.

Income. Total personal income in Nevada totaled just over $78 billion in 2004. This represents a substantial increase from the 1994 level of $43 billion. Statewide per capita income increased from approximately $23,800 in 1994 to approximately $33,800 in 2004 (United States. Department of Commerce, Bureau of Economic Analysis 2006f).

In 2004, per capita income in Clark County was $32,900, slightly lower than the state average. The total personal income of Clark County represents more than 69 percent of the state total (United States Department of Commerce, Bureau of Economic Analysis 2006f).

3.14.3 Recreation

Economic benefits result when visitors spend dollars locally on recreational activities. Those benefits include increased sales, income, and jobs. Direct economic benefits occur when businesses sell goods and services to park visitors. Indirect economic benefits result from the circulation of spending throughout the local economy.

This section describes the direct and indirect economic value of recreation occurring in the GCNRA and the LMNRA. The NPS maintains a database of recreational visits and the economic impacts of those visits. That information is summarized here for Lake Powell and Lake Mead. Lake Mohave is included within the LMNRA. Consequently, the visitor spending associated with Lake Mohave is included as part of the LMNRA discussion further below. A discussion of recreation-related economic activity occurring on the Colorado River downstream of Lake Powell and Lake Mead was not included because no change in recreation activities and resulting change in economic activity is expected under the proposed federal action.

3.14.3.1 Glen Canyon National Recreation Area

GCNRA hosted 1.88 million recreational visits in 2003. (Section 4.12 provides additional information on recreation use occurring within the GCNRA.) Table 3.14-4 summarizes the direct and indirect effects of visitor spending at the GCNRA by sectors. Direct recreation-related expenditures totaled $86.09 million in 2003 resulting in 2,119 jobs and $31.76 million in personal income. As direct spending circulates through the local economy, secondary or indirect economic effects occur. This spending created an additional $14.11 million in personal income and 548 jobs.

Table 3.14-4
Glen Canyon National Recreation Area Economic Impacts of Visitor Spending by Sector for 2003

Sectors	Sales (millions)	Personal Incomes (millions)	Jobs	Value Added (millions)
Direct Effects				
Motel, Hotel, B&B, and Cabins	$16.36	$5.34	356	$8.11
Campsites	$13.21	$4.31	288	$6.55
Restaurants & Bars	$20.65	$7.03	590	$9.80
Admissions & Fees	$13.11	$4.54	387	$7.42
Retail	$14.98	$7.64	410	$11.94
Others	$7.78	$2.31	88	$3.50
Total Direct Effects	$86.09	$31.17	2,119	$47.32
Total Indirect Effects	$38.80	$14.11	548	$24.36
Total Effects	$124.88	$45.28	2,667	$71.68

Source: NPS 2006b.

3.14.3.2 Lake Mead National Recreation Area

LMNRA (Lake Mead and Lake Mohave) hosted 7.92 million recreational visits in 2003. Table 3.14-5 summarizes the direct and indirect effects of visitor spending at the LMNRA by sectors. Direct recreation-related expenditures totaled $176.82 million in 2003 resulting in 5,197 jobs and $63.15 million in personal income. This direct spending created an additional 856 jobs and $18.73 million in personal income.

Table 3.14-5
Lake Mead National Recreation Area Economic Impacts of Visitor Spending by Sector for 2003

Sectors	Sales (millions)	Personal Incomes (millions)	Jobs	Value Added (millions)
Direct Effects				
Motel, Hotel, B&B, and Cabins	$27.08	$7.86	693	$11.95
Campsites	$18.59	$5.39	476	$8.20
Restaurants & Bars	$52.77	$16.62	1,648	$23.15
Admissions & Fees	$30.98	$10.65	912	$17.43
Retail	$35.57	$18.15	1,257	$28.34
Others	$11.82	$4.48	211	$6.51
Total Direct Effects	$176.82	$63.15	5,197	$95.58
Total Indirect Effects	$55.82	$18.73	856	$34.55
Total Effects	$232.64	$81.89	6,052	$130.12

Source: NPS 2006d.

3.15 Environmental Justice

Environmental justice refers to the fair treatment and meaningful involvement of all people in the development, implementation and enforcement of environmental laws, regulations and policies.

- *Fair treatment* means that no group of people, including minority and low-income populations, should bear a disproportionate share of the adverse environmental impacts of government actions.
- *Meaningful involvement* means that people who would be adversely affected by the environmental impacts of government actions should have the opportunity to participate in decisions leading up to those actions and have their views considered.

Exec. Order No. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that all federal agencies make achieving environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. Census data were used to identify the minority and low-income populations living in counties that could potentially be affected by the proposed federal action.

The affected area for environmental justice is comprised of 18 counties; eight in Arizona (Coconino, La Paz, Maricopa, Mohave, Pima, Pinal, Yavapai, and Yuma), and six counties in California (Imperial, Los Angeles, Orange, Riverside, San Bernardino, and San Diego), one county in Nevada (Clark), and three counties in Utah (Garfield, Kane, and San Juan). Ventura County in California is located within the MWD service area, but does not receive any water from the Colorado River, and therefore, it is not addressed in this section.

3.15.1 Minority, Low-Income Populations, and Indian Tribes

For purposes of this analysis, minority populations and low-income populations are defined following the CEQ’s (1997) guidance as:

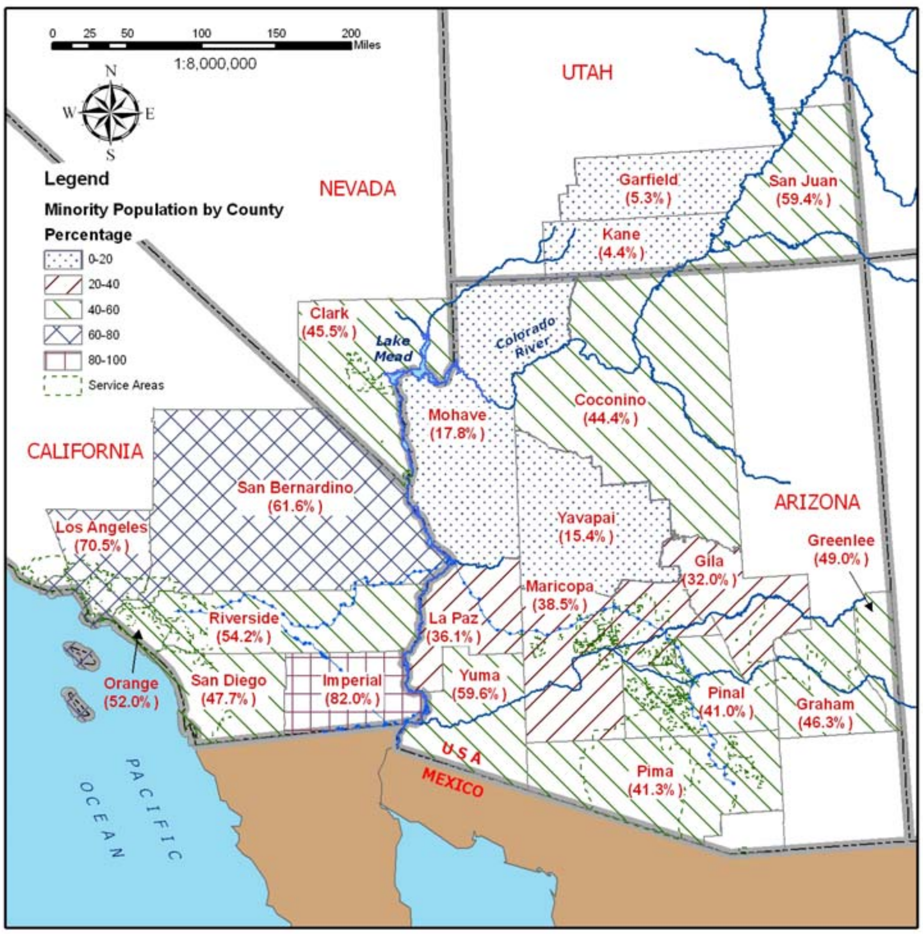
- *Minorities* – Persons of American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; Hispanic; or persons of two or more races (without double-counting persons of Hispanic or Latino origin who are also contained in the latter groups); and
- *Low-income populations* – As reported in the 2000 census, persons living below the poverty level, which is $19,307 for a family of four in 1999 and varies depending on family size (United States Census Bureau 2000b).

Identification of minority and low-income populations was based on the 2000 Census of Population and Housing, which estimates each of the separate categories contained in these definitions. Minority populations were estimated using 2000 Census data that report Hispanic or Latino populations by race, and, separately, populations not Hispanic or Latino by race

(United States Census Bureau 2000a). Low-income populations were estimated using the 2000 Census data that report poverty status in 1999 by age (United States Census Bureau 2000b). The population for whom poverty status is determined is generally slightly less than the total population because the 2000 Census data excludes certain groups from consideration.

Minority populations are identified where minorities of the affected area [county] exceed fifty percent of the total population. In 2000 seven of the 18 counties have a minority population percentage greater than 50 percent: Yuma County, Arizona; Imperial County, Los Angeles County, Orange County, Riverside, and San Bernardino County, California; and San Juan County, Utah; with Imperial County the highest at 82 percent. In the remaining 11 counties, minorities comprise less than 50 percent of the population and therefore, these counties are not considered environmental justice communities. Minority population percentages for various counties in Arizona, California, Nevada, and Utah are displayed in Figure 3.15-1.

Figure 3.15-1
Minority Population by County

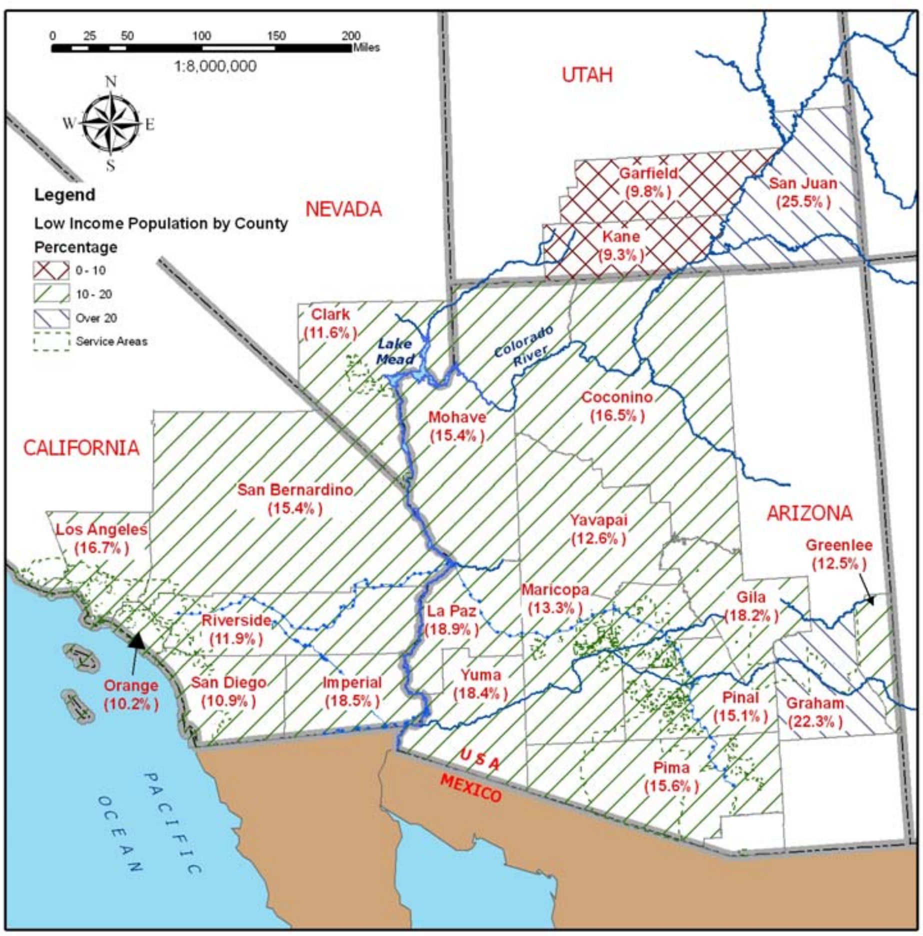


Indians tribes are included within these census data. Following CEQ's 1997 guidance on environmental justice, as well as Exec. Order No. 13175 and the Presidential Memorandum on Government-to-Government Relations with Native American Tribal Governments, Reclamation sought input from 42 federally-recognized tribes including those with reservations located within these counties and from tribes that might have interests in the proposed federal action. A description of the consultations undertaken for this project is included in Chapter 6 of this Final EIS.

In 2000, the percent poverty for the 18 counties is between 9.3 and 25.5 percent, with San Juan County, Utah having the highest percentage. For the environmental justice analysis, low income counties were defined as those above the average poverty percentage for the 18 counties (14.8 percent) in the study area. Low income population percentages for various counties in Arizona, California, Nevada, and Utah are displayed in Figure 3.15-2. As a result five counties were added in Arizona: Coconino, La Paz, Mohave, Pinal, and Pima (five of the minority counties were also low-income).

Therefore, for purposes of this analysis, there are twelve total environmental justice counties/communities.

Figure 3.15-2
Low Income Population by County



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Chapter Four

4.1 Introduction

Chapter 4 presents the probable consequences (impacts or effects) of each of the alternatives described in Chapter 2 on the environmental resources described in Chapter 3. The potential effects of each action alternative compared to the No Action Alternative are presented for each potentially affected resource in this chapter, in the same order as described in Chapter 3.

The methodology and technical assumptions used to analyze the potential impacts to the Colorado River system (e.g., reservoir elevations, releases, flows) are described in Section 4.2. Additional methodologies and assumptions used to analyze specific resources are described in the appropriate resource section of Chapter 4.

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4.2 Methodology

Hydrologic modeling of the Colorado River system was conducted to determine the potential hydrologic effects of the alternatives. The hydrologic modeling provided projections of potential future Colorado River system conditions (e.g., reservoir elevations, reservoir releases, river flows) under the No Action Alternative for comparison to conditions under each action alternative. Due to uncertainties associated with future inflows into the system, multiple simulations were performed for each alternative in order to quantify the uncertainties in future conditions, and the modeling results are typically expressed in probabilistic terms.

Hydrologic modeling also provided the basis for analyzing potential effects of each alternative on other environmental resources such as recreation, biology, energy, etc. The potential effects to specific resource issues are identified and analyzed for each action alternative and compared to the potential effects to that resource issue under the No Action Alternative. These comparisons are typically expressed in terms of the incremental differences in probabilities (or projected circumstances associated with a given probability) between the No Action Alternative and the action alternatives.

This section provides an overview of the hydrologic modeling used and the framework within which the many simulations were undertaken. Further details regarding the model and modeling assumptions are also provided in Appendix A and Appendix M. For some of the resource analyses, additional modeling using other techniques was needed to analyze the potential effects to particular resource issues. In most of these cases, the output from the hydrologic modeling was used as input to these other models. The methodologies used for the additional modeling are described in each respective resource section of Chapter 4.

4.2.1 Alternatives Modeled

Five action alternatives and a No Action Alternative are considered in this Final EIS. The action alternatives are the Basin States, Conservation Before Shortage, Water Supply, and Reservoir Storage alternatives, and the Preferred Alternative. Each alternative includes specific assumptions with regard to the four operational elements of the proposed federal action: Shortage Guidelines, Coordinated Reservoir Operations, Storage and Delivery of Conserved Water, and ISG. Additional details with respect to the modeling assumptions used to represent each alternative are presented in this section, Appendix A, and Appendix M.

4.2.2 Period of Analysis

This Final EIS addresses guidelines that would be in effect for the interim period (2008 through 2026) for Lower Basin reservoir operations and the coordinated operations of Lake Powell and Lake Mead. In the modeling of the alternatives, all action alternatives are assumed to revert back to the assumptions used to represent the No Action Alternative beginning in 2027. Due to the potential for hydrologic effects of the action alternatives beyond the 19-year interim period, the hydrologic modeling for all alternatives extends through 2060.

4.2.3 Model Description

Future Colorado River system conditions under the No Action Alternative and the action alternatives were simulated using the Colorado River Simulation System (CRSS). The model framework used for this process is a commercial river modeling software called RiverWare™; a generalized river basin modeling software package developed by the University of Colorado through a cooperative arrangement with Reclamation and the Tennessee Valley Authority. CRSS was originally developed by Reclamation in the early 1970s and was implemented in RiverWare™ in 1996.

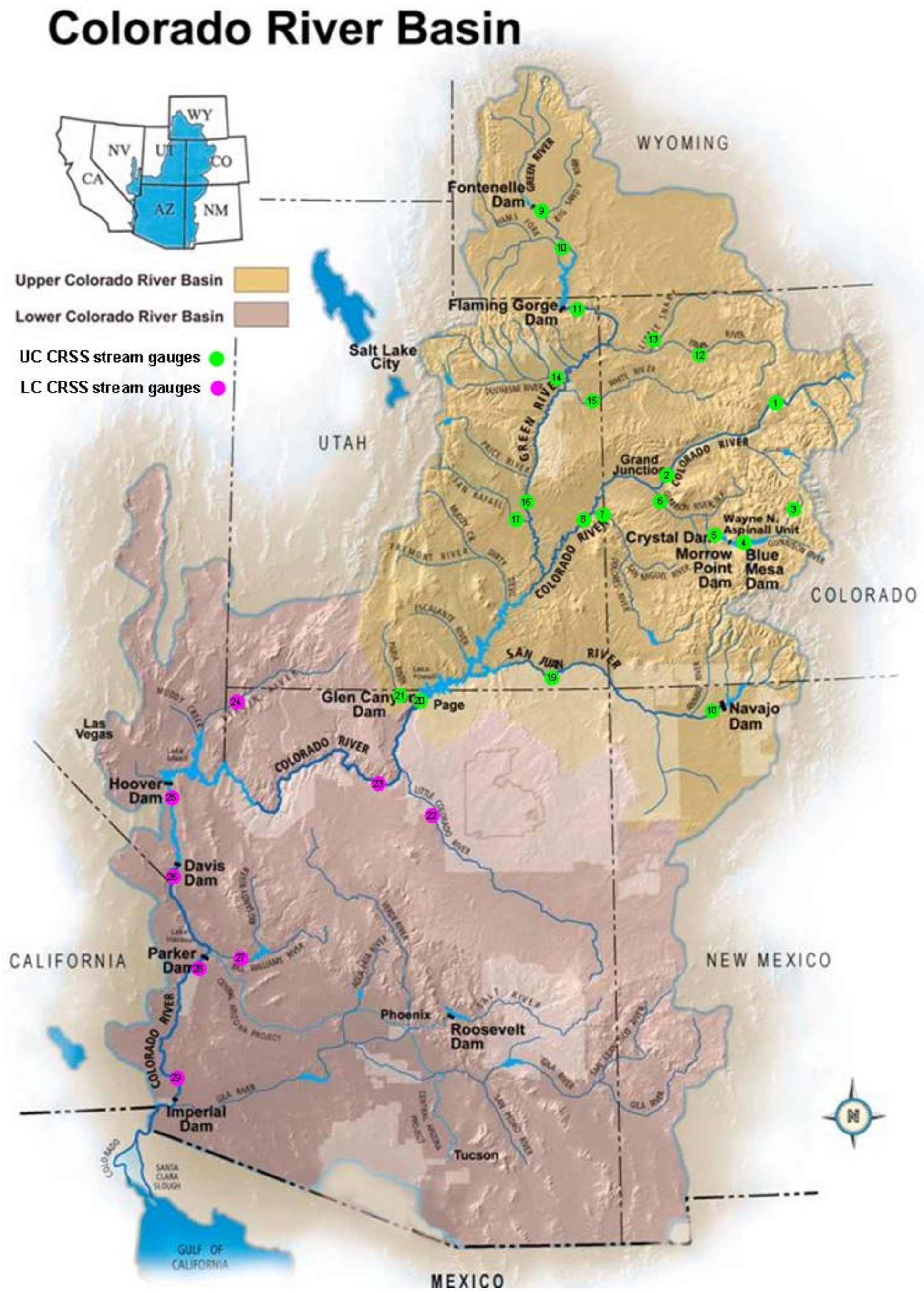
CRSS simulates the operation of the major reservoirs on the Colorado River and provides information regarding the projected future state of the system on a monthly basis in terms of output variables including the amount of water in storage, reservoir elevations, releases from the dams, the amount of water flowing at various points throughout the system, and the diversions to and return flows from the water users throughout the system. The basis of the simulation is a mass balance (or water budget) calculation that accounts for water entering the system, water leaving the system (e.g., from consumptive use of water, trans-basin diversions, evaporation), and water moving through the system (i.e., either stored in reservoirs or flowing in river reaches). Further explanation of the model is provided in Appendix A. The model was used to project the future conditions of the Colorado River system on a monthly time-step for the period 2008 through 2060.

The input data for the model includes monthly natural inflows, various physical process parameters such as the evaporation rates for each reservoir, initial reservoir conditions on January 1, 2008, and the future diversion and depletion schedules for entities in the Basin States (Appendix C and Appendix D) and for Mexico. These future schedules were based on demand and depletion projections prepared and submitted by the Basin States. For purposes of this EIS, depletions (or water use) are defined as diversions from the river less return flow credits, where applicable (Section 3.4).

The rules of operation of the Colorado River mainstream reservoirs including Lake Powell and Lake Mead for each alternative are also provided as input to the model. These sets of operating rules describe how water is released and delivered under various hydrologic conditions. Further explanation of the operating rules for each alternative is provided in Appendix A.

The future hydrology used as input to the model consisted of samples taken from the historic record of natural flow in the river system over the 100-year period from 1906 through 2005 from 29 individual inflow points (or nodes) on the system. The locations of the hydrologic input sites are shown in Figure 4.2-1. This model and other methodologies used to generate future inflow scenarios are discussed in Section 4.2.5.

Figure 4.2-1
Colorado River Simulation System
Location of Hydrologic Inputs Sites within the Colorado River Basin



4.2.4 Model Uncertainty

Long-term planning models such as CRSS are typically used to project future river and reservoir conditions over a period of decades into the future. There are numerous inputs to, and assumptions made by, these models. As the period of analysis increases (for this EIS the analysis period is 53 years), the uncertainty in those inputs and assumptions also increases. Therefore, a large amount of uncertainty in the corresponding outputs is expected. Consequently, these models are not used to predict future conditions, but rather to project what might occur. When analyzing the potential hydrologic impacts from operational alternatives, most inputs, as well as other key modeling assumptions, are held constant for each alternative so as to isolate the differences due to each alternative. In this manner, the analyses for each alternative may be compared, and thus a relative comparison between alternatives can be made.

Although there are literally hundreds of inputs to and assumptions made by CRSS, the uncertainty of some will have greater effects on the outputs than others. Another way of thinking about this is to ask “what is the sensitivity of the output to a particular set of inputs or assumptions?” This question may be answered by conducting a sensitivity analysis whereby only one or perhaps a small number of inputs are varied in order to determine how sensitive the outputs are to that change. For example, in this Final EIS, two sensitivity analyses were performed that examine the sensitivity to variable future hydrologic scenarios (Appendix N) and to modeling assumptions with regard to future water delivery reductions to Mexico (Appendix Q).

There are several sources of uncertainty in the CRSS output including the representation and parameterization of physical processes such as reservoir evaporation and bank storage, the future diversion and depletion schedules for the entities throughout the Colorado River Basin, and the future inflows into the system. In addition, much of the input data are derived from actual measurements which have uncertainties associated with them. For example, the natural flows are based primarily on data acquired from flow gages which, when calibrated properly, have uncertainties on the order of five to ten percent. Although these data are generally the best available, all of these uncertainties limit the absolute accuracy of the model However, by holding most inputs constant, the relative comparisons between the modeled conditions are still valid.

Despite the differences in some of the modeling assumptions under the No Action Alternative and each action alternative, the future conditions of the Colorado River system (e.g., future Lake Mead and Lake Powell elevations) are most sensitive to future inflows. Observations over the period of historical record (1906 through present) show that inflow into the system has been highly variable from year to year, and over decades (Section 3.3). Because it is impossible to predict the actual future inflows into the system, a range of possible future inflows are analyzed and used to quantify the probability of occurrences of particular events (e.g., higher or lower lake elevations). This technique involves multiple simulations for each alternative, one for each future hydrologic sequence, and is the procedure followed for the hydrologic analysis in this EIS.

4.2.5 Future Hydrology

There are several accepted scientific methods for projecting possible future inflow sequences. These methods include resampling the historical record (either from the measured record or a derived record using a "proxy" such as tree-ring data), deriving future inflow data by preserving key statistics of the historical record while adding a random component, and using physically-based models to simulate runoff using precipitation, temperature, and other climate data. For this EIS, Reclamation primarily utilized the existing historical record of natural flows to create a number of different future hydrologic sequences using a resampling technique known as the Indexed Sequential Method (ISM). The ISM provides the basis for quantification of the uncertainty and an assessment of the risk with respect to future inflows and is based upon the best available measured data. ISM is well-documented and has been widely accepted by Colorado River stakeholders (Reclamation 1985; Ouarda et al. 1997). These sequences were used to perform a series of simulations and the output was analyzed to quantify the uncertainty due to hydrologic variability for each variable of interest.

4.2.5.1 Computational Procedures Using the Historical Natural Flow Record

In its current configuration, the CRSS model requires hydrologic inputs at 29 sites throughout the Colorado River system: 20 sites in the Upper Basin upstream of and including the Lees Ferry gaging station in Arizona, and an additional nine sites in the Lower Basin. The locations of these 29 sites are shown in Figure 4.2-1. This level of hydrologic detail is needed to simulate the operation of the major reservoirs throughout the system including the reservoirs on the major sub-basins (the Gunnison, Green, and San Juan rivers)[1].

Reclamation uses data collected from the USGS and other gage sites[2], consumptive use records, records of reservoir releases, and other data to compute the natural flow at each of the 29 sites. In the mid-1990s, Reclamation initiated an on-going program to review and update the natural flow record, document the methodologies used to compute the natural flows, and extend the record as soon as practicable at the conclusion of each year to ensure that the best available information is always available. At this time, the natural flow record consists of monthly data for the 29 sites from 1906 through 2005, a period of 100 years. Additional information, documentation, and the natural flow data are available at http://www.usbr.gov/lc/region/g4000/NaturalFlow/index.html.

For the ISM, each future inflow scenario is generated by cycling through the historical natural flow record. For example, assuming a 100-year historical record (1906 through 2005) and that the model projects 53 years into the future (2008 through 2060), the

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[1] Although these sub-basins are not a part of the geographic scope (Section 3.2), modeling of the reservoirs (e.g., Flaming Gorge) is necessary to simulate the future inflows into Lake Powell.

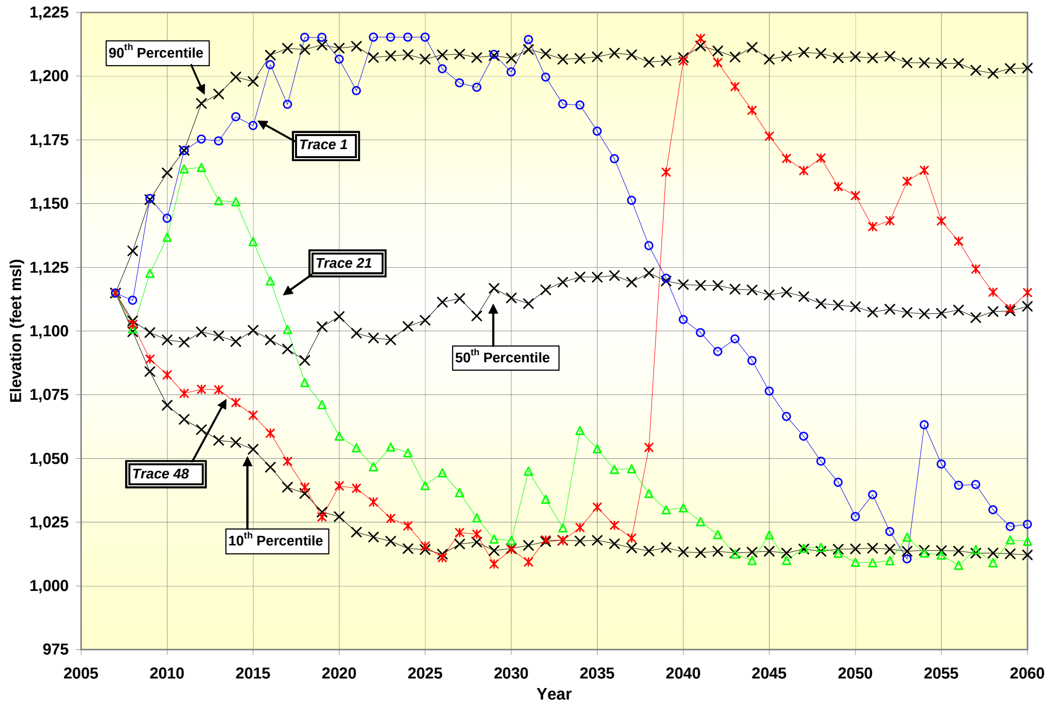
[2] Reclamation provides funding to the USGS to assist in maintaining and expanding, as appropriate, gage sites throughout the Colorado River Basin. Reclamation also installs, maintains, and operates additional gage sites in the Lower Basin.

first inflow sequence would be comprised of the series of historical natural flows from 1906 through 1958; the second inflow sequence would utilize the series of historical natural flows from 1907 through 1959; the last sequence would utilize the series of historical natural flows beginning in 2005, with historical natural flows from 1906 through 1957 appended to the end to form a complete (53-year) sequence.

The result of the ISM applied to the historical record is a set of output (referred to as traces) for 100 separate simulations for each alternative that is analyzed and compared to similar simulation results for the other alternatives. The projections of future hydrologic conditions are probabilistic, based on the hydrologic variability observed in the 100-year historic record which includes periods of severe drought as well as periods with above-average flow.

Figure 4.2-2 presents an example of the output of this technique for future Lake Mead elevations under the No Action Alternative. Three of the 100 traces are shown. Trace 1 is the output for the hydrologic sequence that begins in 1906. Trace 21 is the output for the hydrologic sequence that begins in 1926. Trace 48 is the output for the hydrologic sequence that begins in 1953. Hydrologic inflows over the 100-year record have been highly variable and these traces are representative of that variability. The traces clearly illustrate that future elevations at Lake Mead are highly dependent upon future hydrologic inflows, resulting in large uncertainty with regard to projections of future conditions. This uncertainty may be quantified, however, through the analysis of the 100 traces. An example of one type of analysis is also presented in Figure 4.2-2, where the 90th, 50th, and 10th percentiles of the 100 outputs in each year have been computed and added to the figure.

Figure 4.2-2
Lake Mead End-of-December Elevations Under the No Action Alternative
90th, 50th and 10th Percentile Values



4.2.5.2 Reclamation's Research and Development Efforts

Although the ISM methodology provides the means to compare the alternatives under a wide range of future flow conditions, it is possible that future flows may include periods of wet or dry conditions that are outside the range of sequences observed in the historical record, particularly as a result of climate change and increased hydrologic variability.

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), published in April 2007, presented a selection of key findings regarding projected changes in precipitation and other climate variables as a result of a range of climate change scenarios projected by the IPCC over the next century. Although annual average river runoff and water availability are projected to decrease by ten to 30 percent over some dry regions at mid-latitudes, information with regard to potential impacts on specific river basins is not included. Recently published projections of potential reductions in natural flow on the Colorado River Basin by the mid 21st century range from approximately 45 percent by Hoerling and Eischeid (2006), to approximately six percent by Christensen and Lettenmaier (2006). A recent analysis of future precipitation minus evaporation (a surrogate for runoff) in the basin suggests an "imminent transition to a more arid climate in southwestern North America" (Seager et al. 2007).

While these projections are of great interest, additional research is both needed and warranted to quantify the uncertainty of these estimates in order to better understand the risks of current and future water resource management decisions. The uncertainties include the actual uncertainty in the climate response as well as the uncertainty due to differences in methodological approaches and model biases.

Recognizing this need, particularly in light of the drought in the Colorado River Basin, Reclamation's Lower Colorado (LC) Region initiated a multi-faceted research and development program in 2004 to enable the use of other methods for projecting possible future inflow sequences for Colorado River planning studies. The research and development effort has been designed to provide information for the near-term (e.g., some facets have already been completed and the information has been used in the Final EIS), as well as for the longer-term that involves collaboration with other research organizations (e.g., National Oceanic & Atmospheric Administration (NOAA) and USGS). This effort has two major thrusts:

- ♦ collaboration with other federal agencies and universities to conduct research to gain knowledge and understanding of the potential impacts of climate change and climate variability on the Colorado River; and
- ♦ improvement of Reclamation's decision support framework, including modeling and data handling capabilities, in order to utilize the new information when it becomes available.

Contributions from this research and development program have been invaluable in advising the analysis and content in the Final EIS to address future hydrologic variability and the potential for increased hydrologic variability due to climate change. These and other efforts will continue and will provide Reclamation the ability to incorporate new additional climate change information, as it becomes available, into future Colorado River Basin planning studies.

At this time, there are five key components to the research and development program:

1) Sponsorship of National Research Council's (NRC) Committee on the Scientific Bases of Colorado River Basin Water Management in collaboration with the California Department of Water Resources, the MWD, the SNWA, and the NRC's Water Science and Technology Board.

   This study culminated in a report published in early 2007, titled "Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability." The executive summary of this report is included as Appendix T. Key conclusions and recommendations in the area of hydroclimatic data and sciences included:

   – There has been a trend of increasing mean temperatures across the Colorado River Basin over the 20th century into the 21st century. Many climate model projections show that this trend will continue. There is less consensus regarding future trends in precipitation and runoff. Several hydroclimatic studies project that increasing temperatures will result in significant decreases in precipitation and runoff while other studies suggest increases in future flows. However, the preponderance of the scientific evidence suggests warmer future temperatures will reduce future streamflow and water supplies and contribute to increased severity, frequency, and duration of future droughts.

– Recent studies based on tree-ring data affirm the large year-to-year variations in streamflow as observed in the historical record and demonstrate that multidecadal and centennial fluctuations of mean streamflow have occurred in the past. Given both natural and human-induced climate changes, fluctuations in the mean streamflow are likely to continue in the future. Furthermore, the range of natural variability derived from the tree-ring records reveals greater hydrologic variability than reflected in the gaged record, particularly with regard to drought. These observations coupled with projections of future decreasing streamflows suggest that future droughts will recur and may exceed the severity of the droughts observed in the historical record.

– Measured values of streamflow in the Colorado River Basin are critical to providing the essential information for sound water management decisions. Availability of sufficient resources should be ensured in order to maintain and where appropriate, expand the USGS gaging network.

2) Collaboration with the University of Arizona, the Arizona Water Institute, the Arizona Water Resources Research Center, and the Laboratory of Tree Ring Research on a project focused on integrating improved water supply predictive capability into Colorado River Basin policy and management to enhance water supply reliability.

Reclamation has been participating in this collaborative effort since its inception in July 2004 and the project is anticipated to be concluded in 2008. It is a multi-pronged approach that includes:

– assessing the potential for enhanced modeling capability associated with use of paleoclimatic data, climate forecasts and climate change predictions, and the water management tools that need to be developed to use that information;

– identifying strategies to better utilize paleoclimatology, climate forecasts and climate change predictions to improve water supply predictive capacity;

– evaluating existing management tools to translate improved predictive capacity into enhanced supply reliability for water users; and

– developing practical supply reliability strategies for use by water users and other stakeholders.

A significant aspect of this research involves the evaluation of the potential use of enhanced tree-ring information to improve predictive capability on the Colorado River. An important contribution has been an extension of the long-term record of flows on the Colorado River at Lees Ferry back to 762 A.D., adding to the understanding of historic climate and flow patterns and improving Reclamation’s capability to quantify the uncertainty of future hydrologic conditions. In addition, existing tree-ring information was synthesized using published tree-ring reconstructions (Stockton and Jacoby 1976; Hidalgo et al. 2000). These studies resulted in two key publications: i) Medieval Drought in the Upper Colorado River Basin (Meko et al. 2007); and ii) Updated Streamflow Reconstructions for the Upper Colorado River Basin (Woodhouse et al. 2006).

The tree-ring data resulting from this work has been used to analyze the sensitivity of the hydrologic resources to alternative future hydrologic scenarios (Appendix N).

Ongoing work includes the assessment of techniques for including additional climate prediction information, including the use of downscaled and bias-corrected climate predictions to generate alternative hydrologic scenarios at the spatial scales needed for CRSS. Additional information with regard to this work available at http://www.ag.arizona.edu/AZWATER/EWSR.

3) Collaboration with the University of Colorado and the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) on a project focused on assessing the current drought on the Colorado River in terms of its magnitude and likelihood of recurrence and investigative techniques that can be used to simulate streamflow scenarios that are consistent with the current drought and other realistic, and possible more severe, future drought conditions.

   Reclamation began this on-going collaboration effort in the fall of 2004. The major activities include:

   - Research and development of non-parametric methods for the disaggregation of streamflows at one site, both temporally and spatially, to other sites on the Colorado River Basin. This allows for the use of projections of future inflow at Lees Ferry (e.g., from tree-ring reconstructions) in CRSS.

   - Estimating and analyzing (particularly with regard to the temporal variability) the transition probabilities (i.e. probability of transitioning into a dry state in the following year from a wet state in the current year) from long records of tree-ring reconstructions of streamflows.

   - Generating new synthetic sequences of the state of the system (i.e., wet or dry) and consequently, the probabilities of long dry spells using the transitional probabilities. Conditioned on the state of the system, the flow magnitudes can be generated by conditional resampling from the historical record.

   Future work will include investigation of possible links between the historical transition probabilities and large-scale climate features of El Niño Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and the Atlantic Multidecadal Oscillation (AMO). Such links might provide a technique to condition future inflow sequences on information from climate models regarding these large-scale features.

The key findings and results of this research have been recently published: A Stochastic Nonparametric Technique for Space-time Disaggregation of Streamflows, Prairie et al. 2007. These methods were used to analyze the sensitivity to the hydrologic resources of alternate future hydrologic scenarios developed using the most recent tree-ring data from the University of Arizona (Appendix N).

4) Formation of a climate technical work group[3] to assess the state of knowledge with regard to climate change and modeling for the Colorado River Basin and to prioritize future research and development needs.

   This work culminated in a report that has been included in Appendix U, titled Review of Science and Methods for Incorporating Climate Change Information into Reclamation's Colorado River Basin Planning Studies.[4] Key conclusions and recommendations include:

   – Climate models project that temperatures will increase globally by one to two degrees Celsius in the next 20 to 60 years. Although the downscaling of global temperature increase to the Colorado River Basin is less certain, it is reasonable to expect that temperatures will increase. Regional precipitation response is even less certain;

   – The potential impacts of climate change on the Colorado River Basin have been a subject of research for several decades. Recent studies have been refined in several ways including how the climate change models output is bias-corrected and downscaled to the spatial resolution needed for planning studies. Due to advances in knowledge, technical abilities, and other factors, not all past studies retain the same significance today;

   – Although paleoclimatic information may not necessarily represent future climate scenarios, this information may be useful in framing assumed variability in future hydrologic sequences, particularly with respect to drought potential;

[3] Organizations represented in the work group include the University of Colorado (NOAA - Western Water Assessment), the University of Arizona, the University of Nevada – Las Vegas, the University Corporation for Atmospheric Research, Reclamation, and Hydrosphere Consultants, Inc.

[4] This report will be a forthcoming Reclamation publication with no change to content; however, the formatting will be changed from that used in Appendix U.

- System storage is very sensitive to changes in mean inflows as well as sequences of wet and dry years, highlighting the importance of properly investigating changes in both mean and variability in planning studies;

- For studies and management decisions involving shorter look-ahead horizons (e.g., less than 20 years), interannual to decadal variability may be a more significant uncertainty than that associated with near-term projected climate change. Evaluating the state of interannual/interdecadal oscillation phenomena such as ENSO, PDO, and AMO may add significant information with respect to the risk due to increased variability; and

- For longer look-ahead horizons (20+ years), further research and development is needed to translate climate protections from General Circulation Models (GCMs) to the spatial scales necessary for use in Colorado River planning studies.

In addition, several recommendations for research and development were made. These recommendations are currently being reviewed and prioritized.

5) Improvements and updates to Reclamation's Colorado River natural flow database and decision-modeling framework (including the CRSS model and associated data handling and analysis tools).

The natural flow record is critical to the understanding of the hydrology of the past 100 years and provides the basis for understanding future changes. Reclamation has an on-going program to ensure that this data is the best available. Additionally, all of the new methods have the capability to produce large numbers of possible future inflow sequences (on the order of 1000 or more possibilities), requiring sophisticated data handling, data processing and analysis tools. Furthermore, refinements to the current CRSS model that are needed to incorporate operating policies on key sub-basins have been evolving through other environmental compliance efforts (e.g., the Record of Decision for Navajo Reservoir operations in July 2006), requiring modification of the rules used by CRSS to simulate the operation of the major reservoirs in each sub-basin. These improvements are on-going.

4.2.5.3 Summary

Based on the current inability to precisely project future impacts of climate change to runoff throughout the Colorado River Basin at the spatial scale needed for CRSS, Reclamation based its hydrologic analysis for this EIS primarily on the resampled historical record. However, in order to understand the potential effects of future inflow sequences outside the range of historical flows (i.e., future sequences with increased variability including the severity, frequency, and duration of droughts), particularly during the 19-year period of the application of the proposed federal action, Reclamation analyzed the sensitivity of the hydrologic resources (including reservoir storage, reservoir releases, and river flows) to hydrologic scenarios derived from alternative methodologies (including stochastic hydrology methods and paleo-reconstruction methods) in the Draft EIS. An additional analysis has been added to Appendix N in the Final EIS that incorporates a newly published tree-ring reconstruction of hydrologic inflows at Lees Ferry (Meko et al. 2007) that extends the estimate of annual flow at Lees Ferry back to the year 762, a record length of 1,244 years.

Although precise estimates of the future impacts of climate change to runoff throughout the Colorado River Basin at appropriate spatial scales are not currently available, these impacts may include decreased mean annual flow and increased variability, including more frequent and more severe droughts. Furthermore, even without precise knowledge of the effects on runoff, increasing temperatures alone would likely increase losses (e.g., evapotranspiration and sublimation), resulting in reduced runoff.

Acknowledging the potential for impacts due to climate change and increased hydrologic variability, the Secretary proposes that these guidelines be interim in duration and extend through 2026, providing the opportunity to gain valuable operating experience for the management of Lake Powell and Lake Mead, particularly for low reservoir conditions, and improve the basis for making additional future operational decisions, whether during the interim period or thereafter. In addition, the Preferred Alternative has been crafted to include operational elements that would respond if potential impacts of climate change and increased hydrologic variability are realized. In particular, the Preferred Alternative includes a coordinated operation element that allows for the adjustment of Lake Powell’s release to respond to low reservoir storage conditions in Lake Powell or Lake Mead as described in Section 2.7 and Section 2.3. In addition, the Preferred Alternative will enhance conservation opportunities in the Lower Basin and the retention of water in Lake Mead through adoption of the ICS mechanism. Finally, the Preferred Alternative includes a shortage strategy at Lake Mead that would result in additional shortages being considered, after appropriate consultation, if Lake Mead elevations drop below 1,025 feet msl.

4.2.6 Post-processing and Interpretation Procedures

The physical, biological, and socioeconomic analyses in the Final EIS required the sorting and arranging of various types of model output data into tabulations or plots of specific operational conditions or parameters at various locations on the system. This was done through the use of statistical methods and other numerical analyses.

The hydrologic model generated data on a monthly time-step for over 300 points (or nodes) on the Colorado River system. Furthermore, through the use of ISM, the model generated 100 possible outcomes for each node for each month during the interm period (2008 through 2060). These very large data sets generated for each alternative can be visualized as three-dimensional data “cubes” with the axes of time, space (or node) and trace (or outcome for each future hydrology). The data were aggregated to reduce the volume of data and to facilitate comparison of the alternatives. The type of aggregation varies depending upon the needs of the particular resource analysis. The post-processing techniques used for this Final EIS fall into two basic categories: those that aggregate in time, space, or both, and those that aggregate the 100 possible outcomes.

For aggregation of data in time and space, simple techniques were employed. For example, deliveries of Colorado River water to all California diversion nodes in the model were summed to produce the total delivery to the state for each year. Similarly, lake elevations were chosen on an annual basis (i.e., end of December) to show long-term lake elevation trends as opposed to short-term fluctuations. In other analyses, since the proposed interim period is 2008 through 2026, those analyses found it important to aggregate the data over that period of time and compared the aggregation over the remaining years (2027 through 2060). The particular aggregation used is noted in the methodology section for each resource, where applicable.

Once the appropriate temporal and spatial aggregation was chosen, standard statistical techniques were used to analyze the 100 possible outcomes for a fixed time or particular temporal span. Statistics that were generated included the mean, standard deviation, and percentiles.

Percentiles were determined by simply ranking the outcomes at each time-step (from highest to lowest) and determining the value at the specified percentile. For example, if end-of-calendar year Lake Mead elevations are ranked for each year, the 50th percentile (median) outcome for a given year is the elevation for which half of the values are below and half are above that elevation. Similarly, the 10th percentile value is the elevation for which 10 percent of the values are lower and 90 percent are higher. This statistical method is used to view the results of all hydrologic sequences in a compact manner yet maintains the variability at high, medium, and low reservoir elevations that may be lost by averaging the results of all traces. Several presentations of the ranked data are then possible. For example, a graph (or table) may be produced that is used to compare the 90th percentile, 50th percentile, and 10th percentile outcomes from 2008 through 2060 for the No Action Alternative and the action alternatives. A statistic such as the 10th percentile is not the result of any one hydrologic trace. However, no historical sequence produced the 10th percentile. Such a statistic provides information with regard to the probability (e.g., a 10 percent probability) of the variability of interest being at or below the 10th percentile value in a specified year. However, the statistic cannot be used to understand the probability of remaining at that value in subsequent years.

4.2.7 Modeling Assumptions Common to All Alternatives

In addition to the specific operating rules necessary to model each of the alternatives (discussed in Chapter 2, Appendix A, and in the following section), the modeling of Colorado River system operations also requires certain assumptions about various aspects of water delivery and system operations that are common to all alternatives:

- all simulations were performed with a start year of 2008 and a simulation length of 53 years (2008 through 2060);

- each action alternative was assumed to be in effect for the interim period which extends from 2008 through 2026. For modeling purposes, the operating rules for all action alternatives are assumed to revert to the rules of the No Action Alternative after 2026;

- ♦ the initial conditions for the Upper Basin and Lower Basin reservoirs reflect the 2007 end-of-calendar year (EOCY) elevations as projected by the June 2007 24-Month Study. The Lake Powell and Lake Mead initial elevations (starting condition) in the model were 3,596.77 feet msl and 1,114.85 feet msl, respectively. These starting conditions were updated in the Final EIS from those used in the Draft EIS as additional information became available. Starting conditions for all reservoirs used in both the Draft EIS and the Final EIS are detailed in Appendix A;

- ♦ future hydrology was generated from the 100-year (1906 through 2005) historic record of calculated natural flows at 29 separate inflow points in the Colorado River watershed using the ISM. One hundred simulations were performed for each alternative;

- ♦ the current Upper Basin reservoir operating rules, with the exception of Lake Powell, are identical under all alternatives. Under the action alternatives, the operation of Lake Powell reflects the coordinated operations strategy of each respective alternative during the interim period;

- ♦ future water demands for Upper Division water users are based on depletion projections prepared by the Upper Division states in coordination with the Upper Colorado River Commission and Reclamation, and are as published in the SIA Final EIS (Volume II, Appendix G). These depletion schedules are also provided in Appendix C;

- ♦ Lake Mead flood control procedures are always in effect;

- ♦ except during flood control conditions, Lake Mead is operated to meet downstream demands under the water supply condition (Normal, Surplus, or Shortage condition) in effect in a particular year;

- ♦ future water demands for Lower Division water users are based on depletion schedules prepared by the Lower Division states and published in the SIA Final EIS (Volume II, Appendix G) with some exceptions. Depletion schedules under a Normal Condition for IID, CVWD, and MWD are those specified in the Colorado River Water Delivery Agreement and include accelerated Inadvertent Overrun Paybacks and any subsequent changes in payback schedules. Depletion schedules for all Arizona users were provided by the Arizona Department of Water Resources for this EIS effort. These depletion schedules are provided in Appendix D;

- ♦ if Lake Mead elevations fall below 1,000 feet msl, delivery to SNWA is reduced to zero. This reflects the limitations of the SNWA intakes which are used to pump water from Lake Mead;

- ♦ Lake Mohave and Lake Havasu are operated in accordance with their existing rule curves;

- water deliveries to Mexico are pursuant to the requirements of the 1944 Treaty. This provides annual deliveries of 1.5 maf to Mexico and up to 1.7 maf during Lake Mead flood control release conditions;

- Mexico's principal diversion is at Morelos Diversion Dam where most of its Colorado River apportionment of 1.5 mafy is diverted. In practice, up to 140 kafy is delivered to Mexico near the SIB. The model, however, extends to just south of the NIB to include the Morelos Diversion Dam and accounts for the entire 1944 Treaty delivery at that point;

- for 2008 and 2009, the model sets the delivery schedule to Mexico at the NIB to 1.577 mafy. The additional 77 kafy reflects the average annual volume of non-storable flows that are delivered to Mexico for the period 1964 through 2005, excluding years when there were flood control releases on the mainstream Colorado River or Gila River;

- beginning in 2010, the proposed Drop 2 Storage Reservoir is assumed to be in operation and is assumed to conserve an average of 69 kafy, reducing the average annual volume of non-storable flows that are delivered to Mexico from 77 kafy to 8 kafy;

- the bypass of return flows from the Welton-Mohawk Irrigation and Drainage District to the Cienega de Santa Clara in Mexico is assumed to be 109 kafy, the historical average for the period 1990 through 2005, and is not counted as part of the 1944 Treaty delivery;

- except under the Conservation Before Shortage and the Reservoir Storage alternatives, replacement of the bypassed water is not assumed to occur in the future. The United States recognizes that it has an obligation to replace, as appropriate, the bypass flows, and the assumptions made herein for modeling purposes do not necessarily represent the policy that Reclamation will adopt for replacement of bypass flows. The assumptions made with respect to modeling the bypass flows are intended only to provide a thorough and comprehensive accounting of the Lower Basin water supply. The United States is exploring options for replacement of the bypass flows, including options that would not require operation of the Yuma Desalting Plant; and

- for modeling purposes, the Yuma Desalting Plant is not assumed to operate over the modeling period.

Assumptions with regard to reduction of deliveries to the Lower Division states and Mexico are as described below.

4.2.7.1 Shortage Sharing and Water Delivery Reduction Assumptions

A summary of modeling assumptions with respect to the reduction of deliveries to the Lower Division states and Mexico was provided in Section 2.2. These modeling assumptions are identical for all alternatives and are explained further in this section. Shortage sharing assumptions within a particular state are detailed in Section 4.4 and in Appendix G.

It was assumed that shortages would be allocated to each Lower Division state. Two sets of percentages were assumed depending upon the amount of total Lower Basin shortage to be applied. Shortages less than or equal to the magnitude that would cause Arizona 4^{th} priority users to be reduced to zero are termed Stage 1 shortages. This magnitude is dependent upon the scheduled depletions for the Arizona 4^{th} priority users (post-September 30, 1968 contractors, including CAP), which vary over the period of analysis. In a Stage 2 shortage, additional shortages above that magnitude are applied.

In order to assess the potential effects of the proposed federal action in this Final EIS, certain modeling assumptions were used that display projected water deliveries to Mexico. These modeling assumptions assume that Mexico would share proportionately in Lower Basin shortages. An analysis that considers the sensitivity of the hydrologic resources to these assumptions is presented in Appendix Q. In that analysis, a different set of modeling assumptions were used that assume that Mexico would share proportionally in both Upper Basin and Lower Basin shortages.

Allocation of Colorado River water to Mexico is governed by the 1944 Treaty. The proposed federal action is for the purpose of adopting additional operational guidelines to improve the Department's annual management and operation of key Colorado River reservoirs for an interim period through 2026. As such, Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

Therefore, for purposes of modeling and the resource analyses, the shortage-sharing percentages were computed as follows:

Stage 1 Shortage Sharing Modeling Assumptions. Shortages are first imposed under Stage 1 and would be applied to the most junior users within Arizona (those with post-1968 water rights, i.e., 4th and 5th priority rights within Arizona), Nevada and Mexico. Stage 1 shortages would continue until the deliveries to the post-1968 water rights holders in Arizona (including CAP) are reduced to zero. The maximum amount of Stage 1 shortages during the period of analysis is dependent on the scheduled depletions for the post-1968 water rights holders and decreases in time (2008 through 2060) from approximately 1.8 maf to 1.7 maf[5].

The assumed Stage 1 shortage sharing percentages are explained in Table 4.2-1.

Stage 2 Shortage Sharing Modeling Assumptions. After deliveries to those with 4th and 5th priority rights within Arizona are reduced to zero, it is assumed that any additional delivery reductions would be distributed to Arizona, California, Nevada, and Mexico. The assumed Stage 2 shortage sharing percentages are explained in Table 4.2-2. Under a Stage 2 Shortage, the total Lower Basin shortage is the sum of the computed Stage 1 and Stage 2 shortage amounts.

Table 4.2-1
Modeling Assumptions for Distribution of Stage 1 Shortages

Entity	Percentage of Stage 1 Shortage	Calculation
Arizona[1]	80	▪ Computed assuming that Arizona takes the remaining amount of shortage after Nevada and Mexico take their respective shares ▪ Calculated as: 1.0 – 0.1667 – 0.0333 = 0.80 or 80.0 percent
California	0	▪ Does not receive shortage under Stage 1
Nevada	3.33	▪ Computed as a ratio of Nevada's allotment to the total allotments of the Lower Division states and Mexico ▪ Calculated as: 0.3 maf / 9.0 maf = 0.0333 or 3.33 percent
Mexico[2]	16.67	▪ Computed as a ratio of Mexico's allotment to the total allotments of the Lower Division states and Mexico ▪ Calculated as: 1.5 maf / 9.0 maf = 0.1667 or 16.67 percent

1. *Within CAP, Ak-Chin and Salt River Pima-Maricopa Indian Community tribes have contracts for the delivery of 72 kaf that is not reduced until a Stage 2 Shortage is applied as the associated water rights have a pre-1968 priority date.*
2. *These modeling assumptions do not reflect policy decisions and are not intended to constitute an interpretation or application of the 1944 Treaty.*

[5] Although these assumptions are common to all alternatives, shortages of high magnitudes either occur infrequently or not at all for all alternatives (Section 4.4.4).

Table 4.2-2
Modeling Assumptions for Distribution of Stage 2 Shortages

Entity	Percentage of Stage 2 Shortage	Calculation
Arizona	15-20	▪ The percentage changes as Arizona's 4th priority use schedule changes and ranges between 15 and 20 percent ▪ Computed as a ratio of Arizona's allotment less the amount of shortage applied to Arizona under Stage 1, to the total allotments of the Lower Division states and Mexico less the total amount shorted to users under Stage 1 ▪ Calculated as: (2.8 – Arizona Stage 1 shortage) / (9.0 – total Stage 1 shortage)
California	60-65	▪ California shortage sharing percentage changes as Arizona's 4th priority use schedule changes and ranges between 60 and 65 percent ▪ Computed assuming that California takes the remaining amount of the additional shortage ▪ Calculated as: 1.0 – 0.1667 – 0.0333 – Arizona's Stage 2 percentage expressed as a fraction
Nevada	3.33	▪ Computed as a ratio of Nevada's allotment less the amount of shortage applied to Nevada under Stage 1, to the total allotments of the Lower Division states and Mexico less the amount shorted to users under Stage 1 ▪ Calculated as: (0.3 – Nevada Stage 1 shortage) / (9.0 – total Stage 1 shortage) = 0.0333 or 3.33 percent
Mexico[1]	16.67	▪ Computed as a ratio of Mexico's allotment less the amount of shortage applied to Mexico under Stage 1, to the total allotments of the Lower Division states and Mexico less the total amount shorted to users under Stage 1 ▪ Calculated as: (1.5 – Mexico Stage 1 shortage) / (9.0 – total Stage 1 shortage) = 0.1667 or 16.67 percent

1. *These modeling assumptions do not reflect policy decisions and are not intended to constitute an interpretation or application of the 1944 Treaty.*

4.2.7.2 Shortage Sharing Between Arizona and Nevada

Pursuant to the Arizona Nevada Shortage Sharing Agreement dated February 9, 2007, Arizona and Nevada have agreed to share shortages during the interim period (2008 through 2026) between the two states by specified amounts at each discrete level of total Lower Basin shortage. The shortage amounts that are allocated to Arizona and Nevada pursuant to the Arizona Nevada Shortage Sharing Agreement are shown in Table 4.2-3.

In the Draft EIS, the distribution of shortages among the Lower Division states was made according to assumed percentages (Section 2.2.1). This modeling assumption allocated 80 percent and 3.33 percent of the total Lower Basin shortage amount to Arizona and Nevada, respectively. Reclamation used the same assumption in the Final EIS. This modeling assumption is common among all alternatives and enabled Reclamation to model the distribution of shortages to the Lower Division states for volumes different than those considered in the Arizona Nevada Shortage Sharing Agreement.

Table 4.2-3 provides a comparison of the shortage amounts to Arizona and Nevada based on the shortage distribution assumptions used in the modeling to the amounts specified in the Arizona-Nevada Shortage Sharing Agreement. As shown on this table, the shortage amounts allocated to Arizona are the same under both methodologies and the shortage amounts allocated to Nevada differ slightly. Also, these differences exist only when the total Lower Basin shortages shown in this table occur. Additional details on the assumptions used to model the distribution of shortages between the Lower Division states are provided in Appendix A and Appendix G.

Table 4.2-3
Comparison of Shortage Allocation to Arizona and Nevada for the Specified Lower Basin Shortage
Differences Between Modeling Assumptions and Arizona-Nevada Shortage Sharing Agreement

Total Lower Basin Shortage (af)	Distribution of Shortage per Arizona-Nevada Shortage Sharing Agreement (af)		Distribution of Shortages per Modeling Assumptions (af)	
	Arizona Share	Nevada Share	Arizona Share[1]	Nevada Share[2]
400,000	320,000	13,000	320,000	13,333
500,000	400,000	17,000	400,000	16,667
600,000	480,000	20,000	480,000	20,000

1. *The allocation of Arizona's share of a shortage is calculated in the model by multiplying the total Lower Basin shortage amount by 80 percent.*
2. *The allocation of Nevada's share of a shortage is calculated in the model by multiplying the total Lower Basin shortage amount by 3.333333 percent.*

4.2.8 Modeling Assumptions Specific to Alternatives

Each alternative includes specific assumptions with regard to the four operational elements of the proposed federal action. Assumptions with regard to Shortage Guidelines, Coordinated Reservoir Operations, and the ISG were presented in Chapter 2 and are detailed in Appendix A. Assumptions with regard to the Storage and Delivery of Conserved Water element are detailed in Appendix M.

4.3 Hydrologic Resources

This section identifies the potential effects on hydrologic resources that may occur as a result of implementing the No Action Alternative and the action alternatives.

4.3.1 Methodology

The methodology and the CRSS model used to analyze the potential impacts of the alternatives to reservoir storage, reservoir releases, and the corresponding changes in river flows downstream of the reservoirs are described in Section 4.2 and Appendix A.

The CRSS model is a monthly time-step model and its output for simulated water system conditions, such as reservoir elevations or releases, can be provided on monthly and annual bases. The data and output used in the impact analysis may vary depending on the specific issue being addressed. An example of how specific months are considered to represent certain issues or conditions in the analyses follows:

Lake Powell:

- **March:** representative of months (or period) with seasonal low Lake Powell elevations;
- **July:** representative of months (or period) with seasonal high Lake Powell concentration of visitors; and
- **September:** month representing End-of-Water Year, used for water accounting and reporting in Upper Basin.

Lake Mead:

- **July:** representative of months (or period) with seasonal low Lake Mead elevations; and
- **December:** month representing End-of-Calendar Year, used for water accounting and reporting in Lower Basin.

The specific data and output used in the different resource analyses are presented in this section.

4.3.1.1 Methodology Used To Estimate a Range of Daily Glen Canyon Dam Releases

The observed CRSS model output for individual traces for specific annual Lake Powell release volumes or volume ranges was used to estimate the monthly volumes that would likely be seen under water year release volumes that were less than, equal to, and greater than 8.23 maf. These annual release volumes consisted of 7.00, 7.48, 7.80, 8.23, 9.00, 9.50, 9.50 to 11.0, and 11.0 to 16 mafy, corresponding to the Glen Canyon Dam release volumes observed under the modeled alternatives. For each month corresponding to each of these annual flow volumes, the average, maximum, and minimum daily flow volumes were then calculated using the allowable daily fluctuation parameters specified in the 1996 Glen Canyon ROD. It is recognized that monthly and daily flow patterns observed in the different release years could potentially deviate somewhat from the flow values and patterns calculated using this approach although they would most likely be very close to the calculated value. It is also noted that the release patterns for the 7.0 maf release are not as consistent because the monthly volumes would be affected by balancing of Lake Powell and Lake Mead storage. When balancing takes place, monthly release volumes shift as forecast inflow shifts, resulting in more than one possible pattern for the 7.0 maf release years.

4.3.1.2 Methodology Used To Estimate Evaporation Loss from Lake Powell and Lake Mead

Evaporation at Lake Powell and Lake Mead is simulated in CRSS by multiplying the monthly average reservoir surface area by monthly evaporation coefficients. A description of the methodology and the monthly evaporation coefficients is provided in Appendix A. A comparison of the mean and median evaporation volumes for Lake Powell and Lake Mead for the No Action Alternative and the action alternatives is provided in Appendix P.

4.3.1.3 Methodology Used To Estimate the Effect on Groundwater

The annual median elevation of the water surface in the lower Colorado River has been used as an indicator of groundwater elevations adjacent to the Colorado River within the potentially affected river reaches. This is due to the slow movement of groundwater and the time required for the decline in the groundwater table to stabilize at a decline equal to that of the river (Reclamation 2004a, Appendix J and Appendix K). The methodology used to analyze the potential effects to groundwater followed the methodology established in the LCR MSCP analysis.

4.3.2 Lake Powell and Glen Canyon Dam

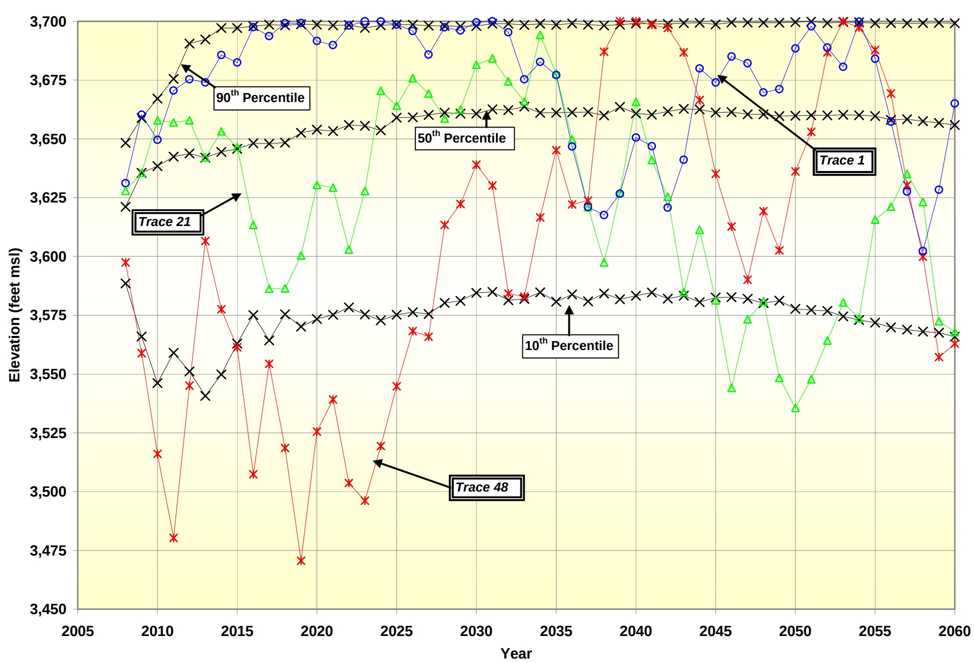
Future elevations of Lake Powell are expected to be within the range of historic water levels (Section 3.3). However, each action alternative may alter the probability (when compared to the No Action Alternative) that the reservoir may be at a given elevation in the future.

Under the No Action Alternative, the elevation of Lake Powell is projected to fluctuate between full and lower levels during the period of analysis (2008 through 2060). Figure 4.3-1 illustrates the range of reservoir elevations by three plots, labeled 90th percentile, 50th percentile and 10th percentile. The 50th percentile plot shows the modeled median elevation for each future year. The median elevation gradually increases from about 3,620 feet msl to about 3,655 feet msl in the year 2060. The 10th percentile plot shows the elevations that would be exceeded 90 percent of the time for each future year. The 10th percentile lake elevation would gradually decline from about 3,590 feet msl to about 3,565 feet msl in the year 2060.

Lake Powell elevations depicted in Figure 4.3-1 (and in Figure 4.3-2) are for modeled lake elevations at the end of July. Lake Powell elevation generally reaches its seasonal high in July whereas the seasonal low generally occurs in March.

Three distinct traces were added to Figure 4.3-1 to illustrate what was actually simulated under the various traces and respective hydrologic sequences and to highlight that the 90th, 50th, and 10th percentile plots do not represent actual traces, but rather the ranking of each year's data from the 100 traces for the conditions modeled. The traces also illustrate the variability among the different traces and that the reservoir elevations could temporarily decline below the 10th percentile line. Trace 1 represents the hydrologic sequence that begins in 1906. Trace 21 represents the hydrologic sequence that begins in 1926. Trace 48 represents the hydrologic sequence that begins in 1953.

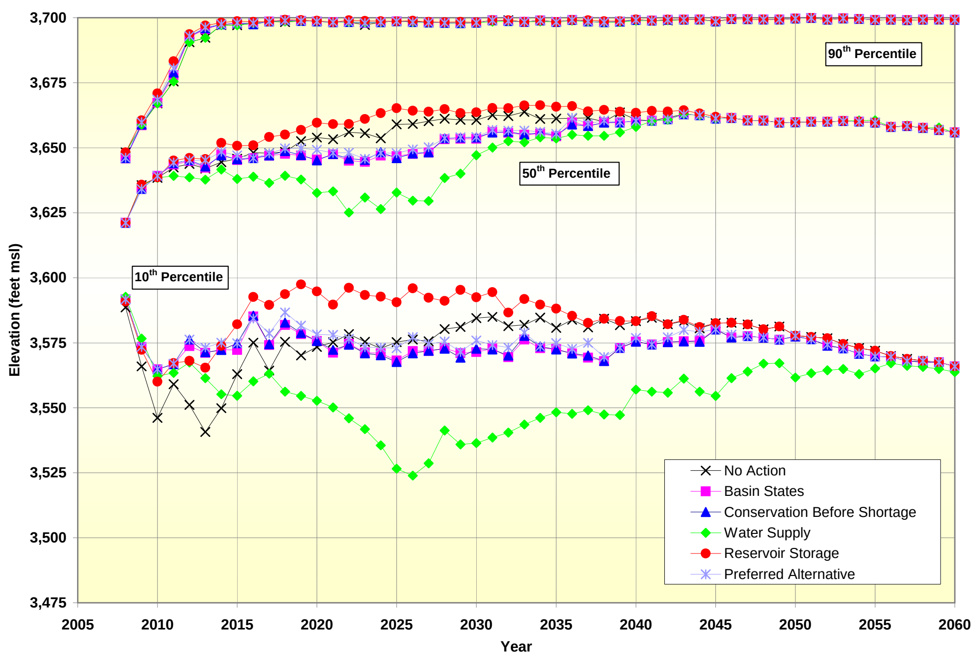
Figure 4.3-1
Lake Powell End-of-July Elevations Under the No Action Alternative
90th, 50th and 10th Percentile Values



In Figure 4.3-1, the 90th and 10th percentile lines bracket the range where 80 percent of the elevations simulated for the No Action Alternative occurred. The highs and lows shown on the three traces would likely be temporary conditions. The reservoir elevation would tend to fluctuate in the range through multi-year periods of above-average and below average inflows. Neither the timing of reservoir elevation variations, nor the length of time the elevations would remain high or low can be predicted. These events would depend on the future variation in basin runoff conditions and therefore, only projections of the likelihood of these events are possible.

Figure 4.3-2 presents a comparison of the 90th, 50th, and 10th percentile values obtained for the No Action Alternative to those of the action alternatives. This figure is best used for comparing the relative differences in the general lake elevation trends that result from the simulation of the different alternatives.

Figure 4.3-2
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values



As illustrated in Figure 4.3-2, the 90th percentile results were nearly identical for all of the alternatives. For the 50th and the 10th percentile results, the Reservoir Storage Alternative had the highest Lake Powell elevations and the Water Supply Alternative had the lowest elevations. Reservoir elevations under the Basin States and the Conservation Before Shortage alternatives, and the Preferred Alternative were similar and were generally lower than those under the No Action Alternative.

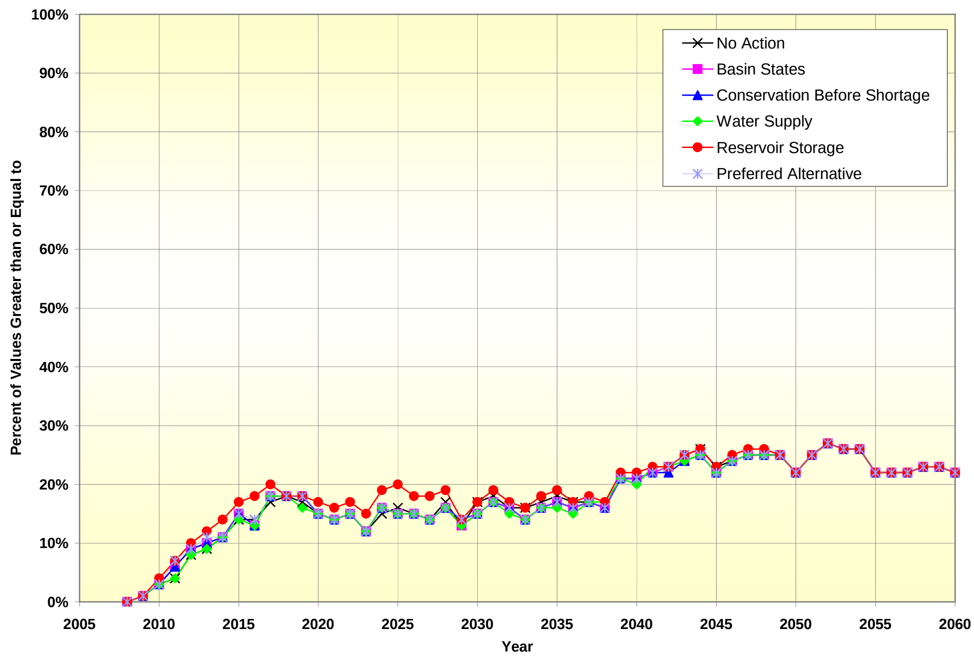
Table 4.3-1 provides a summary of the data illustrated in Figure 4.3-2, which is the 90th percentile, median (50th percentile), and 10th percentile values of the action alternatives compared to those of the No Action Alternative. The values presented in this table include those for 2026 and 2060 only. Results for the 90th percentile show that Lake Powell elevations under the action alternatives were almost the same as those under the No Action Alternative. For the 50th percentile, lake elevations under the Water Supply, Basin States, and the Conservation Before Shortage alternatives, and the Preferred Alternative were lower than those under the No Action Alternative during 2026, but were almost the same by 2060. The 10th percentile trend was very similar to the 50th percentile trend.

Table 4.3-1
Lake Powell End-of-July Elevations (feet msl)
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Alternative	Year 2026			Year 2060		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
No Action	3,698.52	3,659.17	3,576.25	3,699.21	3,655.92	3,565.89
Basin States	3,698.29	3,647.56	3,571.83	3,699.21	3,655.92	3,565.89
Conservation Before Shortage	3,698.35	3,647.79	3,570.92	3,699.21	3,655.92	3,565.89
Water Supply	3,698.31	3,629.62	3,523.95	3,699.21	3,655.87	3,563.72
Reservoir Storage	3,698.80	3,664.23	3,595.91	3,699.21	3,655.93	3,565.89
Preferred Alternative	3,698.29	3,649.33	3,577.15	3,699.21	3,655.92	3,565.89

When the Lake Powell elevation is at or exceeds 3,695 feet msl, the reservoir is considered to be essentially full. Figure 4.3-3 shows the frequency that future Lake Powell End-of-July elevations would exceed 3,695 feet msl under the No Action Alternative and the action alternatives. This type of graphical representation is best used to compare the likelihood that Lake Powell would be at or above the noted elevation (3,695 feet msl in this example) under an action alternative as compared to the No Action Alternative. Figure 4.3-3 illustrates that the percent of values that were above elevation 3,695 feet msl under the action alternatives were similar to the No Action Alternative throughout the period of analysis. The exception to this is the Reservoir Storage Alternative which provides slightly higher exceedence values than the No Action Alternative between 2010 through 2037. This means that Lake Powell elevations would generally tend to be higher under the Reservoir Storage Alternative, as compared to the No Action Alternative.

Figure 4.3-3
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Greater Than or Equal to Elevation 3,695 feet msl



As summarized in Table 4.3-2, the exceedence values under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative were essentially the same as those observed under the No Action Alternative in most years. The probability values under the Reservoir Storage Alternative were slightly higher than those under the No Action Alternative.

Table 4.3-2
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Greater Than or Equal to Elevation 3,695 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	0	14	15	17	21	22	22
Basin States	0	13	15	15	21	22	22
Conservation Before Shortage	0	13	15	15	21	22	22
Water Supply	0	13	15	15	20	22	22
Reservoir Storage	0	18	18	17	22	22	22
Preferred Alternative	0	14	15	15	21	22	22

The threshold for water access to Rainbow Bridge is elevation 3,650 feet msl. Below this threshold elevation, access to Rainbow Bridge would require hiking. As shown in Figure 4.3-4, the Reservoir Storage Alternative had the lowest frequency of occurrences below this threshold, and the Water Supply Alternative had higher frequency of occurrences below elevation 3,650 feet msl relative to the No Action Alternative.

Figure 4.3-4
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,650 feet msl

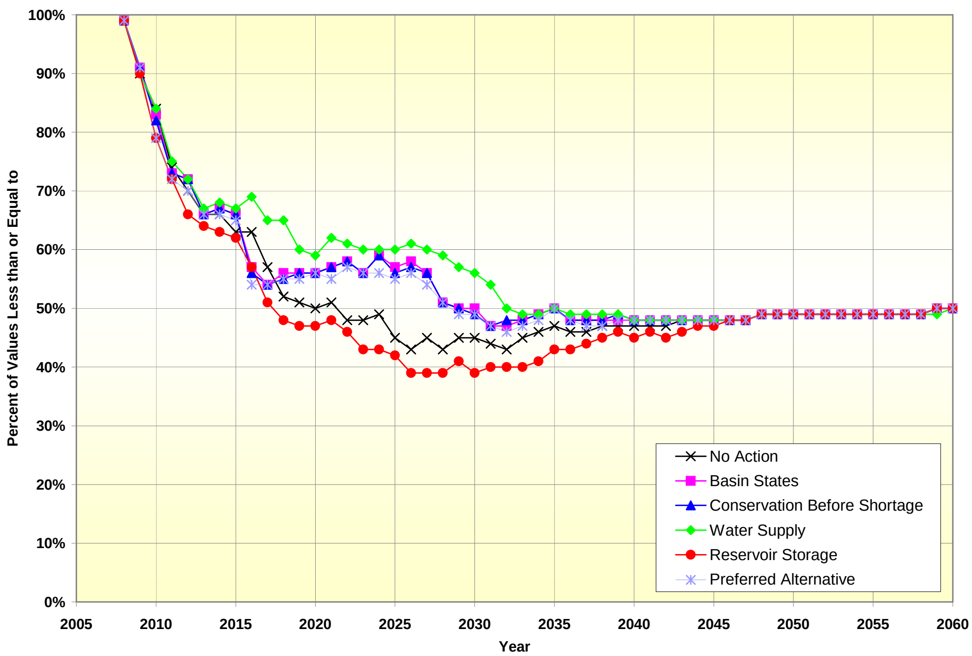


Table 4.3-3 summarizes the results shown in Figure 4.3-4 for elevation 3,650 feet msl for the No Action Alternative and the action alternatives for selected years. All alternatives were similar at the beginning and end of the modeled years, but variation did occur from about 2016 until about 2040. During that period, Lake Powell elevations under the Reservoir Storage Alternative were below elevation 3,650 feet msl less frequently than those under the No Action Alternative; the elevations under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative were below elevation 3,650 feet msl more frequently than those under the No Action Alternative.

Table 4.3-3
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,650 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	99	63	43	45	47	49	50
Basin States	99	57	58	50	48	49	50
Conservation Before Shortage	99	56	57	49	48	49	50
Water Supply	99	69	61	56	48	49	50
Reservoir Storage	99	57	39	39	45	49	50
Preferred Alternative	99	54	56	49	48	49	50

Figure 4.3-5 illustrates the results for elevations equal to or less than 3,626 feet msl. An elevation of 3,626 feet msl is the level at which there is a navigational detour at the Wahweap Marina and at Gregory Butte. As is shown on this figure, the Reservoir Storage Alternative had less impact on this threshold than the No Action Alternative. The elevations under the Water Supply, Basin States, and Conservation Before Shortage alternatives, and the Preferred Alternative, were below elevation 3,626 feet msl more frequently than those under the No Action Alternative. All alternatives were similar by about 2053.

Figure 4.3-5
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,626 feet msl

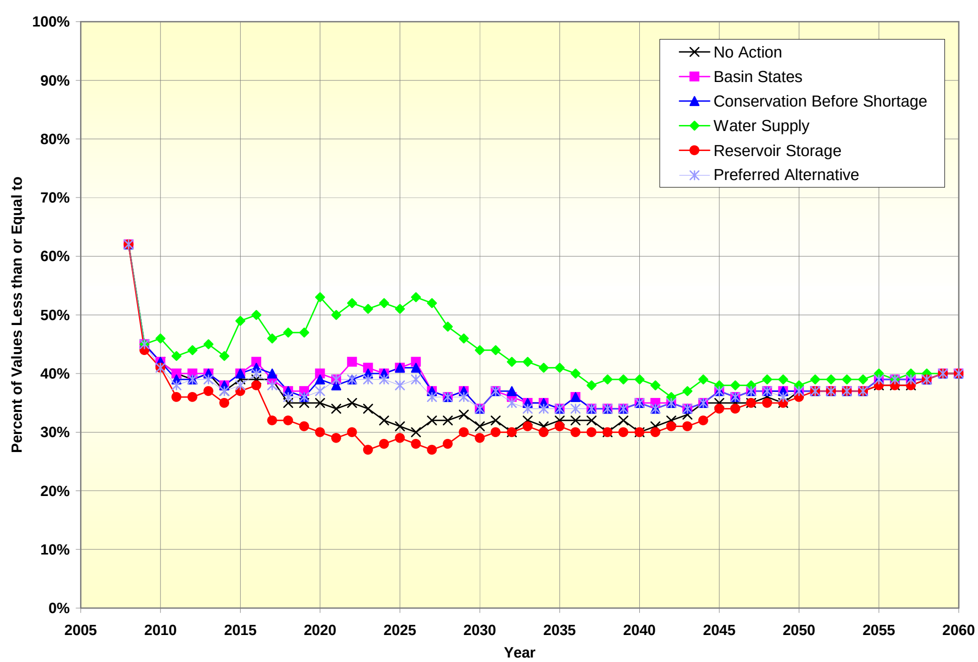


Table 4.3-4 summarizes the data illustrated in Figure 4.3-5 for elevation 3,626 feet msl. Lake Powell elevations under the Reservoir Storage Alternative were below 3,626 feet msl less frequently than those under the No Action Alternative. Lake elevations under the Water Supply, Basin States, and Conservation Before Shortage alternatives, and the Preferred Alternative, were below elevation 3,626 feet msl more frequently than those under the No Action Alternative.

Table 4.3-4
Lake Powell End-of- September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,626 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	62	39	30	31	30	37	40
Basin States	62	42	42	34	35	37	40
Conservation Before Shortage	62	41	41	34	35	37	40
Water Supply	62	50	53	44	39	38	40
Reservoir Storage	62	38	28	29	30	36	40
Preferred Alternative	62	40	39	34	35	37	40

Figure 4.3-6 compares the percent of values less than or equal to elevation 3,620 feet msl for the No Action Alternative and the action alternatives. The Hite Marina, Hite Public Launch Ramp, and Castle Rock Cut are closed at elevation 3,620 feet msl. Lake Powell elevations under the Water Supply, Basin States, and Conservation Before Shortage alternatives, and the Preferred Alternative were below 3,620 feet msl more frequently than those under the No Action Alternative. Lake Powell elevations under the Reservoir Storage Alternative were below 3,620 feet msl less frequently than those under the No Action Alternative for most of the modeled years.

Table 4.3-5 shows that all of the action alternatives varied from the No Action Alternative from about 2016 until about 2040. During this period, most of the alternatives, including the No Action Alternative, were below 3,620 feet msl between 25 and 40 percent of the time. The exceptions were elevations under the Water Supply Alternative which were below 3,620 feet msl between 37 and 52 percent of the time and elevations under the Reservoir Storage Alternative which were below 3,620 feet msl between 24 and 33 percent of the time.

Figure 4.3-6
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,620 feet msl

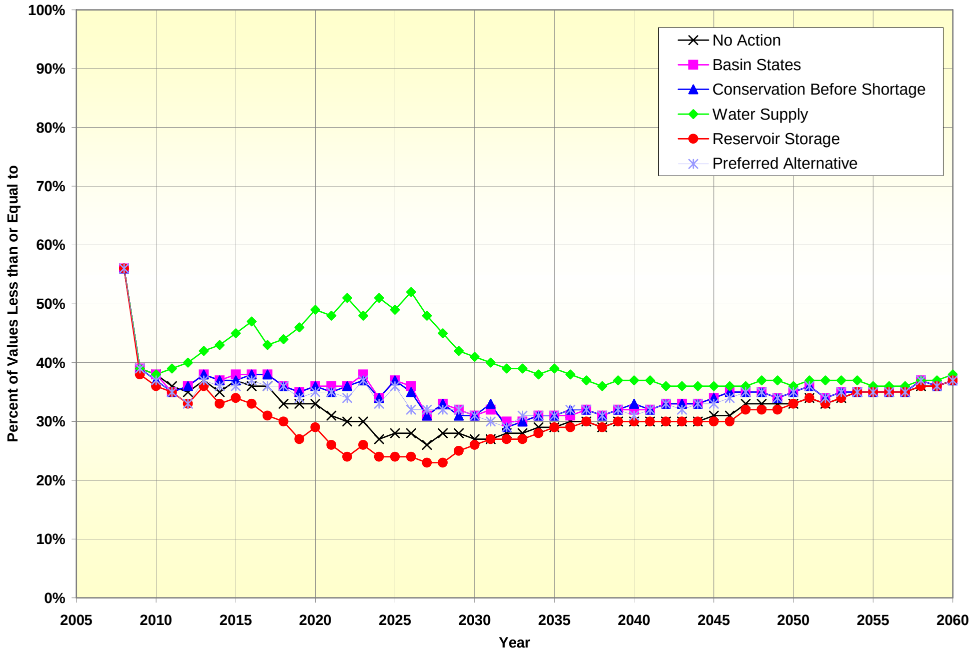


Table 4.3-5
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,620 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	56	36	28	27	30	35	37
Basin States	56	38	36	31	32	35	37
Conservation Before Shortage	56	38	35	31	33	35	37
Water Supply	56	47	52	41	37	36	38
Reservoir Storage	56	33	24	26	30	33	37
Preferred Alternative	56	37	32	31	31	35	37

Figure 4.3-7 compares the percent of values less than or equal to elevation 3,588 feet msl for the No Action Alternative and the action alternatives. When Lake Powell elevations are below 3,588 feet msl, the Antelope Point Public Launch Ramp is closed. Lake elevations under the Reservoir Storage Alternative were below 3,588 feet msl less frequently than those under the No Action Alternative for most of the modeled years. Lake elevations under the Water Supply, Basin States, and Conservation Before Shortage alternatives, and the Preferred Alternative were below 3,588 feet msl more frequently than those under the No Action Alternative.

Figure 4.3-7
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,588 feet msl

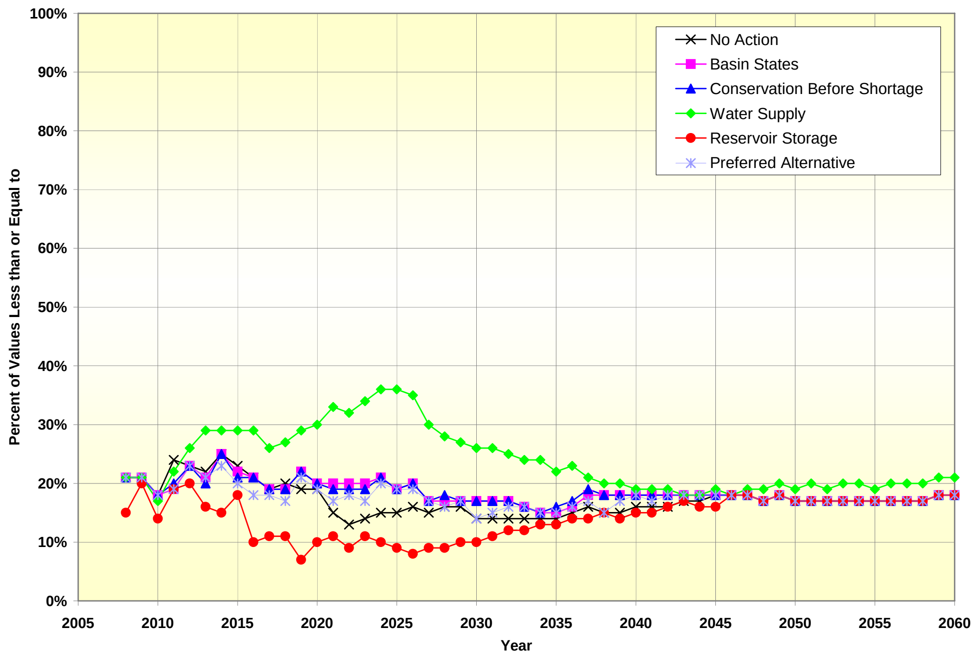


Table 4.3-6 provides a summary of the data illustrated in Figure 4.3-7 for an elevation of 3,588 feet msl. In general, lake elevations for all alternatives were below 3,588 feet msl between 14 and 21 percent of the time. The exceptions are the elevations under the Water Supply Alternative which were below 3,588 feet msl between 19 and 35 percent of the time and elevations under the Reservoir Storage Alternative which were below 3,588 feet msl between 8 and 18 percent of the time.

Table 4.3-6
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,588 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	21	21	16	14	16	17	18
Basin States	21	21	20	17	18	17	18
Conservation Before Shortage	21	21	20	17	18	17	18
Water Supply	21	29	35	26	19	19	21
Reservoir Storage	15	10	8	10	15	17	18
Preferred Alternative	21	18	19	14	18	17	18

Figure 4.3-8 compares the percent of values less than or equal to elevation 3,560 feet msl for the No Action Alternative and the action alternatives. Below an elevation of 3,560 feet msl, the Wahweap and Stateline Public Launch Ramps, the Bullfrog Low Water Alternative Launch Ramp, and the Halls Crossing Public Launch Ramps are closed. Results indicate that for most alternatives, the Lake Powell end-of-September elevations were lower than 3,560 feet msl between zero and 15 percent of the time, with the exception of the Water Supply Alternative. Lake elevations under the Water Supply Alternative were below 3,560 feet msl as much as 23 percent of the time.

Figure 4.3-8
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,560 feet msl

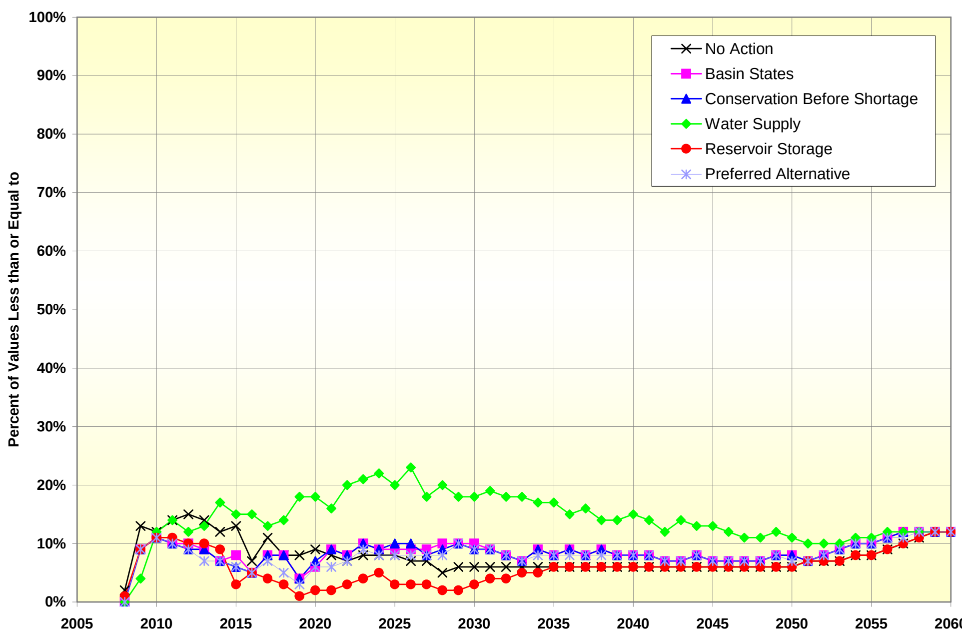


Table 4.3-7 provides a summary of the data illustrated in Figure 4.3-8 for elevation 3,560 feet msl. Lake Powell elevations under the Water Supply Alternative were below 3,560 feet msl more frequently than those under the No Action Alternative. Elevations under the Reservoir Storage Alternative were below 3,560 feet msl less frequently than those under the No Action Alternative.

Table 4.3-7
Lake Powell End-of- September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,560 feet msl

Alternative	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	2	7	7	6	6	6	12
Basin States	0	5	9	10	8	8	12
Conservation Before Shortage	0	5	10	9	8	8	12
Water Supply	0	15	23	18	15	11	12
Reservoir Storage	1	5	3	3	6	6	12
Preferred Alternative	0	5	8	9	8	7	12

Figure 4.3-9 compares the percent of values equal to or less than elevation 3,555 feet msl for the No Action Alternative and the action alternatives. Below an elevation of 3,555 feet msl, the Wahweap, Antelope Point, Bullfrog, and Halls Crossing marinas are closed. Results indicate that for most alternatives, the Lake Powell end-of-September elevations were lower than 3,555 feet msl between zero and 12 percent of the time. The exceptions are the elevations under the Water Supply Alternative which were lower than 3,555 feet msl up to 23 percent of the time.

Figure 4.3-9
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,555 feet msl

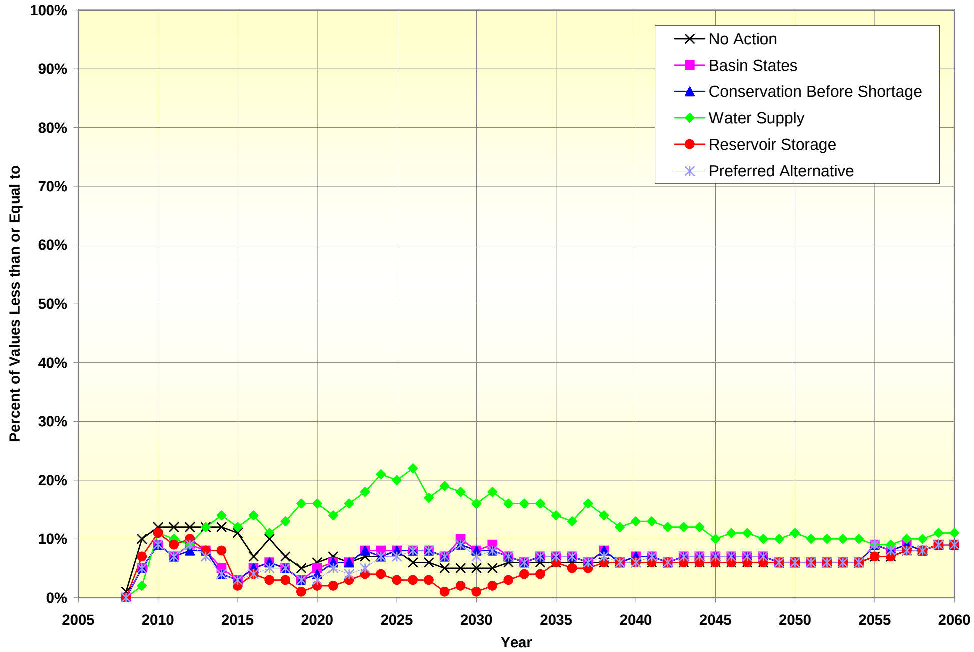


Table 4.3-8 provides a summary of the data illustrated in Figure 4.3-9 for elevation 3,555 feet msl. Lake Powell elevations under the Water Supply Alternative were below 3,555 feet msl more frequently than those under the No Action Alternative. Elevations under the Reservoir Storage Alternative were below 3,555 feet msl less frequently than those under the No Action Alternative through year 2035 and thereafter, the values were similar.

Table 4.3-8
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,555 feet msl

Alternative	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	1	7	6	5	6	6	9
Basin States	0	5	8	8	7	6	9
Conservation Before Shortage	0	5	8	8	7	6	9
Water Supply	0	14	22	16	13	11	11
Reservoir Storage	0	4	3	1	6	6	9
Preferred Alternative	0	4	8	7	6	6	9

Figure 4.3-10 compares the percent of values equal to or less than 3,550 feet msl projected under the No Action Alternative and the action alternatives. Below this elevation, the operation of the John Atlantic Burr Ferry may be affected. The Lake Powell end-of-September elevations under the alternatives were lower than 3,550 feet msl infrequently, ranging between zero and 12 percent. The exception to this was the Water Supply Alternative, which had elevations that were below 3,550 feet msl up to 20 percent of the time. Elevations under the Reservoir Storage, Basin States, and Conservation Before Shortage alternatives, and the Preferred Alternative, were all very similar to those under the No Action Alternative throughout the period of analysis.

Figure 4.3-10
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,550 feet msl

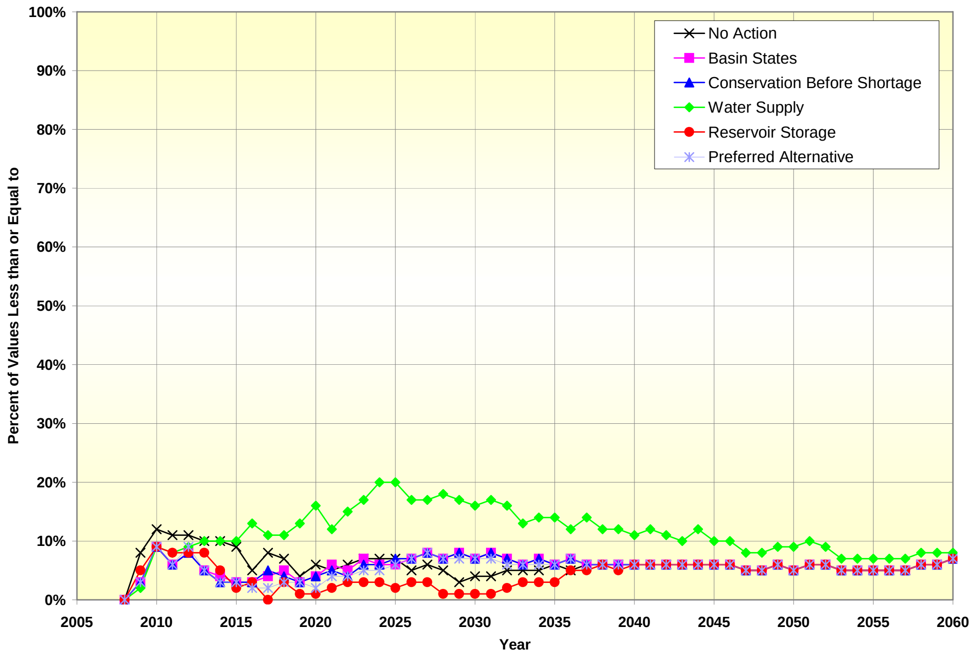


Table 4.3-9 provides a summary of the data illustrated in Figure 4.3-10 and shows that Lake Powell elevations under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, were generally within the same range of those observed under the No Action Alternative. Elevations under the Water Supply Alternative were below 3,550 feet msl more frequently compared to the other alternatives.

Table 4.3-9
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,550 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	0	5	5	4	6	5	7
Basin States	0	3	7	7	6	5	7
Conservation Before Shortage	0	3	7	7	6	5	7
Water Supply	0	13	17	16	11	9	8
Reservoir Storage	0	3	3	1	6	5	7
Preferred Alternative	0	2	7	7	6	5	7

Figure 4.3-11 compares the percent of values for Lake Powell end-of-March elevations that were less than or equal to 3,490 feet msl, the minimum power pool for efficient electrical generation at the Glen Canyon Powerplant, between the No Action Alternative and the action alternatives. Lake Powell generally reaches its seasonal low water elevation in March. Figure 4.3-11 shows that Lake Powell end-of-March elevation were below 3,490 feet msl infrequently under the No Action, Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative. Lake Powell end-of-March elevations under the Water Supply Alternative were below 3,490 feet msl more frequently than those under the No Action Alternative, with the differences up to eight percent.

Figure 4.3-11
Lake Powell End-of-March Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,490 feet msl

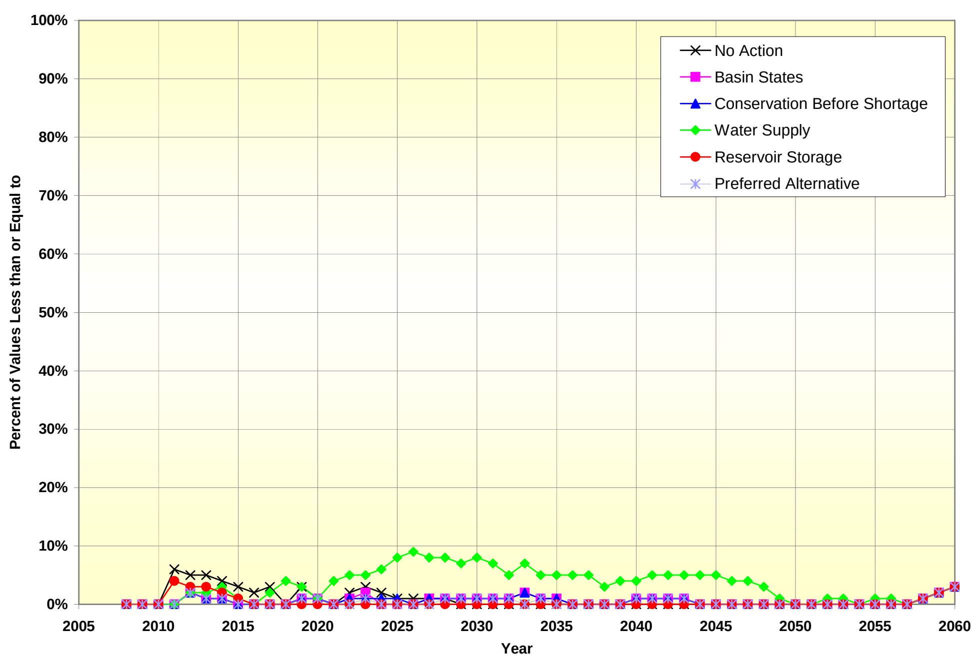


Table 4.3-10 provides a summary of the data illustrated in Figure 4.3-11 for elevation 3,490 feet msl. As presented in this table, elevations under all alternatives, with the exception of the Water Supply Alternative, were below 3,490 feet msl no more than three percent of the time in the years displayed.

Table 4.3-10
Lake Powell End-of-March Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,490 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	0	2	1	0	0	0	3
Basin States	0	0	0	1	1	0	3
Conservation Before Shortage	0	0	0	1	1	0	3
Water Supply	0	0	9	8	4	0	3
Reservoir Storage	0	0	0	0	0	0	3
Preferred Alternative	0	0	0	1	1	0	3

4.3.3 Glen Canyon Dam to Lake Mead

The river flows that occur between Glen Canyon Dam and Lake Mead result primarily from controlled releases from Glen Canyon Dam (Lake Powell). The gains from tributaries in this reach on average are less than three percent of the total flow, are concentrated over very short periods of time, and will not be affected by the proposed federal action. However, future annual and the monthly distribution of releases from Glen Canyon Dam may be affected by the proposed federal action (Section 3.3).

Table 4.3-11 provides a comparison of the relative frequency of occurrence of different annual release volumes from Glen Canyon Dam under the No Action Alternative and the action alternatives for the period 2008 through 2026. Table 4.3-12 provides a similar comparison for the period 2008 through 2060. The reported values are water year values. Releases greater than 9.5 maf generally correspond to years where either equalization or spill avoidance releases are made from Glen Canyon Dam.

Table 4.3-11
Glen Canyon Dam Annual Water Releases
Probability of Occurrence of Different Release Volumes (percent)
Comparison of Action Alternatives to No Action Alternative
Water Years 2008 through 2026

Glen Canyon Dam Release Volumes	Alternative					
	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Greater than 16.00 maf	3.63	3.26	3.32	2.89	3.74	3.53
Between 11.01 to 16.00 maf	17.11	16.79	16.89	17.26	16.84	16.42
Between 9.01 to 11.00 maf	14.05	13.53	13.42	38.95	15.74	14.37
Between 8.51 to 9.00 maf	4.42	26.00	25.37	6.05	4.21	22.37
Between 8.24 to 8.50 maf	2.74	2.37	2.47	3.68	3.21	2.11
Minimum Objective Release of 8.23 maf	57.74	27.79	28.42	21.37	38.95	31.16
Between 7.51 to 8.22 maf	0.21	0.95	0.79	3.95	17.32	0.68
Between 7.01 to 7.50 maf	0.05	8.32	8.26	4.32	0.00	8.11
Less than or equal to 7.00 maf	0.05	1.00	1.05	1.53	0.00	1.26
Total	100.00	100.00	100.00	100.00	100.00	100.00

Table 4.3-12
Glen Canyon Dam Annual Water Releases
Probability of Occurrence of Different Release Volumes (percent)
Comparison of Action Alternatives to No Action Alternative
Water Years 2008 through 2060

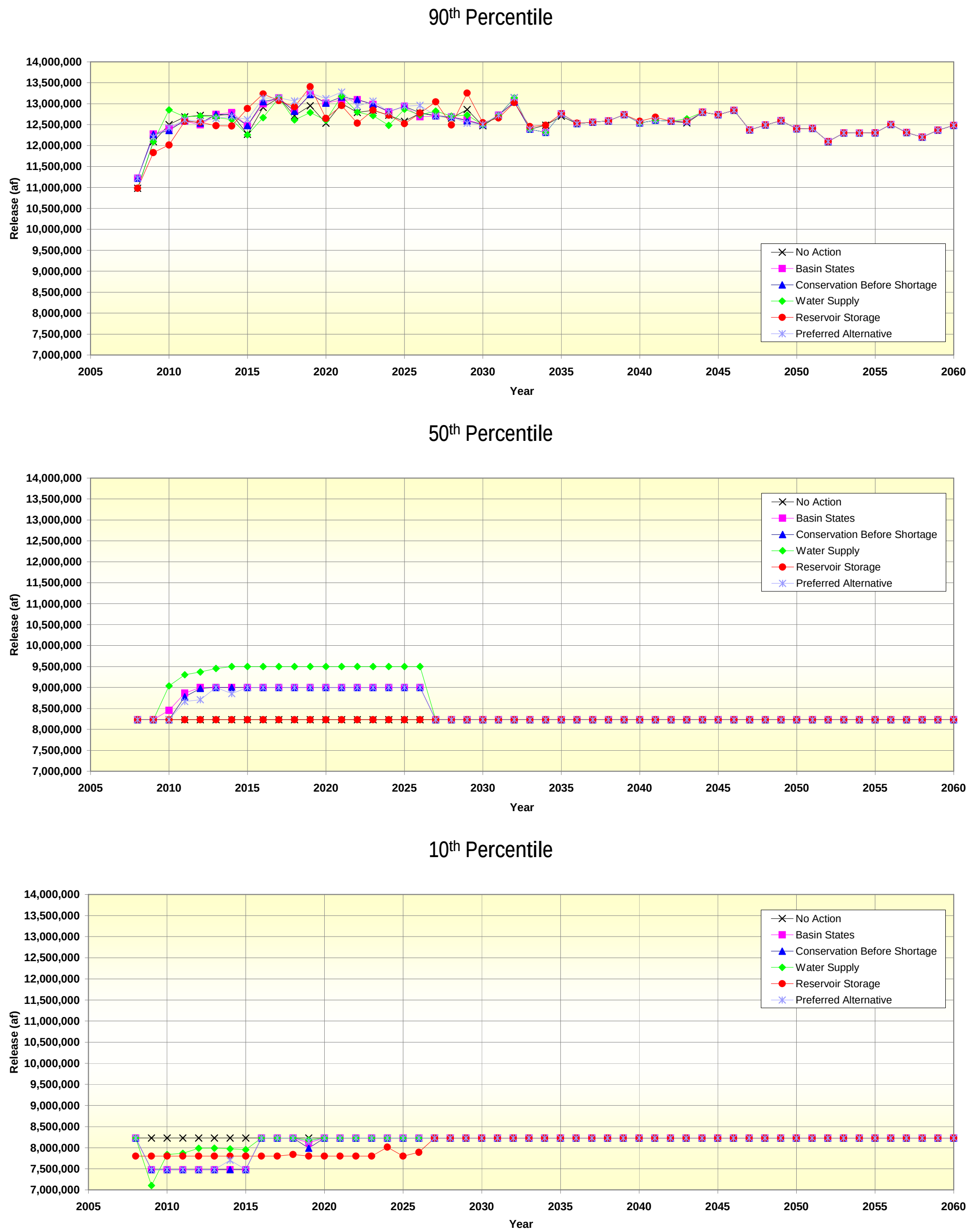
Glen Canyon Dam Release Volumes	Alternative					
	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Greater than 16.00 maf	4.00	3.83	3.85	3.19	4.04	3.96
Between 11.01 to 16.00 maf	14.08	13.85	13.92	14.49	14.40	13.72
Between 9.01 to 11.00 maf	12.81	12.36	12.28	20.91	13.08	12.66
Between 8.51 to 9.00 maf	3.72	11.53	11.30	4.30	3.68	10.19
Between 8.24 to 8.50 maf	2.25	2.08	2.11	2.77	2.36	2.00
Minimum Objective Release of 8.23 maf	63.04	52.68	52.91	50.68	56.25	53.87
Between 7.51 to 8.22 maf	0.08	0.34	0.28	1.57	6.21	0.25
Between 7.01 to 7.50 maf	0.02	2.98	2.96	1.55	0.00	2.91
Less than or equal to 7.00 maf	0.02	0.36	0.38	0.55	0.00	0.45
Total	100.00	100.00	100.00	100.00	100.00	100.00

As is shown in Table 4.3-11, during the interim period (2008 through 2026), the most frequently occurring releases under the No Action Alternative are 8.23 maf, occurring approximately 58 percent of the time. The frequency of releases equal to the annual minimum objective release of 8.23 maf under the action alternatives ranged from approximately 21 to 39 percent. Releases less than the annual minimum objective release of 8.23 maf occurred less than one percent of the time under the No Action Alternative, approximately 10 percent under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, and approximately 17 percent under the Reservoir Storage Alternative. Releases greater than the annual minimum objective release of 8.23 maf occurred approximately 42 percent under the No Action Alternative, approximately 62 percent under the Basin States and Conservation Before Shortage alternatives, approximately 69 percent under the Water Supply Alternative, approximately 59 percent under the Preferred Alternative, and approximately 44 percent under the Reservoir Storage Alternative.

The distribution of the modeled annual Glen Canyon Dam releases is different if the values for the entire period of analysis are considered as compared to those during the interim period. As is shown in Table 4.3-12, during the entire period (2008 through 2060), the most frequently occurring releases for all alternatives are 8.23 maf, primarily due to the assumption that operations under all action alternatives revert to those of the No Action Alternative after 2026. Releases equal to the annual minimum objective release of 8.23 maf occurred approximately 63 percent under the No Action Alternative, approximately 53 percent under the Basin States, and Conservation Before Shortage alternatives, and the Preferred Alternative, approximately 51 percent under the Water Supply Alternative, and approximately 56 percent under the Reservoir Storage Alternative. Releases less than the annual minimum objective release of 8.23 maf occurred less than one percent of the time under the No Action Alternative, approximately four percent under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, and approximately six percent under the Reservoir Storage Alternative.

Figure 4.3-12 presents a comparison of the 90th, 50th, and 10th percentile values of the Glen Canyon Dam water year releases observed under the action alternatives to those under the No Action Alternative. As illustrated in Figure 4.3-12, the 90th percentile values under all of the alternatives fluctuate and range between 11.0 mafy to about 13.4 mafy, primarily due to spill avoidance releases. For the 50th percentile values, the Reservoir Storage Alternative and the No Action Alternative are nearly identical, with consistent releases of 8.23 maf. The Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative show releases greater than the minimum objective release of 8.23 maf, a result of balancing with a 9.0 maf maximum release constraint. The Water Supply Alternative shows releases greater than the minimum objective release of 8.23 maf due to balancing with a 9.5 maf maximum release constraint.

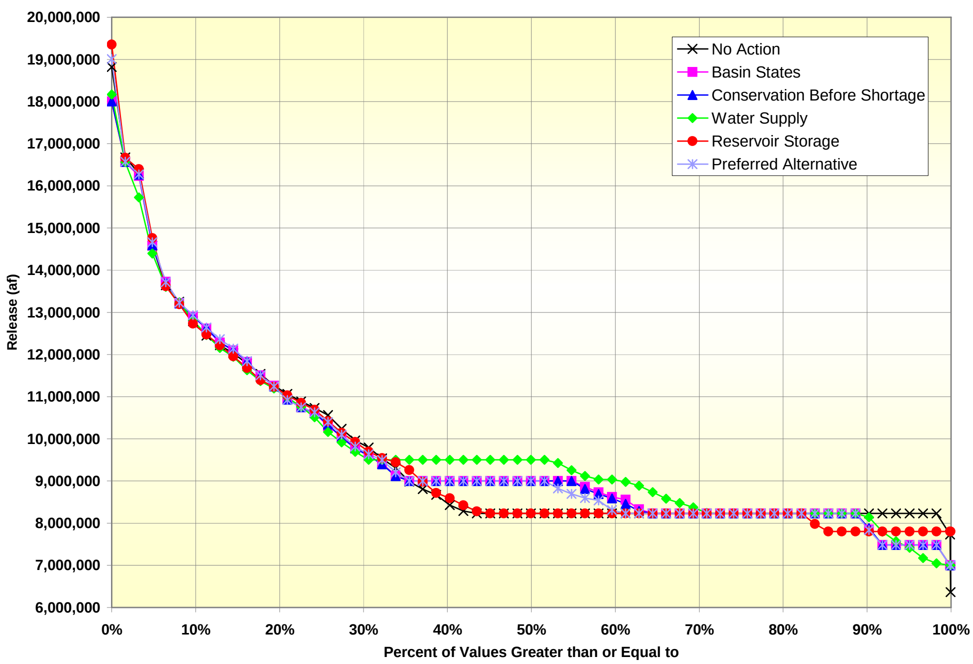
Figure 4.3-12
Glen Canyon Dam Water Year Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values



The 10th percentile values showed that the Water Supply Alternative provided lower releases than the No Action Alternative from 2009 and 2015, and thereafter, were similar to those observed under the No Action Alternative. The Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative also provided lower annual release volumes than the No Action Alternative from 2009 through 2015. The 10th percentile values for releases under the Reservoir Storage Alternative are below those of the No Action Alternative through 2026.

Figure 4.3-13 illustrates the cumulative distribution of the Glen Canyon Dam water year releases under the No Action Alternative and the action alternatives for the interim period (2008 through 2026). This figure provides a means for comparing the frequency that the minimum objective release of 8.23 maf is made under the different alternatives as well as identifying the frequency and magnitude of Glen Canyon Dam releases above and below the minimum objective release of 8.23 maf. As illustrated in Figure 4.3-13, the minimum objective release of 8.23 maf under the No Action Alternative is met or exceeded approximately 98 percent or more of the time. The minimum objective release of 8.23 maf under the action alternatives is met or exceeded approximately 86 percent or more of the time. The exception to this is the Reservoir Storage Alternative under which the minimum objective release of 8.23 maf is met or exceeded approximately 82 percent of the time.

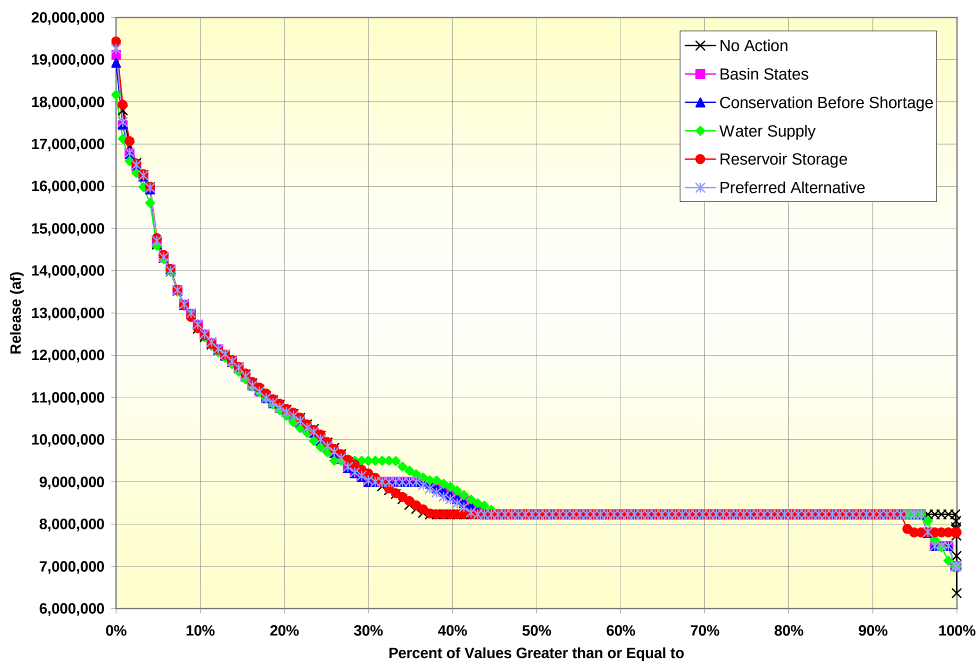
Figure 4.3-13
Glen Canyon Dam Water Year Releases
Comparison of Action Alternatives to No Action Alternative
Water Years 2008 through 2026



The minimum observed release volume of 6.36 maf occurs under the No Action Alternative. Unlike the action alternatives, the No Action Alternative does not include a range of elevations where annual releases less than 8.23 maf are permitted. A release of less than 8.23 maf can only occur under the No Action Alternative due to physical release constraints at Lake Powell (approximately elevation 3,460 feet msl). Appendix B, Section B.2 describes this physical release constraint in more detail. By providing for releases less than 8.23 maf (as low as 7.0 maf), the action alternatives avoid reaching elevations where releases are physically constrained. The minimum observed water year release volume under the Preferred Alternative and the Basin States, Conservation Before Shortage, and Water Supply alternatives is 7.0 maf. The minimum observed water year release volume under the Reservoir Storage Alternative is 7.8 maf.

Figure 4.3-14 illustrates the cumulative distribution of the Glen Canyon Dam water year releases under the No Action Alternative and the action alternatives for the modeling period 2008 through 2060. As illustrated in Figure 4.3-14, the minimum objective release of 8.23 maf in the alternatives is met or exceeded 96 percent or more of the time. The exception to this is the Reservoir Storage Alternative under which the minimum objective release of 8.23 maf is met or exceeded approximately 93 percent of the time. The minimum releases observed during the interim period in Figure 4.3-13 are also observed in Figure 4.3-14, which reflects the overlap in the modeling period covered for these analyses.

Figure 4.3-14
Glen Canyon Dam Water Year Releases
Comparison of Action Alternatives to No Action Alternative
Water Years 2008 through 2060



4.3.3.1 Effect of Glen Canyon Dam Annual Releases on Daily River Flows Below Glen Canyon Dam

Table 4.3-11 and Figure 4.3-13 compare the probabilities of occurrence of different Glen Canyon Dam annual release volumes for each alternative relative to the No Action Alternative. Relatively small differences are seen at the higher releases (above 9.5 maf) that are primarily a result of equalization and spill avoidance releases. The majority of differences are due to operations under each action alternative that deviate from the minimum objective release of 8.23 maf – when releases are being made to balance Lake Powell and Lake Mead contents and when Glen Canyon Dam releases are constrained to specific values other than 8.23 maf.

Changes in the annual release volume will likely result in changes to the monthly distribution of releases. Furthermore, even though future daily and hourly releases are expected to continue to be made according to the parameters of the 1996 Glen Canyon Dam ROD (Section 3.3.2), changes in monthly releases may result in different distributions of daily and hourly releases.

To assess the potential impacts of such changes, monthly release patterns were developed for a set of annual release volumes and/or ranges (7.0, 7.48, 7.8, 8.23, 9.0, 9.5, 9.5 to 11.0, and 11.0 to 16.0 maf). The monthly release patterns were the result of an analysis of the monthly modeled releases and are considered to be representative of all of the alternatives. Based on the monthly release patterns, the 1996 Glen Canyon Dam ROD parameters were applied to determine the average, minimum, and maximum daily releases for each month and each annual release volume (Tables 4.3-13, Table 4.3-14, and Table 4.3-15 respectively). These data show the correlation between annual release volumes and the likely daily and hourly flows; however, actual daily and hourly flows will be the result of decisions based on actual operating conditions and other factors considered in real-time.

The information in Tables 4.3-13, Table 4.3-14, and Table 4.3-15 may be coupled with the information in Table 4.3-11 to determine the probability of occurrence for each alternative of specific minimum, maximum, and average daily flows for specific months. This information can then be used to evaluate potential downstream impacts to water quality and other environmental resources.

Table 4.3-13
Average Daily Glen Canyon Dam Releases (cfs)
Corresponding to Various Annual Release Volumes

	7.0 maf[1]	7.48 maf	7.8 maf	8.23 maf	9.0 maf	9.5 maf	9.5 to 11.0 maf	11.0 to 16.0 maf
Oct	9,758	7,806	9,758	9,758	9,758	9,758	10,775	11,518
Nov	10,083	8,403	10,083	10,083	10,083	10,083	11,048	11,806
Dec	13,011	9,758	9,758	13,011	13,011	13,011	14,309	15,094
Jan	10,759	13,011	13,011	13,011	13,011	13,824	15,286	16,654
Feb	9,724	10,804	10,804	10,804	11,704	11,704	14,722	17,347
Mar	7,319	9,758	9,758	9,758	10,571	10,571	12,376	14,634
Apr	7,563	8,403	10,083	10,083	10,083	10,924	12,127	15,226
May	7,319	9,758	9,758	9,758	10,571	13,011	11,523	15,449
Jun	9,076	10,083	10,083	10,924	13,444	15,125	14,485	22,385
Jul	11,711	13,011	13,011	13,824	16,263	17,077	16,202	22,281
Aug	11,711	13,011	13,011	14,637	17,077	17,890	19,201	24,355
Sep	7,866	10,083	10,083	10,588	13,444	14,285	17,780	22,563

1. The analysis showed that a consistent monthly release pattern was not evident for 7.0 maf annual release years, primarily due to the variability in forecasted inflows. The monthly pattern shown was taken from a representative trace (Trace 89 for WY 2017 from the Water Supply Alternative)

Table 4.3-14
Minimum Hourly Glen Canyon Dam Releases (cfs)
Corresponding to Various Annual Release Volumes

	7.0 maf[1]	7.48 maf	7.8 maf	8.23 maf	9.0 maf	9.5 maf	9.5 to 11.0 maf	11.0 to 16.0 maf
Oct	6,458	5,006	6,458	6,458	6,458	6,458	7,475	8,218
Nov	6,783	5,603	6,783	6,783	6,783	6,783	7,748	8,506
Dec	8,711	6,458	6,458	8,711	8,711	8,711	10,009	10,794
Jan	7,459	8,711	8,711	8,711	8,711	9,524	10,986	12,354
Feb	6,924	7,504	7,504	7,504	8,404	8,404	10,422	13,047
Mar	5,000	6,458	6,458	6,458	7,271	7,271	9,076	10,334
Apr	5,000	5,603	6,783	6,783	6,783	7,624	8,827	11,926
May	5,000	6,458	6,458	6,458	7,271	8,711	8,223	11,149
Jun	6,276	6,783	6,783	7,624	9,144	10,825	10,185	17,000
Jul	8,411	8,711	8,711	9,524	11,963	12,777	11,902	17,000
Aug	8,411	8,711	8,711	10,337	12,777	13,590	14,901	17,000
Sep	5,066	6,783	6,783	7,288	9,144	9,985	13,480	17,000

1. The analysis showed that a consistent monthly release pattern was not evident for 7.0 maf annual release years, primarily due to the variability in forecasted inflows. The monthly pattern shown was taken from a representative trace (Trace 89 for WY 2017 from the Water Supply Alternative)

Table 4.3-15
Maximum Hourly Glen Canyon Dam Releases (cfs)
Corresponding to Various Annual Release Volumes

	7.0 maf[1]	7.48 maf	7.8 maf	8.23 maf	9.0 maf	9.5 maf	9.5 to 11.0 maf	11.0 to 16.0 maf
Oct	12,458	10,006	12,458	12,458	12,458	12,458	13,475	14,218
Nov	12,783	10,603	12,783	12,783	12,783	12,783	13,748	14,506
Dec	16,711	12,458	12,458	16,711	16,711	16,711	18,009	18,794
Jan	13,459	16,711	16,711	16,711	16,711	17,524	18,986	20,354
Feb	11,924	13,504	13,504	13,504	14,404	14,404	18,422	21,047
Mar	10,000	12,458	12,458	12,458	13,271	13,271	15,076	18,334
Apr	10,000	10,603	12,783	12,783	12,783	13,624	14,827	17,926
May	10,000	12,458	12,458	12,458	13,271	16,711	14,223	19,149
Jun	11,276	12,783	12,783	13,624	17,144	18,825	18,185	25,000
Jul	14,411	16,711	16,711	17,524	19,963	20,777	19,902	25,000
Aug	14,411	16,711	16,711	18,337	20,777	21,590	22,901	25,000
Sep	10,066	12,783	12,783	13,288	17,144	17,985	21,480	25,000

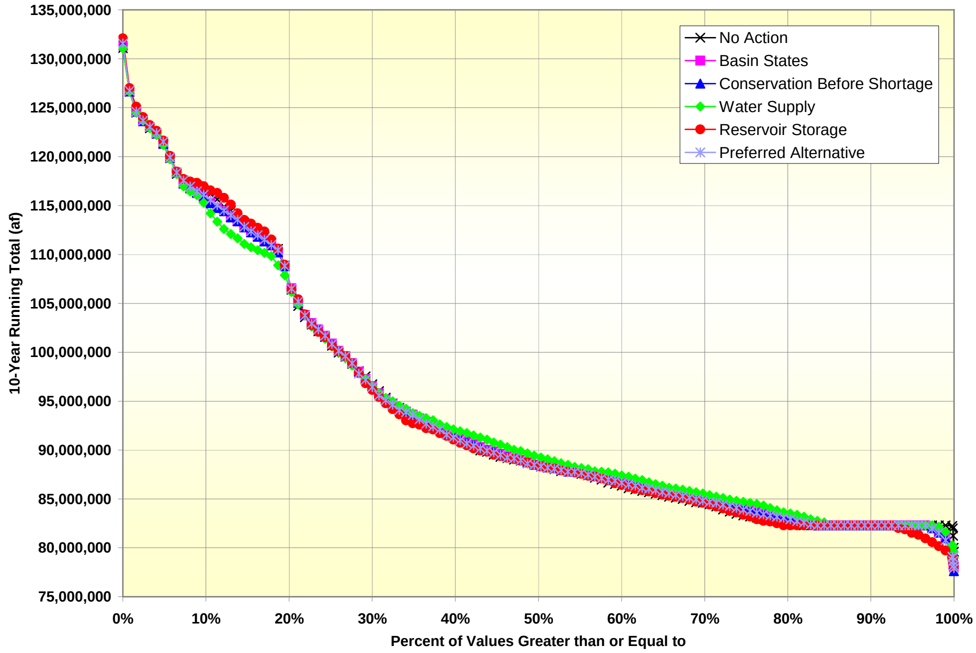
1. *The analysis showed that a consistent monthly release pattern was not evident for 7.0 maf annual release years, primarily due to the variability in forecasted inflows. The monthly pattern shown was taken from a representative trace (Trace 89 for WY 2017 from the Water Supply Alternative)*

4.3.3.2 10-year Running Total of Glen Canyon Dam Releases

Figure 4.3-15 compares the 10-year running totals of the Glen Canyon Dam water year releases under the action alternatives to the No Action Alternative. The values used to compute the 10-year running total for 2008 through 2017 included a combination of historical values for years prior to 2006, projections from the 24-month study for 2007 (Section 4.2 and Appendix A), and output from the CRSS model for 2008 and later. The upper limit of the 10-year running total was similar under the No Action Alternative and the action alternatives and equaled approximately 131 maf. The 10-year running total under all of the alternatives, including the No Action Alternative, was always above 75 maf.

The 10-year running total under the No Action Alternative was less than 82.3 maf in less than one percent of the years with a minimum value of 79.6 maf. The 10-year running totals under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative were less than 82.3 maf in approximately three percent of the years and the minimum value was 77.6 maf. The 10-year running total under the Water Supply Alternative was less than 82.3 maf in two percent of the years and the minimum value was 79.0 maf. The 10-year running total under the Reservoir Storage Alternative was less than 82.3 maf in approximately 7.2 percent of the years and the minimum value was 78.1 maf.

Figure 4.3-15
Glen Canyon Dam 10-Year Running Total of Annual Releases
Comparison of Action Alternatives to No Action Alternative
Water Years 2008 through 2060



4.3.3.3 Beach/Habitat-Building Flows

The frequencies at which BHBF releases from Glen Canyon Dam would occur under the No Action Alternative and under the action alternatives were estimated using CRSS. The model simulates BHBF releases by using the BHBF triggering criteria (described in Appendix P, Section P-HR.1) and computes the probability of occurrence of BHBF releases for each calendar year throughout the modeling period. The results of this analysis for each alternative are presented in Appendix P (Section P-HR.1), and a summary is presented below.

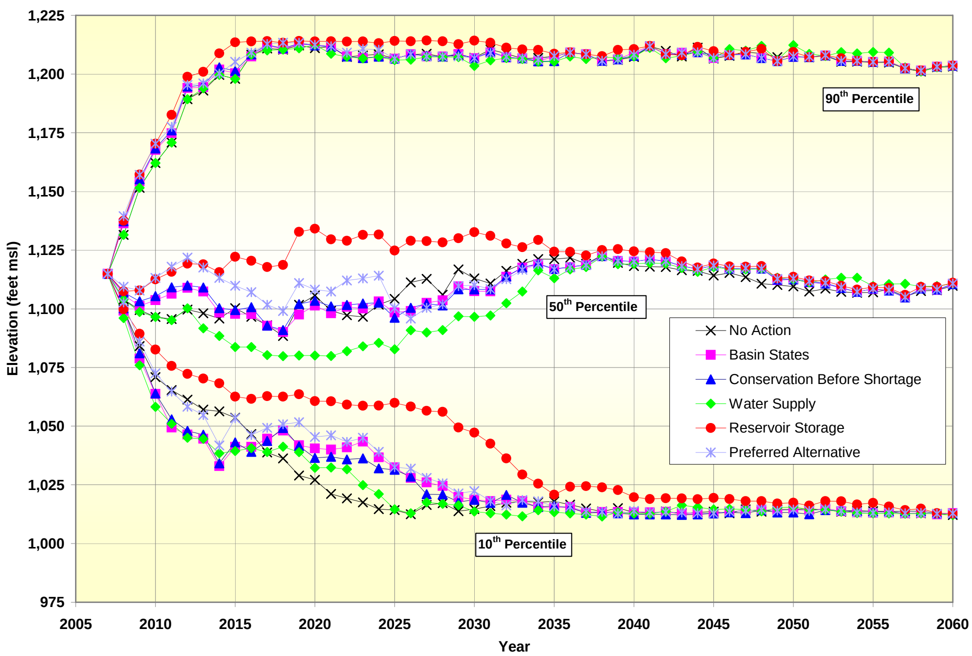
In general, the average probability that BHBF releases could be made under the No Action Alternative and the action alternatives are similar (approximately seven percent) during the interim period (2008 through 2026). The exception to this is the Reservoir Storage Alternative which has an average probability of BHBF releases that is approximately one percent higher than that of the No Action Alternative and the other action alternatives. The average probabilities for all of the alternatives are lower during the interim period as compared to the average probabilities observed during the post-interim period (2027 through 2060). This is primarily due to the low reservoir starting conditions. The average probability that BHBF releases under the No Action Alternative and the action alternatives are approximately 11.5 percent during the post-interim period (2027 through 2060). The exception to this is the Reservoir Storage Alternative which has an average probability of BHBF releases that is approximately half a percent higher than that of the No Action Alternative and the other action alternatives. The Reservoir Storage Alternative generally provides a slightly higher probability of BHBF releases than the No Action Alternative and the other action alternatives because this alternative generally provides higher reservoir elevations.

4.3.4 Lake Mead and Hoover Dam

Future elevations of Lake Mead are expected to be within the range of historic water levels (Section 3.3). However, each alternative may alter the probability (when compared to the No Action Alternative) that the reservoir may be at a given elevation in the future.

Figure 4.3-16 presents a comparison of the 90th, 50th, and 10th percentile values observed for the action alternatives to those under the No Action Alternative for Lake Mead end-of-December elevations. Under the No Action Alternative, Lake Mead is projected to fluctuate between full pool (elevation 1,219.6 feet msl) and lower elevations during the period of analysis (2008 through 2060). The 90th percentile plot increases from starting conditions to nearly full pool, about elevation 1,212 feet msl. The median elevation values (50th percentile) under the No Action Alternative fluctuated between approximately 1,090 feet msl and approximately 1,120 feet msl from 2008 through 2035. The 10th percentile values show a declining trend between 2008 and 2025, from about elevation 1,115 feet msl to about 1,015 feet msl.

Figure 4.3-16
Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values



All action alternatives showed similar 90th percentile values compared to the No Action Alternative. Lake Mead elevations depicted in Figure 4.3-16 represent values at the end of December which is when lake elevations are typically at a seasonal high. Conversely, the Lake Mead elevation generally reaches its seasonal low in July.

Values at the 50th percentile under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative were at or above the No Action Alternative prior to 2025. The Water Supply Alternative had lower 50th percentile values than the No Action Alternative during the interim period. The Reservoir Storage Alternative had higher 50th percentile values than the No Action Alternative throughout the entire period. During the interim period, the 10th percentile values for the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative were higher than the No Action Alternative, and the values for the Reservoir Storage Alternative were significantly higher than the No Action Alternative.

Table 4.3-16 provides a summary of the data illustrated in Figure 4.3-16 which reflects the 90th, 50th, and 10th percentile end-of-December elevations for Lake Mead observed under the No Action Alternative and the action alternatives. The values presented in this table include those for years 2026 and 2060 only.

Table 4.3-16
Lake Mead End-of-December Elevations (feet msl)
Comparison of Action Alternatives to No Action Alternative
90th , 50th , and 10th Percentile Values

Alternative	Year 2026			Year 2060		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
No Action	1,208.27	1,111.31	1,012.48	1,203.15	1,109.73	1,012.14
Basin States	1,208.44	1,099.06	1,027.98	1,203.52	1,110.50	1,012.95
Conservation Before Shortage	1,208.44	1,100.41	1,028.45	1,203.52	1,110.50	1,012.87
Water Supply	1,206.11	1,090.89	1,012.88	1,203.43	1,110.66	1,012.14
Reservoir Storage	1,214.02	1,129.00	1,058.40	1,203.62	1,111.10	1,012.74
Preferred Alternative	1,208.44	1,095.83	1,031.95	1,203.52	1,110.75	1,012.93

The 90th percentile values in year 2026 vary little between the action alternatives and the No Action Alternative. The exception to this is the Reservoir Storage Alternative which is approximately seven feet higher than that of the No Action Alternative.

The 50th percentile values for the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative in year 2026 are approximately 12, 11, 20, and 16 feet lower than that of the No Action Alternative, respectively. In contrast, the 50th percentile value for the Reservoir Storage Alternative in year 2026 is approximately 18 feet higher than that of the No Action Alternative.

The 10th percentile values for the Basin States, Conservation Before Shortage, Water Supply, and Reservoir Storage alternatives, and the Preferred Alternative were all higher than that of No Action Alternative in year 2026 (Table 4.3-16). The greatest difference of elevations observed occurs between the Reservoir Storage Alternative and No Action Alternative, which is about 46 feet.

Figure 4.3-17 illustrates the results for exceedence values above an elevation of 1,200 feet msl, nearly the full pool elevation of Lake Mead. All of the action alternatives were very similar to the No Action Alternative throughout the modeled years, with exceedence values ranging between zero and 20 percent.

Figure 4.3-17
Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Greater Than or Equal to Elevation 1,200 feet msl

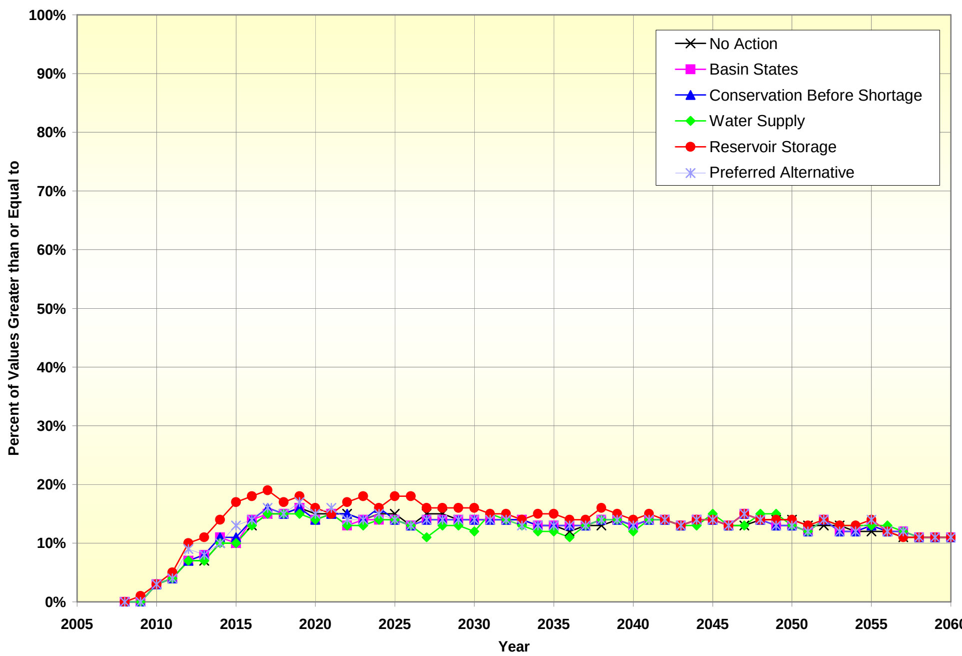


Table 4.3-17 provides a summary of the exceedence values for elevation 1,200 feet msl for selected years. As listed in this table, the exceedence values for the alternatives are similar, although the Reservoir Storage Alternative provides slightly higher exceedence values.

Table 4.3-17
Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Greater Than or Equal to Elevation 1,200 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	0	13	13	14	13	14	11
Basin States	0	14	13	14	13	13	11
Conservation Before Shortage	0	14	13	14	13	13	11
Water Supply	0	13	13	12	12	13	11
Reservoir Storage	0	18	18	16	14	14	11
Preferred Alternative	0	14	13	14	13	13	11

Figure 4.3-18 illustrates the frequency that future Lake Mead end-of-December elevations would be below 1,178 feet msl. Lake Mead elevations of 1,178 feet msl and 1,000 feet msl were used by the Clean Water Coalition as reference elevations for its Lake Mead water quality analysis (Systems Conveyance and Operations Program Final Environmental Impact Statement [SCOP FEIS] Clean Water Coalition 2006). The SCOP FEIS analyzed water quality changes corresponding to Lake Mead elevation drawdown from 1,178 feet msl to 1,000 feet msl. These potential Lake Mead water quality changes are discussed in Section 4.5. As shown in Figure 4.3-18, the results for the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative are similar to those of the No Action Alternative. Elevations under the Reservoir Storage Alternative were below 1,178 feet msl less frequently than those under the No Action Alternative. Elevations under the Water Supply Alternative were below 1,178 feet msl more frequently than those under the No Action Alternative.

Figure 4.3-18
Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,178 feet msl

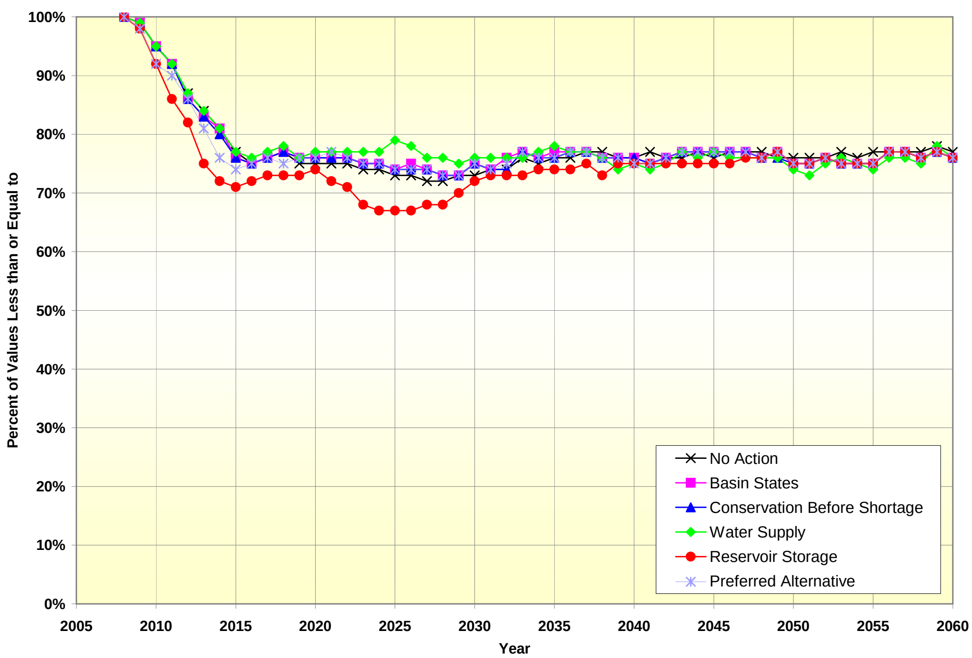


Table 4.3-18 provides a summary of the results illustrated in Figure 4.3-18 for elevation 1,178 feet msl in tabular form for selected years. As shown in Table 4.3-18, Lake Mead elevations under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative are similar to those under the No Action Alternative. Elevations under the Reservoir Storage Alternative were below 1,178 feet msl less frequently than those under the No Action Alternative. Elevations under the Water Supply Alternative were below elevation 1,178 feet msl more frequently than those under the No Action Alternative.

Table 4.3-18
Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less than or Equal to Elevation 1,178 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	100	75	73	73	76	76	77
Basin States	100	75	75	75	76	75	76
Conservation Before Shortage	100	75	74	75	76	75	76
Water Supply	100	76	78	76	75	74	76
Reservoir Storage	100	72	67	72	75	75	76
Preferred Alternative	100	75	74	75	75	75	76

Figure 4.3-19 illustrates the frequency that future Lake Mead end-of-July elevations would be below elevation 1,175 feet msl. Lake Mead generally reaches its seasonal low elevation in July. Below this elevation, the Pearce Bay Launch Ramp is closed and whitewater boaters must paddle an additional 16 miles to South Cove. As illustrated in Figure 4.3-19, the results for the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative are similar to those of the No Action Alternative. Elevations under the Reservoir Storage Alternative were below 1,175 feet msl less frequently than those under the No Action Alternative.

Figure 4.3-19
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,175 feet msl

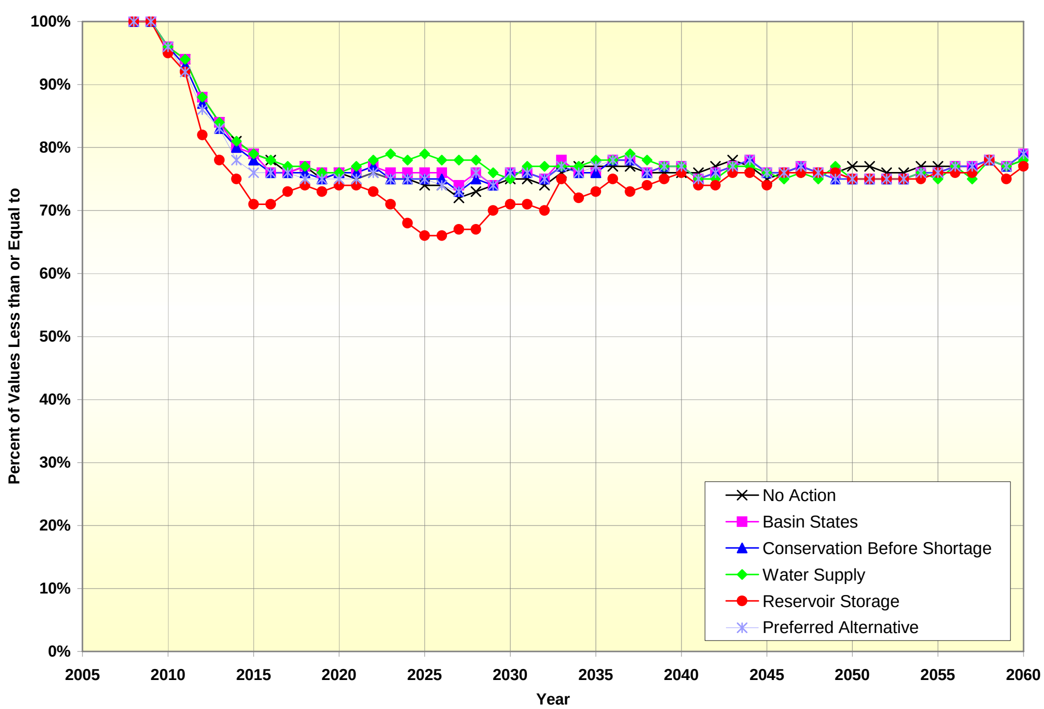


Table 4.3-19 provides a summary of the results illustrated in Figure 4.3-19 for elevation 1,175 feet msl for selected years. As shown in Table 4.3-19, Lake Mead elevations under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative are similar to those under the No Action Alternative. Elevations under the Reservoir Storage Alternative were below 1,175 feet msl less frequently than those under the No Action Alternative.

Table 4.3-19
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,175 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	100	78	74	75	76	77	78
Basin States	100	76	76	76	77	75	79
Conservation Before Shortage	100	76	75	76	77	75	79
Water Supply	100	78	78	75	77	75	78
Reservoir Storage	100	71	66	71	76	75	77
Preferred Alternative	100	76	74	76	77	75	79

Figure 4.3-20 illustrates the frequency that Lake Mead end-of-July elevations would be below elevation 1,170 feet msl, the minimum elevation needed to maintain navigation between Grand Wash and Pearce Ferry. At elevations below 1,170 feet msl, potential sediment aggradation could potentially impair navigation between these two locations. As illustrated in Figure 4.3-20, the results for the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative are similar to those observed under the No Action Alternative. Lake Mead elevations under the Water Supply Alternative were below 1,170 feet msl more frequently than those under the No Action Alternative through 2033. Elevations under the Reservoir Storage Alternative were below 1,170 feet msl less frequently than those under the No Action Alternative.

Figure 4.3-20
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,170 feet msl

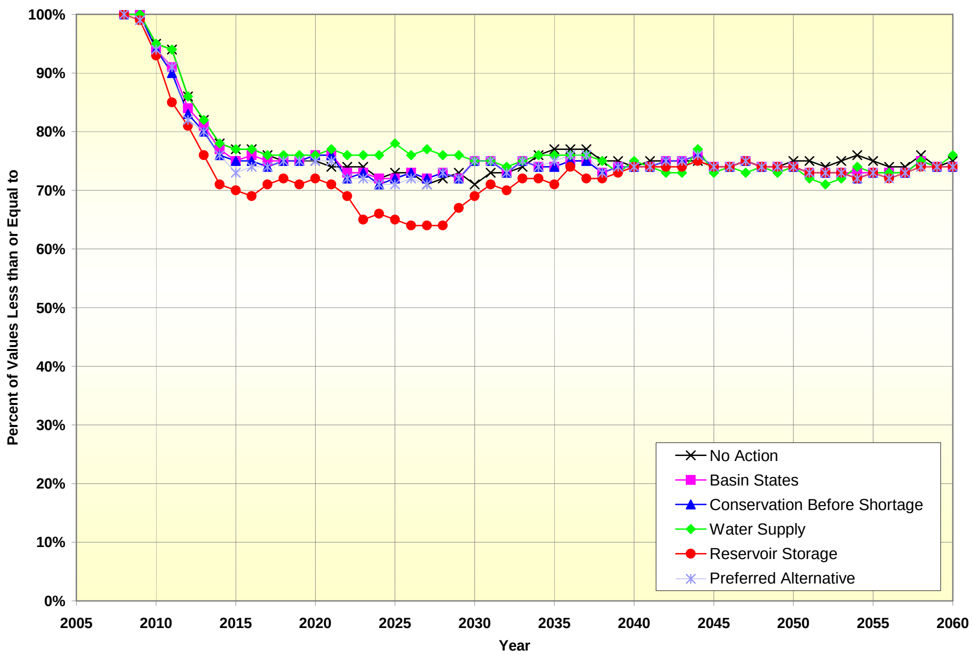


Table 4.3-20 provides a summary of the results illustrated in Figure 4.3-20 for the Lake Mead end-of-July elevation of 1,170 feet msl for selected years.

Table 4.3-20
Lake Mead End-of- July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,170 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	100	77	73	71	74	75	75
Basin States	100	76	73	75	74	74	74
Conservation Before Shortage	100	75	73	75	74	74	74
Water Supply	100	77	76	75	75	74	76
Reservoir Storage	100	69	64	69	74	74	74
Preferred Alternative	100	74	72	75	74	74	74

Figure 4.3-21 illustrates the frequency that Lake Mead end-of-July elevations were below elevation 1,125 feet msl. At lake elevations lower than 1,125 feet msl, the Overton Beach Marina and South Cove Ramp are closed. As illustrated in Figure 4.3-21, Lake Mead elevations under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative were below 1,125 ft msl less frequently than under the No Action Alternative prior to 2025. Elevations under the Water Supply Alternative were below 1,125 feet msl more frequently than those under the No Action Alternative between 2015 and 2041. Elevations under the Reservoir Storage Alternative were below 1,125 feet msl less frequently than those under the No Action Alternative.

Figure 4.3-21
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,125 feet msl

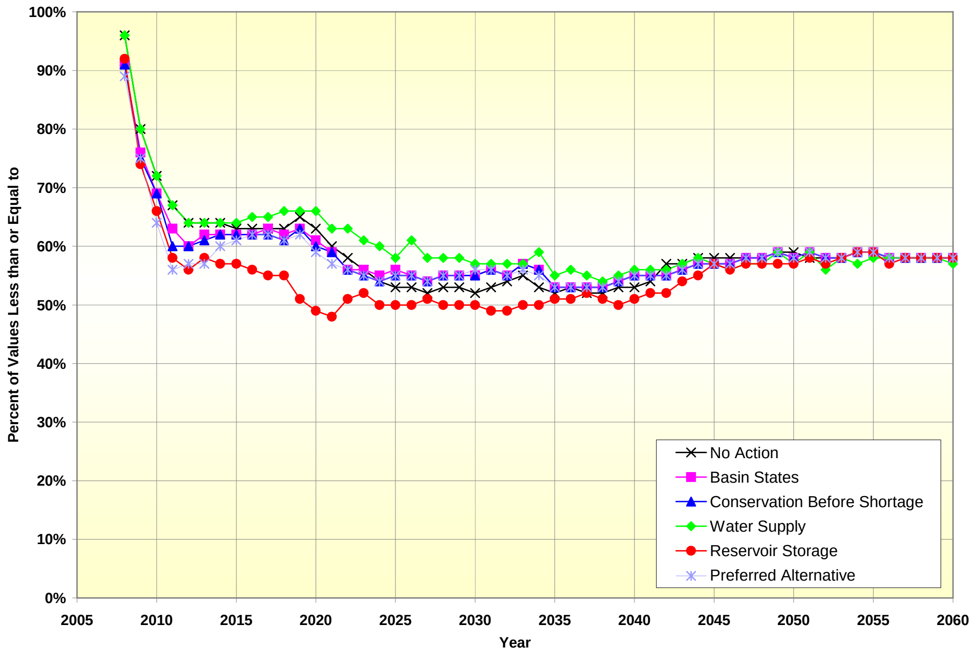


Table 4.3-21 provides a summary of the results for the Lake Mead end-of-July elevation of 1,125 feet msl for selected years.

Table 4.3-21
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,125 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	96	63	53	52	53	59	58
Basin States	91	62	55	55	55	58	58
Conservation Before Shortage	91	62	55	55	55	58	58
Water Supply	96	65	61	57	56	57	57
Reservoir Storage	92	56	50	50	51	57	58
Preferred Alternative	89	62	55	56	55	58	58

Figure 4.3-22 illustrates the frequency that Lake Mead end-of-July elevations would be below elevation 1,080 feet msl. At Lake Mead elevations below 1,080 feet msl, operations of the Lake Mead Marina Public Launch Ramp, Hemenway Public Launch Ramp, and Temple Bar Public Launch Ramp could potentially be affected. As illustrated in Figure 4.3-22, Lake Mead elevation was below 1,080 feet msl under the Reservoir Storage Alternative less frequently than under the No Action Alternative between 2010 and 2045. Elevations under the Preferred Alternative were below 1,080 feet msl less frequently than under the No Action Alternative during the period between 2010 and 2025. Elevations under the Basin States and Conservation Before Shortage alternatives were below 1,080 feet msl slightly more frequently between 2015 and 2030. Elevations under the Water Supply Alternative were below 1,080 feet msl more frequently than those under the No Action Alternative between 2015 and 2033.

Figure 4.3-22
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,080 feet msl

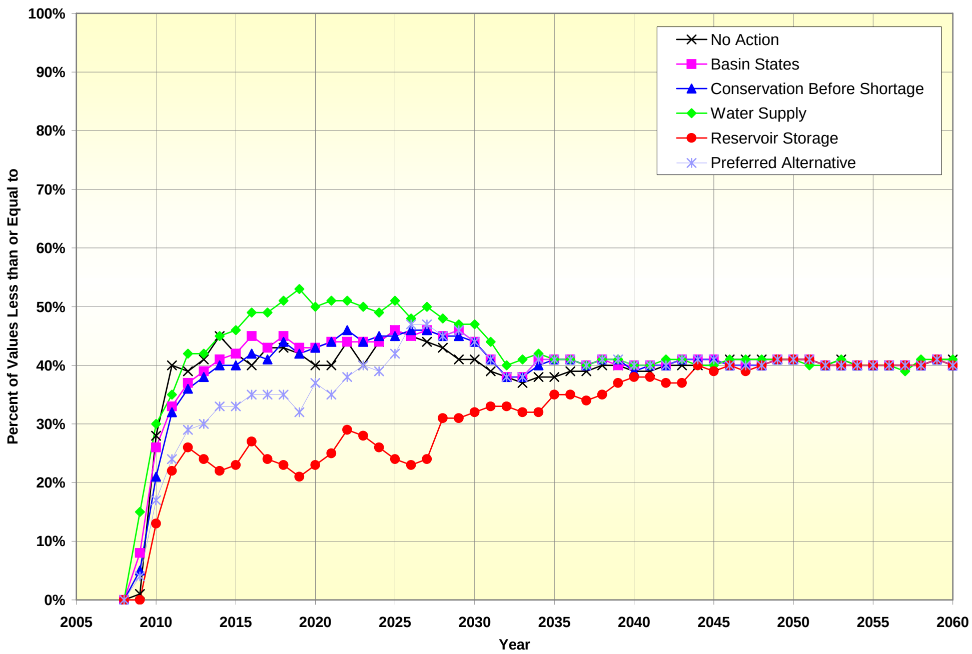


Table 4.3-22 provides a summary of the results for the Lake Mead-end-of-July elevation of 1,080 feet msl for selected years. As listed in Table 4.3-22, the action alternatives vary from the No Action Alternative mostly between years 2010 and 2030 and are similar in subsequent years.

Table 4.3-22
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,080 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	0	40	45	41	39	41	41
Basin States	0	45	45	44	40	41	40
Conservation Before Shortage	0	42	46	44	39	41	40
Water Supply	0	49	48	47	40	41	41
Reservoir Storage	0	27	23	32	38	41	40
Preferred Alternative	0	35	47	44	40	41	40

Figure 4.3-23 illustrates the frequency that Lake Mead end-of-July elevations would be below elevation 1,050 feet msl. Lake Mead elevation of 1,050 feet msl is the minimum elevation needed for efficient power generation at the Hoover Powerplant, the minimum elevation for operation of the upper intake of SNWA, and the minimum elevation for the Echo Bay Boat Launch. As illustrated in Figure 4.3-23, Lake Mead elevations under the Basin States and Conservation Before Shortage alternatives were below 1,050 feet msl less frequently than those under the No Action Alternative from 2016 through 2028. The same pattern held for the Preferred Alternative beginning in 2013. Elevations under the Water Supply Alternative were below 1,050 feet msl less frequently than under the No Action Alternative between 2018 and 2026. Elevations under the Reservoir Storage Alternative were below 1,050 feet msl less frequently than those under the No Action Alternative (lower by as much as 10 to 20 percent), reflecting higher reservoir elevations.

Figure 4.3-23
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,050 feet msl

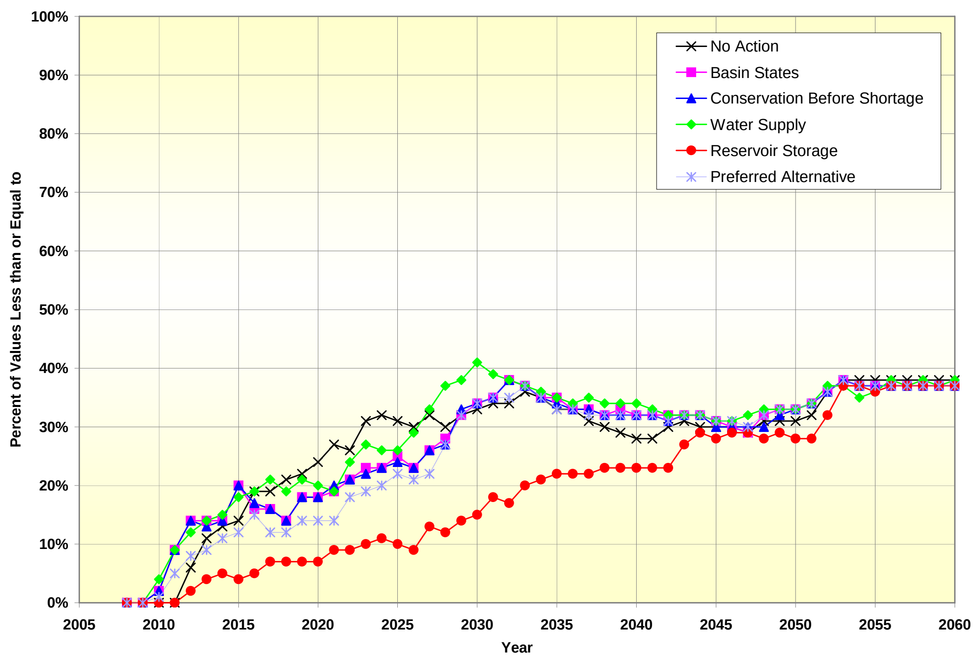


Table 4.3-23 provides a summary of the results illustrated in Figure 4.3-23 for the Lake Mead end-of-July elevation of 1,050 feet msl for selected years.

Table 4.3-23
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,050 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	0	19	30	33	28	31	38
Basin States	0	16	23	34	32	33	37
Conservation Before Shortage	0	17	23	34	32	33	37
Water Supply	0	19	29	41	34	33	38
Reservoir Storage	0	5	9	15	23	28	37
Preferred Alternative	0	15	21	34	32	33	37

Figure 4.3-24 illustrates the frequency that Lake Mead end-of-July elevations would be below elevation 1,000 feet msl. Lake Mead elevation of 1,000 feet msl is the minimum elevation needed by SNWA, to pump water from Lake Mead through its lower intake. Lake Mead elevation 1,000 feet msl was also a reference elevation for the Lake Mead water quality analysis. The SCOP FEIS analyzed water quality changes corresponding to Lake Mead elevation drawdown from 1,178 feet msl to 1,000 feet msl. These potential water quality changes are discussed in Section 4.5. As illustrated in Figure 4.3-24, Lake Mead end-of-July elevations under the No Action Alternative, and the Conservation Before Shortage and Reservoir Storage alternatives were not below 1,000 feet msl. Elevations under the Basin States Alternative and the Preferred Alternative do show some instances below 1,000 feet msl, although the frequency is very low. The maximum observed probability for elevations below 1,000 feet msl under the Water Supply Alternative is 12 percent and occurs towards the end of the interim period. Under the Basin States Alternative and the Preferred Alternative, the maximum observed probability for elevations below 1,000 feet msl is two percent and also occurs toward the end of the interim period.

Figure 4.3-24
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,000 feet msl

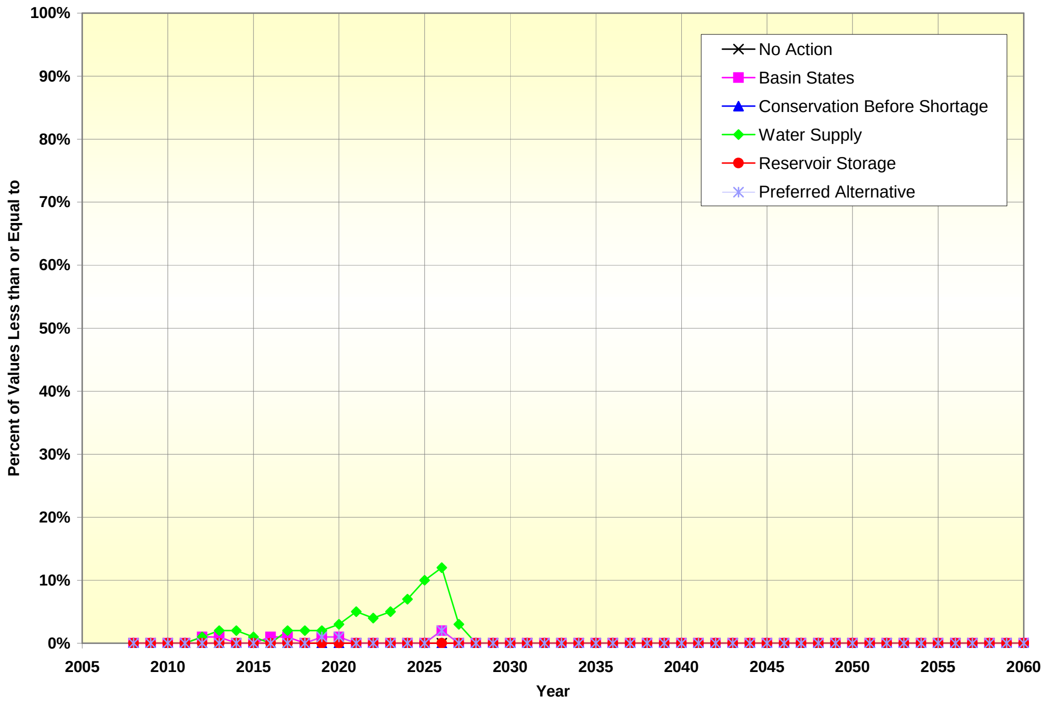


Table 4.3-24 provides a summary of the results illustrated in Figure 4.3-24 for the Lake Mead end-of-July elevation of 1,000 feet msl for selected years. The Water Supply and Basin States alternatives, and the Preferred Alternative are the only alternatives that show instances where lake elevations were below 1,000 feet msl.

Table 4.3-24
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 1,000 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	0	0	0	0	0	0	0
Basin States	0	1	2	0	0	0	0
Conservation Before Shortage	0	0	0	0	0	0	0
Water Supply	0	0	12	0	0	0	0
Reservoir Storage	0	0	0	0	0	0	0
Preferred Alternative	0	0	2	0	0	0	0

Figure 4.3-25 illustrates the minimum Lake Mead end-of-July elevations that were observed in the modeling of the action alternatives and No Action Alternative during the period of analysis (2008 through 2060). The minimum lake elevations under the No Action Alternative were not below 1,000 feet msl throughout the period of analysis. Similarly, the minimum lake elevations under the Conservation Before Shortage and Reservoir Storage Alternatives were not below 1,000 feet msl throughout the period of analysis. The minimum lake elevations under the Reservoir Storage Alternative are generally higher than those observed under the No Action Alternative. The minimum lake elevations under the Water Supply Alternative are generally lower than those observed under the No Action Alternative and were below 1,000 feet msl for nearly all years of the interim period. The minimum lake elevations under the Basin States Alternative are also below 1,000 feet msl during the interim period, but at higher elevations compared to the Water Supply Alternative. Lake Mead elevations modeled under the Preferred Alternative were below 1,000 feet msl, albeit only in a few years and only a few feet below elevation 1,000 feet msl. The minimum Lake Mead end-of-July elevation values under the action alternatives and the No Action Alternative remain at about 1,000 feet msl after 2030 due to the modeling assumptions after 2026.

Figure 4.3-25
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Minimum Elevation Values (feet msl)

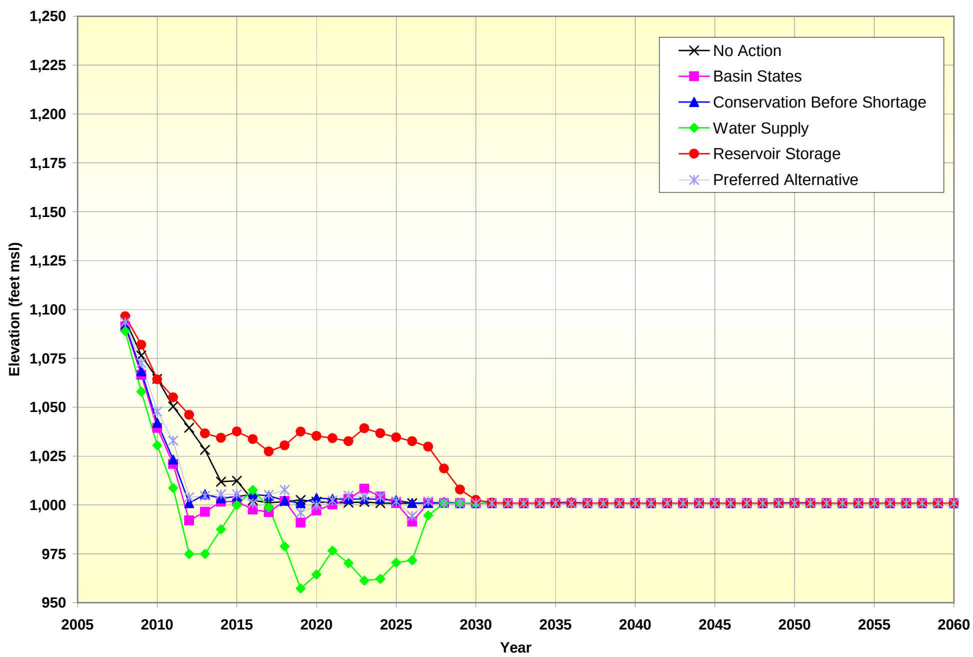


Table 4.3-25 provides a summary of the results illustrated in Figure 4.3-25 for the Lake Mead end-of-July minimum elevations for selected years. As listed in this table, the greatest variability between the action alternatives and the No Action Alternative occurs during the interim period.

Table 4.3-25
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Minimum Elevation Values (feet msl)

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
No Action	1,094.8	1,002.4	1,000.9	1,000.9	1,000.9	1,000.9	1,000.9
Basin States	1,091.3	997.7	991.4	1,000.9	1,000.9	1,000.9	1,000.9
Conservation Before Shortage	1,091.9	1,005.3	1,001.0	1,000.9	1,000.9	1,001.1	1,000.9
Water Supply	1,088.9	1,007.6	971.7	1,000.9	1,000.9	1,000.9	1,000.9
Reservoir Storage	1,096.5	1,033.7	1,032.6	1,002.6	1,000.9	1,000.9	1,000.9
Preferred Alternative	1,093.5	1,000.9	994.4	1,000.9	1,000.9	1,000.9	1,000.9

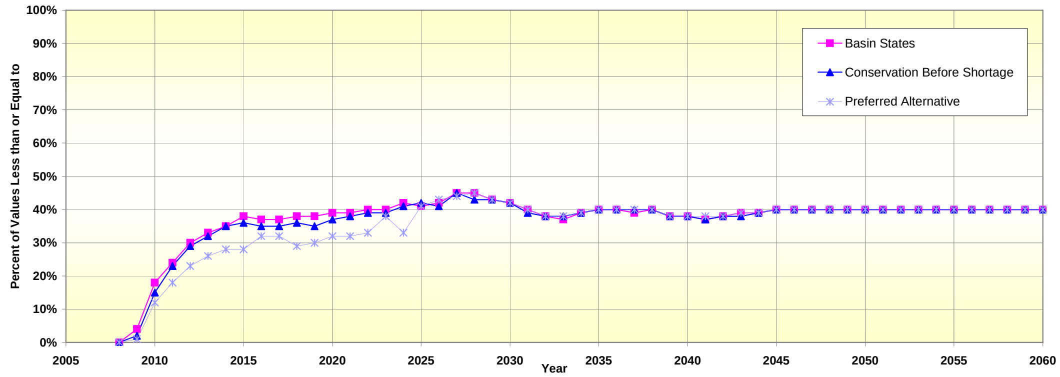
4.3.4.1 Probability of Reaching Other Key Lake Mead Elevations

The Basin States Alternative and the Preferred Alternative provide discrete levels of shortage associated with specific Lake Mead elevations (Section 2.3 and Section 2.7, respectively). These alternatives provide for shortages of 333 kaf, 417 kaf, and 500 kaf to users within the Lower Division states at Lake Mead elevations of 1,075 feet msl, 1,050 feet msl, and 1,025 feet msl, respectively. Additionally, when Lake Mead is below elevation 1,025 feet msl, additional consultations would occur under the Basin States Alternative and the Preferred Alternative to discuss further measures that may be undertaken consistent with the Law of the River. Lake Mead elevations of 1,075 feet msl, 1,050 feet msl, and 1,025 feet msl are also the conservation trigger elevations provided in the Conservation Before Shortage Alternative and correlate with voluntary water conservation actions of 400 kaf, 500 kaf, and 600 kaf, respectively.

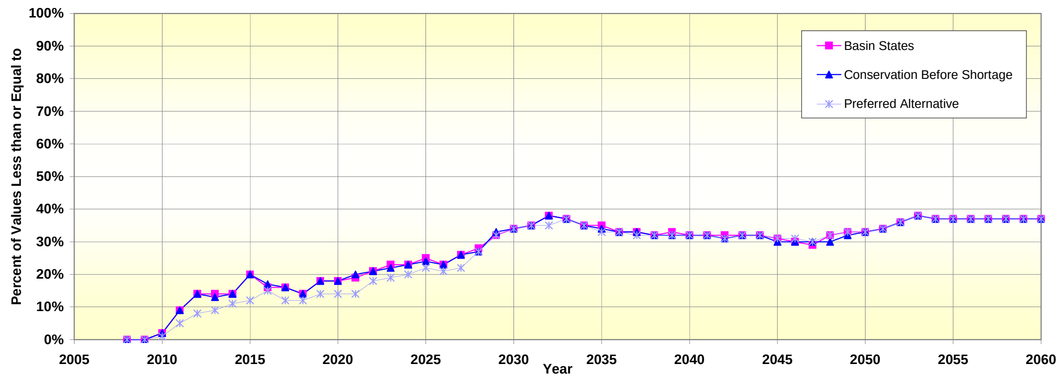
Figure 4.3-26 compares the percent of values less than or equal to the shortage trigger elevations of Lake Mead (1,075 feet msl, 1,050 feet msl, and 1,025 feet msl) under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative. These three key elevations are relevant only to the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative, and therefore, the plots for the No Action Alternative, and the Water Supply and Reservoir Storage Alternatives are not shown. Figure 4.3-26 is best used to assess the probability of occurrence of the shortages or conservation actions associated with the three different trigger elevations. For example, in 2026, the probability that Lake Mead would be below the trigger elevation of 1,075 feet msl is 42 percent under the Basin States Alternative and Preferred Alternative and 41 percent under the Conservation Before Shortage Alternative. Additional comparisons of the probabilities are provided in tabular format in Table 4.3-26, Table 4.3-27, and Table 4.3-28.

Figure 4.3-26
Lake Mead End-of-July Elevations
Comparison of Action Alternatives
Percent of Values Less Than or Equal to Shortage Trigger Elevations of Lake Mead

Elevation 1,075 feet msl



Elevation 1,050 feet msl



Elevation 1,025 feet msl

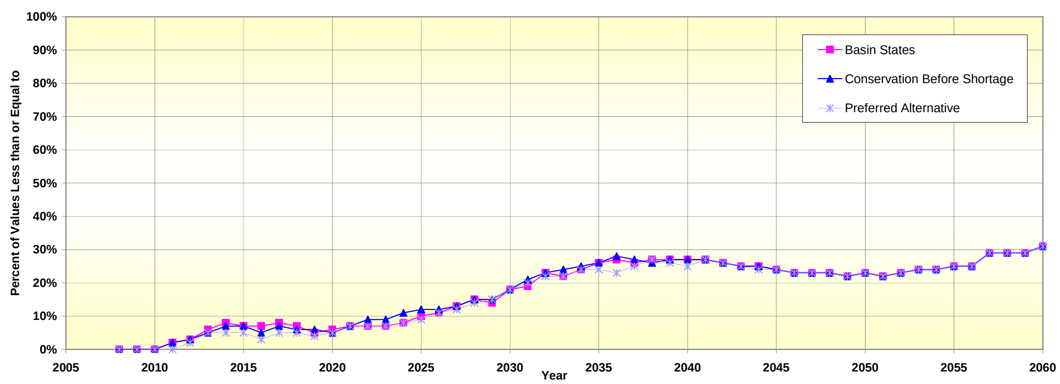


Table 4.3-26
Lake Mead End-of-July Elevations
Comparison of Action Alternatives
Percent of Values Less Than or Equal to Elevation 1,075 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
Basin States	0	37	42	42	38	40	40
Conservation Before Shortage	0	35	41	42	38	40	40
Preferred Alternative	0	32	43	42	38	40	40

Table 4.3-27
Lake Mead End-of-July Elevations
Comparison of Action Alternatives
Percent of Values Less Than or Equal to Elevation 1,050 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
Basin States	0	16	23	34	32	33	37
Conservation Before Shortage	0	17	23	34	32	33	37
Preferred Alternative	0	15	21	34	32	33	37

Table 4.3-28
Lake Mead End-of-July Elevations
Comparison of Action Alternatives
Percent of Values Less Than or Equal to Elevation 1,025 feet msl

Alternatives	Year						
	2008	2016	2026	2030	2040	2050	2060
Basin States	0	7	11	18	27	23	31
Conservation Before Shortage	0	5	12	18	27	23	31
Preferred Alternative	0	3	11	18	25	23	31

4.3.4.2 Storage of Conserved Water in Lake Mead

Under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative, the assumptions made for the storage and delivery mechanism for conserved system and non-system water could potentially impact the volume of water in storage in Lake Mead. An overall increase in the volume of water in Lake Mead is likely due to the system assessment whereby a percentage of the conserved water is retained in Lake Mead.

An analysis of the sensitivity of the volume of water in storage in Lake Mead to the storage and delivery mechanism was performed by comparing these four alternatives with and without the mechanism in place. Without the mechanism in place, it was assumed that the voluntary shortages (i.e., reduced water deliveries due to conservation proposed to occur at and below Lake Mead elevations of 1,075 feet msl) proposed in the Conservation Before Shortage Alternative would occur. Under this assumption, the conserved water would remain in Lake Mead. All other conservation activities assumed to be associated with the storage and delivery mechanism as described in Appendix M were assumed not to exist for the Conservation Before Shortage, Basin States, and Reservoir Storage Alternatives, and the Preferred Alternative.

Figure 4.3-27 presents a comparison of the 90th, 50th, and 10th percentile values observed for the action alternatives to those under the No Action Alternative. This figure illustrates Lake Mead elevations for the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative if the storage and delivery mechanism is not in place. Lake Mead elevations illustrated in Figure 4.3-27 for these alternatives can be contrasted to those shown in Figure 4.3-16 which shows Lake Mead elevations for these alternatives if the storage and delivery mechanism is in place. As illustrated by this comparison, the inclusion of mechanism in these alternatives would have a tendency to provide higher Lake Mead elevations.

Figure 4.3-27
Lake Mead End-of-December Elevations
Comparison of Action Alternatives With Storage and
Delivery Mechanism Removed to No Action Alternative
90th, 50th, and 10th Percentile Values

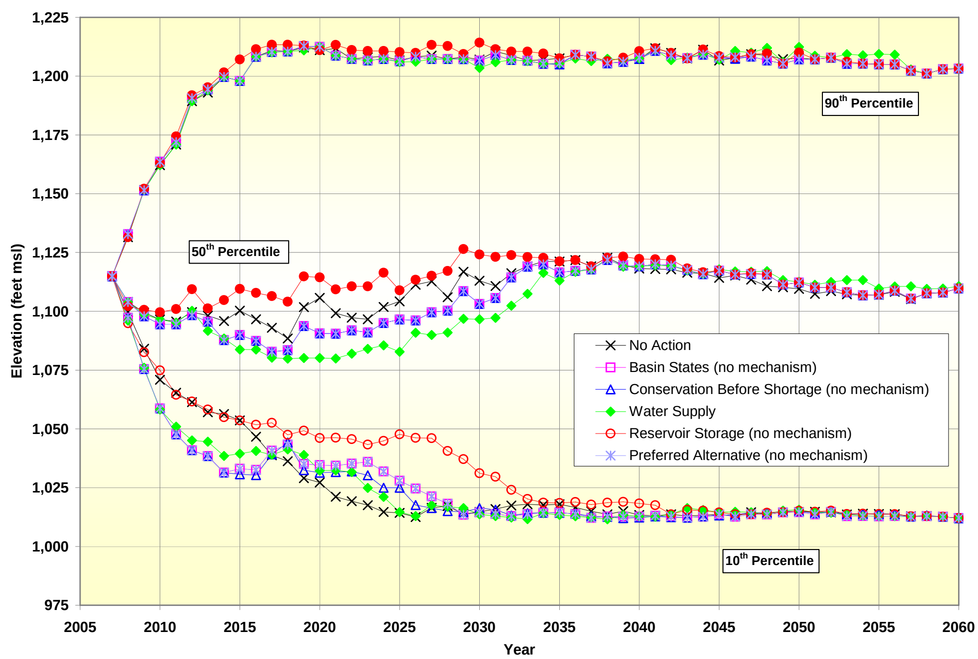


Figure 4.3-28 compares the 90th, 50th, and 10th percentile Lake Mead elevations for the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative with a storage and delivery mechanism, to the same alternatives without a storage and delivery mechanism.

Figure 4.3-28
Lake Mead End-of-December Elevations
Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism
90th, 50th, and 10th Percentile Values

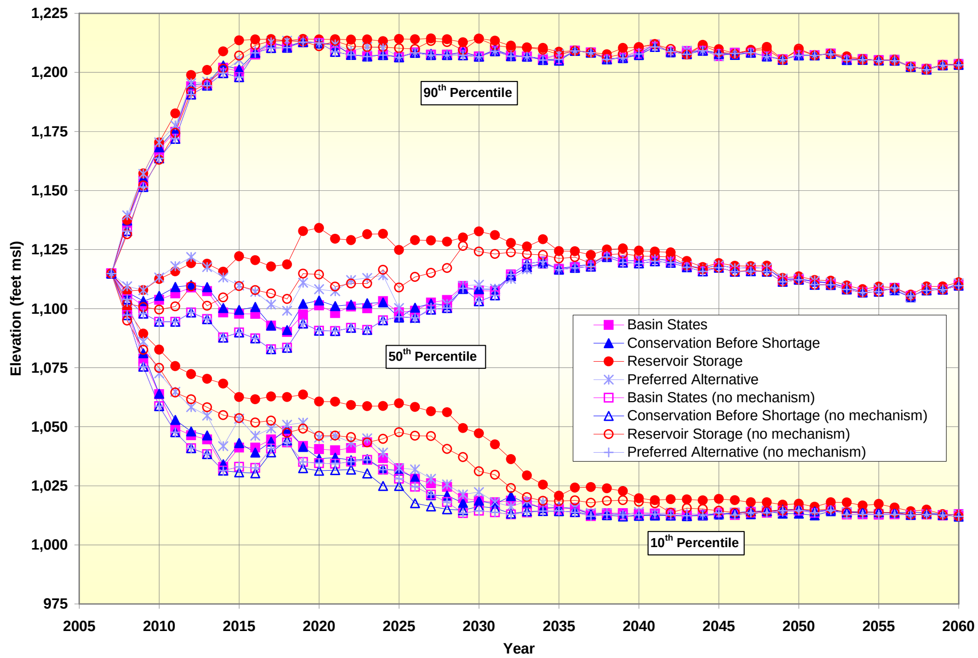


Table 4.3-29 provides a summary of the increases in Lake Mead elevations for selected years that can be attributed to the inclusion of the storage and delivery mechanism in the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative. As listed in this table for the 50th and 10th percentile values, the storage and delivery mechanism could potentially provide higher Lake Mead elevations, by as much as 15.6 feet under the Reservoir Storage Alternative, 13.3 feet under the Conservation Before Shortage Alternative, 10.3 feet under the Basin States Alternative, and 19.7 feet under the Preferred Alternative.

Table 4.3-29
Lake Mead End-of-December Elevations
Increase/Decrease ( ) in Lake Mead Elevations (feet) Resulting From a Storage and Delivery Mechanism
Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism
90th, 50th, and 10th Percentile Values

Year	Basin States			Conservation Before Shortage		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
2008	3.6	2.0	1.9	4.5	3.0	2.9
2016	(0.7)	10.3	8.6	0.2	13.3	8.7
2026	0.2	2.9	3.4	0.2	4.3	10.8
2030	0.2	4.4	4.2	0.2	5.2	2.4
2040	1.5	0.9	0.5	0.5	1.0	0.1
2050	0.3	0.2	(0.1)	0.3	0.2	(1.8)
2060	0.4	0.8	0.8	0.4	0.8	0.9
Year	Reservoir Storage			Preferred Alternative		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
2008	6.1	5.3	4.9	6.7	5.5	5.5
2016	2.5	12.7	9.8	0.9	19.7	13.6
2026	4.2	15.6	12.2	0.2	(0.3)	7.3
2030	0.1	8.5	16.1	0.2	7.0	7.9
2040	0.1	2.3	1.5	0.5	0.9	1.2
2050	(0.6)	1.4	2.3	0.4	0.5	(0.1)
2060	0.5	1.4	0.6	0.4	1.0	0.8

4.3.5 Hoover Dam to Davis Dam

The river flows between Hoover Dam and Lake Mohave are comprised mainly of releases from Hoover Dam (Lake Mead) and tributary inflows. These tributary inflows, mostly from side washes, comprise less than one percent of the total annual flow in this reach. During the 10-year period between 1996 and 2005, the annual Hoover Dam releases have ranged between 8.274 maf and 12.774 maf, and averaged 10.415 maf.

Future annual and monthly releases may be affected by the proposed federal action (Section 3.3). Each action alternative may alter the probability (when compared to the No Action Alternative) of the magnitude and timing of particular releases. However, due to the presence of Lake Mohave immediately downstream, these potential changes in releases will have an effect only on hydropower generation.

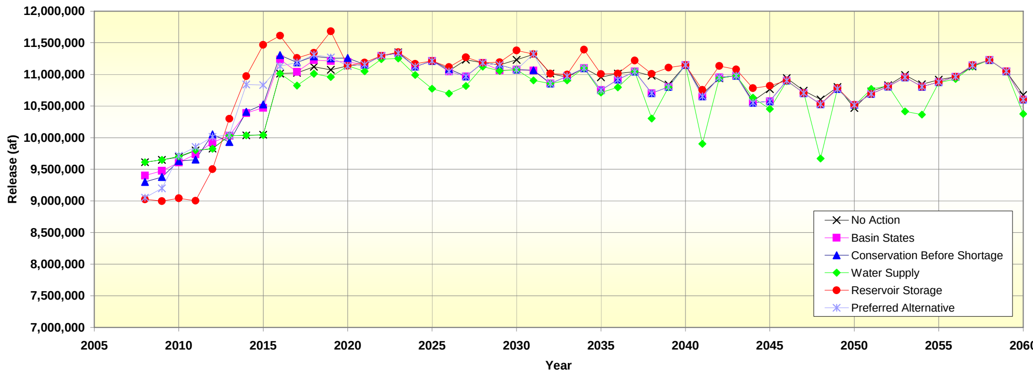
Figure 4.3-29 presents a comparison of the 90th, 50th, and 10th percentile values observed under the action alternatives and the No Action Alternative for Hoover Dam annual (calendar year) releases. The greatest variability between the action alternatives and the No Action Alternative generally occurs during the period between 2008 and 2026. Also, the greatest variability occurs between the Reservoir Storage Alternative and the No Action Alternative and is consistent with the underlying strategy of the Reservoir Storage Alternative which is to maintain more water in storage. This is facilitated through more frequent involuntary delivery reductions and is reflected in the 50th and 10th percentile values which are lower for this alternative between 2008 and 2026. Since more water is held in storage, as compared to the No Action Alternative, the Reservoir Storage Alternative provides more opportunities for more frequent and higher flood control and surplus releases, which is reflected in the 90th percentile values for this alternative. In contrast, the strategy of the Water Supply Alternative is to meet the water users' delivery requirements with less regard to preserving water in storage. As such, the 50th and 10th percentile values under the Water Supply Alternative show that more water is delivered under this alternative between 2008 and 2026, as compared to the No Action Alternative. The ranges of water releases at the 90th, 50th, and 10th percentiles that occur under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative generally coincide with the range of releases observed under the No Action Alternative and differences, where they occur, are relatively small.

Another observation relates to the 50th and 10th percentile annual Hoover Dam release volumes that are slightly below those of the No Action Alternative under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative after 2026. This difference can be attributed to the assumption that SNWA would develop additional permanent non-system water supplies from sources located downstream of Hoover Dam (described as system augmentation in Appendix M) that would be delivered to Lake Mead through some form of transfer or exchange with another agency that has a point of delivery also located downstream of Hoover Dam, thereby reducing the release from Hoover Dam.

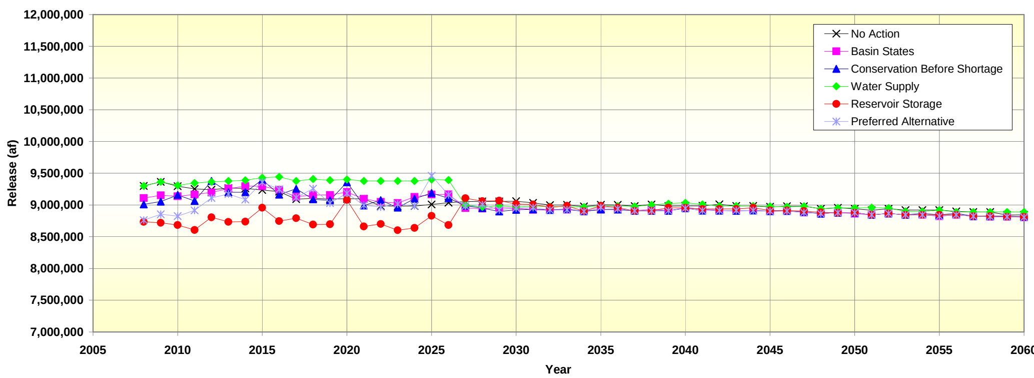
Figure 4.3-30 illustrates the cumulative distribution of Hoover Dam annual releases under the action alternatives and the No Action Alternative for the interim period (2008 through 2060). The observed minimum and maximum annual releases under the No Action Alternative are 7.46 maf and 17.13 maf, respectively. By comparison, the minimum annual release under the action alternatives is 7.3 maf, and occurs under the Conservation Before Shortage Alternative; the maximum annual release is 17.16 maf, and occurs under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative. In general, the observed annual release volumes under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative are similar to those observed under the No Action Alternative. The annual releases observed under the Water Supply Alternative are generally higher than those observed under the No Action Alternative. The annual releases observed under the Reservoir Storage Alternative are generally lower than those observed under the No Action Alternative.

Figure 4.3-29
Hoover Dam Annual Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th and 10th Percentile Values

90th Percentile



50th Percentile



10th Percentile

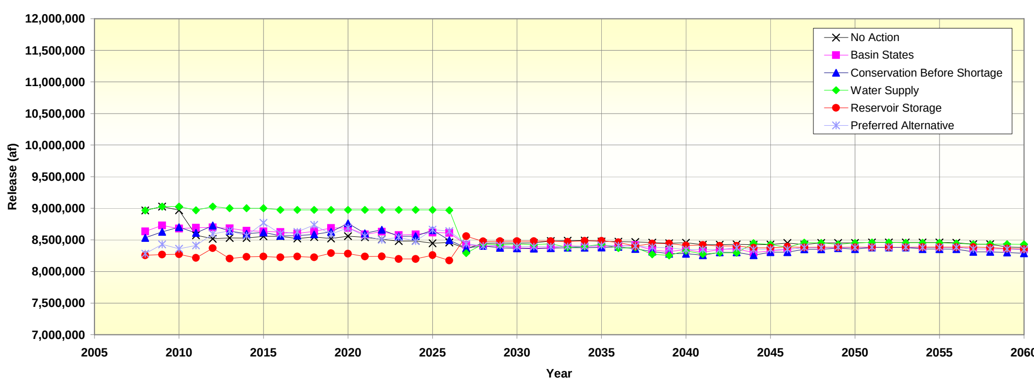


Figure 4.3-30
Hoover Dam Cumulative Annual Releases
Comparison of Action Alternatives to No Action Alternative
Years 2008 through 2026

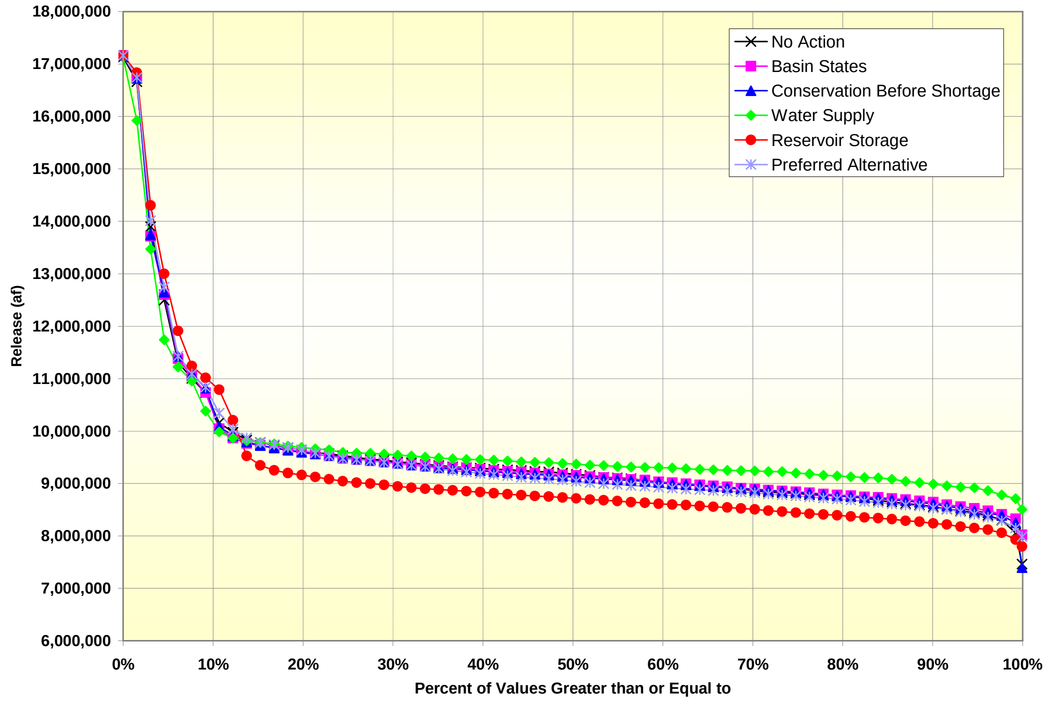


Figure 4.3-31 illustrates the cumulative distribution of Hoover Dam annual releases under the action alternatives and the No Action Alternative for years 2008 through 2060. The observed annual releases under all the alternatives (including the No Action Alternative) fluctuate between 6.33 maf and about 17.2 maf. The minimum annual release is 6.33 maf and occurs under the Water Supply Alternative, although it only occurs less than one percent of the time.

Figure 4.3-31
Hoover Dam Cumulative Annual Releases
Comparison of Action Alternatives to No Action Alternative
Years 2008 through 2060

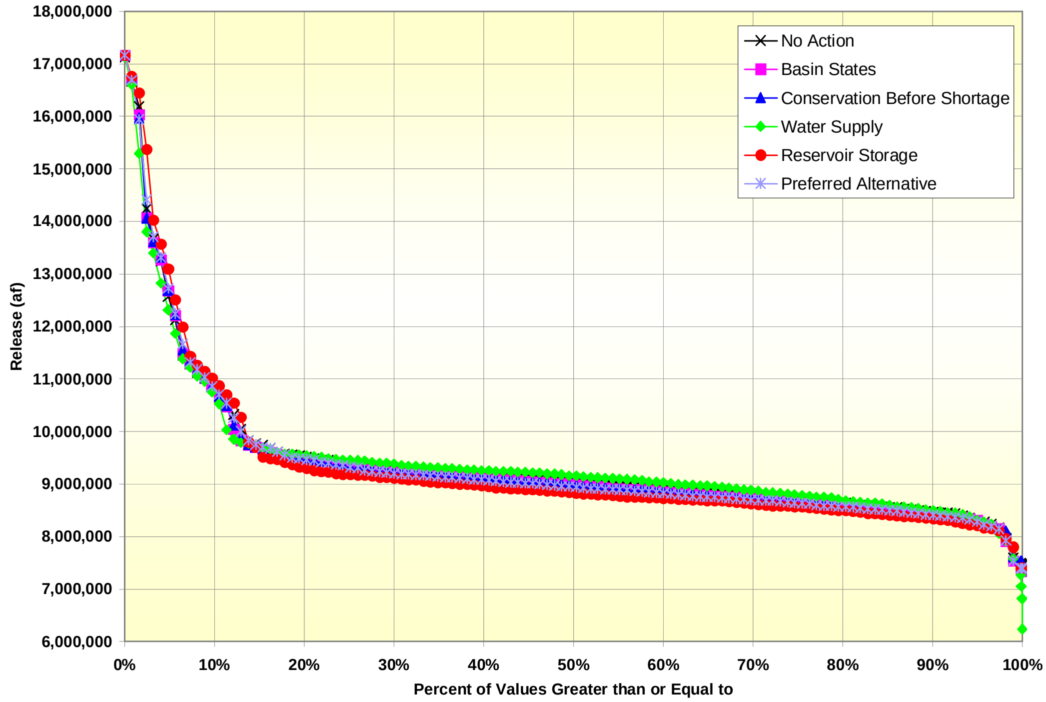


Table 4.3-30 and Table 4.3-31 provide a summary of the distribution of the Hoover Dam releases within different flow ranges of interest over the periods 2008 through 2026 and 2008 through 2060, respectively.

As shown in Table 4.3-30, the frequency of Hoover Dam releases greater than 10.0 mafy are similar under all the alternatives. The greatest variability between the action alternatives and the No Action Alternative occurs in the range of 8.01 to 10.0 mafy. The Water Supply Alternative generally provides higher annual release volumes and this is made apparent in Table 4.3-30 by the high frequency of releases in the range of 9.01 to 10.0 mafy. In contrast, the Reservoir Storage Alternative provides the lowest annual releases as illustrated by the percentage of annual releases less than 9.0 mafy.

Table 4.3-30
Hoover Dam Annual Releases
Probability of Occurrence of Different Annual Release Volumes (percent)
Comparison of Action Alternatives to No Action Alternative
Years 2008 through 2026

Hoover Dam Release Volumes	Alternative					
	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Greater than 10.0 mafy	11.89	11.26	11.16	10.68	12.79	12.58
Between 9.01 to 10.0 mafy	48.53	50.47	49.42	78.68	14.26	40.53
Between 8.01 to 9.00 mafy	39.05	38.26	39.26	10.63	71.58	46.74
Less than or equal to 8.00 mafy	0.53	0.00	0.16	0.00	1.37	0.16
Total	100.0	100.0	100.0	100.0	100.0	100.0

As provided in Table 4.3-31 for the modeled period between 2008 to 2060, Hoover Dam releases in the range of 8.01 mafy to 10.0 mafy differ mostly under the Water Supply and Reservoir Storage Alternatives. The Water Supply Alternative provides more frequent annual releases greater than 9.0 mafy and the Reservoir Storage Alternative provides annual releases equal to or greater than 9.0 mafy less often as compared to the No Action Alternative and the other action alternatives. The other action alternatives are similar to the No Action Alternative.

Table 4.3-31
Hoover Dam Annual Releases
Probability of Occurrence of Different Annual Release Volumes (percent)
Comparison of Action Alternatives to No Action Alternative
Years 2008 through 2060

Hoover Dam Release Volumes	Alternative					
	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Greater than 10.0 mafy	13.17	12.49	12.43	11.47	13.60	12.98
Between 9.01 to 10.0 mafy	38.00	36.94	36.53	49.85	24.47	33.45
Between 8.01 to 9.00 mafy	46.60	48.51	49.81	36.30	60.00	51.49
Less than or equal to 8.00 mafy	2.23	2.06	1.23	2.38	1.92	2.08
Total	100.0	100.0	100.0	100.0	100.0	100.0

4.3.5.1 Lake Mohave Water Levels

Lake Mohave is operated under a rule curve that provides specific target elevations at the end of each month (Section 3.3). The same rule curve would be used and applied in future operations under the action alternatives and the No Action Alternative. Therefore, Lake Mohave end-of-month elevations are not affected by the proposed federal action.

4.3.6 Davis Dam to Parker Dam

4.3.6.1 River Flows

River flows between Davis Dam and Parker Dam are comprised mainly of releases from Davis Dam (Lake Mohave) and tributary inflows from the Bill Williams River. During the 10-year period between 1996 and 2005, the annual Davis Dam releases have ranged between 8.1 maf and 12.6 maf and averaged 10.2 maf. Releases greater than 9.5 maf generally correspond to years when surplus or flood flow releases are made at Hoover Dam and are passed through Lake Mohave. Flows less than 8.5 maf are associated with voluntary or involuntary delivery reductions to water users in the Lower Basin.

Figure 4.3-32 presents a comparison of the 90th, 50th, and 10th percentile values for Davis Dam observed for the action alternatives to those under the No Action Alternative. The values and variability of the 90th, 50th, and 10th percentile values under the No Action Alternative and action alternatives are similar to those in Figure 4.3-29 (Hoover Dam releases) because the releases from Hoover Dam are passed through Lake Mohave. The differences are mostly due to losses attributed to evaporation at Lake Mohave, which would be the same in all of the alternatives due to rule curve operations.

Figure 4.3-33 illustrates the cumulative distribution of the Davis Dam releases for the No Action Alternative and the action alternatives during the interim period (2008 through 2060). The range and frequency of the releases under the different alternatives are similar to those shown for Hoover Dam in Figure 4.3-30. Again, the reason for this is that releases from Hoover Dam are essentially passed through Lake Mohave to meet downstream demands.

Figure 4.3-34 illustrates the cumulative distribution of the Davis Dam releases for the No Action Alternative and the action alternatives for the period 2008 through 2060. The range and frequency of the releases under the different alternatives are similar to those shown for Hoover Dam in Figure 4.3-31.

4.3.6.2 Colorado River Annual Flows Near Havasu NWR

A point located immediately downstream of the Havasu NWR was used to further analyze the river flows for this reach.

The 90th, 50th, and 10th percentile annual flow volumes at this point are shown in Figure 4.3-35. These river flows show the same general patterns that were observed in the corresponding plots for Hoover Dam and Davis Dam releases (Figure 4.3-29 and Figure 4.3-32 respectively) since those dams are operated, except during flood control operations, to meet downstream demands. The differences in magnitudes between the releases from Hoover Dam, releases from Davis Dam, and flows near Havasu NWR are due to evaporation loss at Lake Mohave (which would be the same in all of the alternatives due to rule curve operations) and the relatively small diversions along this stretch of the river.

Figure 4.3-32
Davis Dam Annual Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

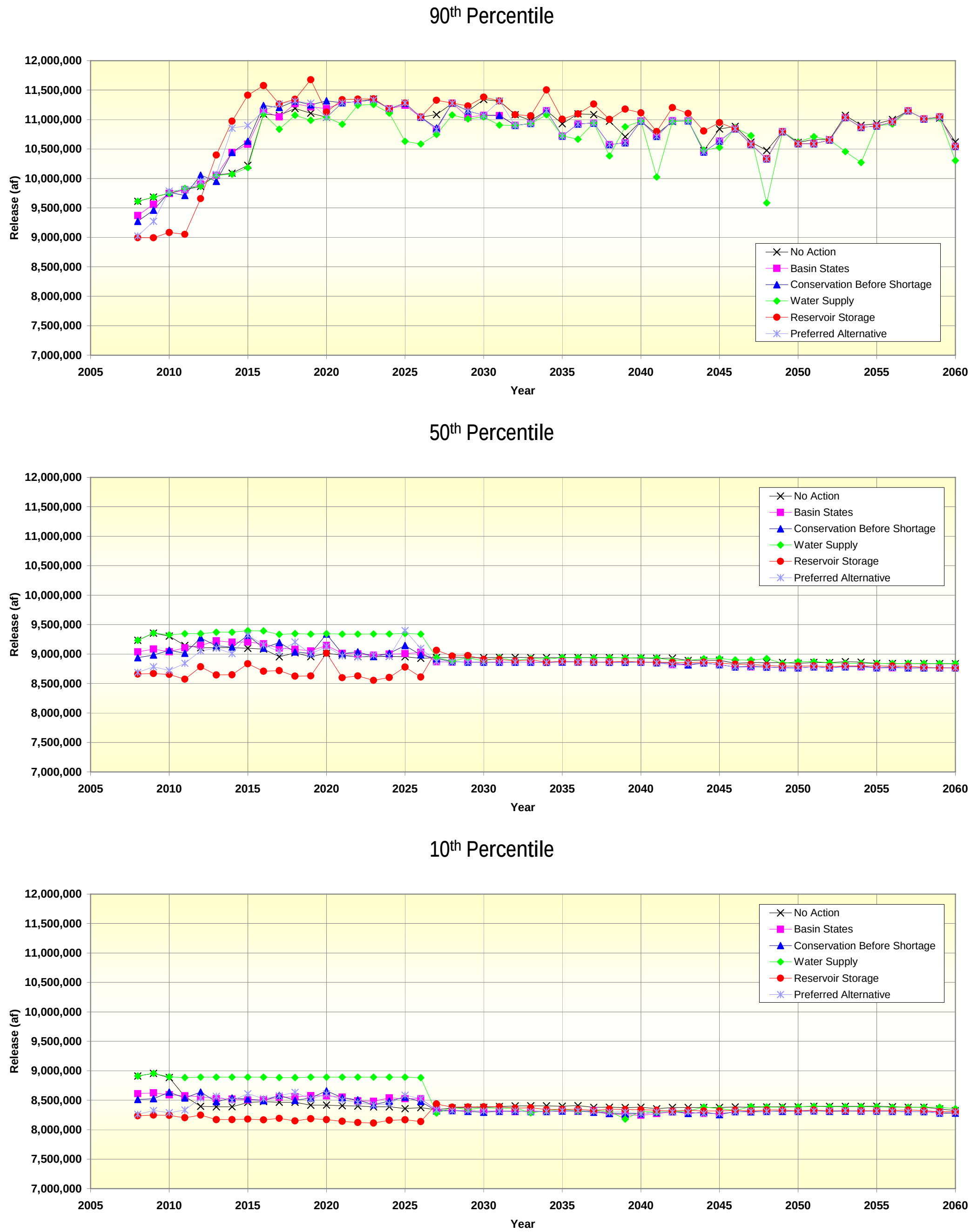


Figure 4.3-33
Davis Dam Cumulative Annual Releases
Comparison of Action Alternatives to No Action Alternative
Years 2008 through 2026

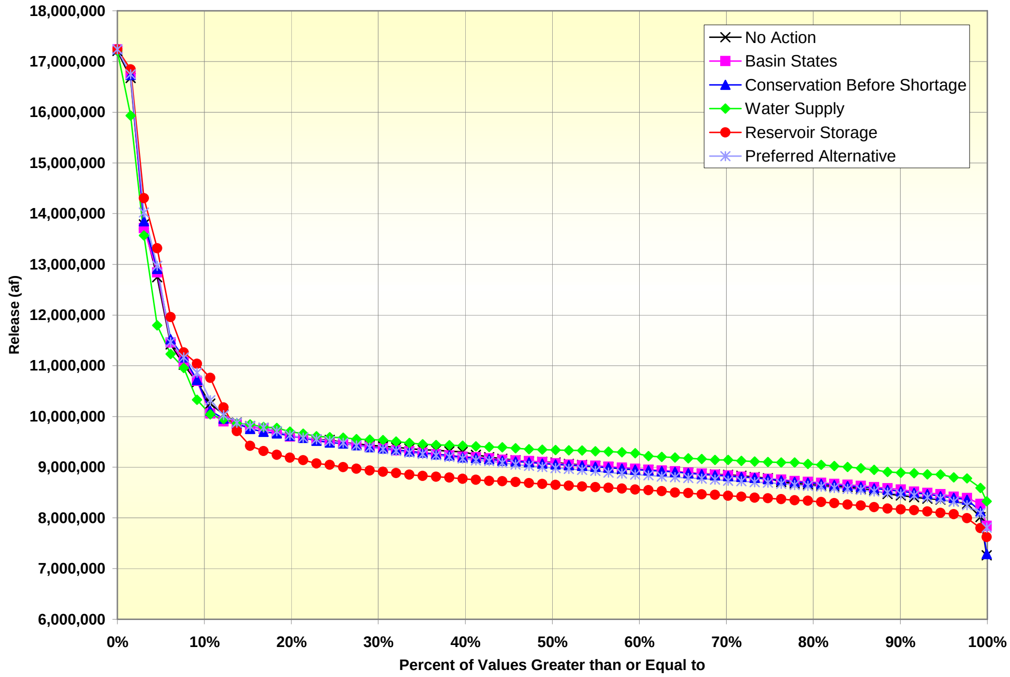


Figure 4.3-34
Davis Dam Cumulative Annual Releases
Comparison of Action Alternatives to No Action Alternative
Years 2008 through 2060

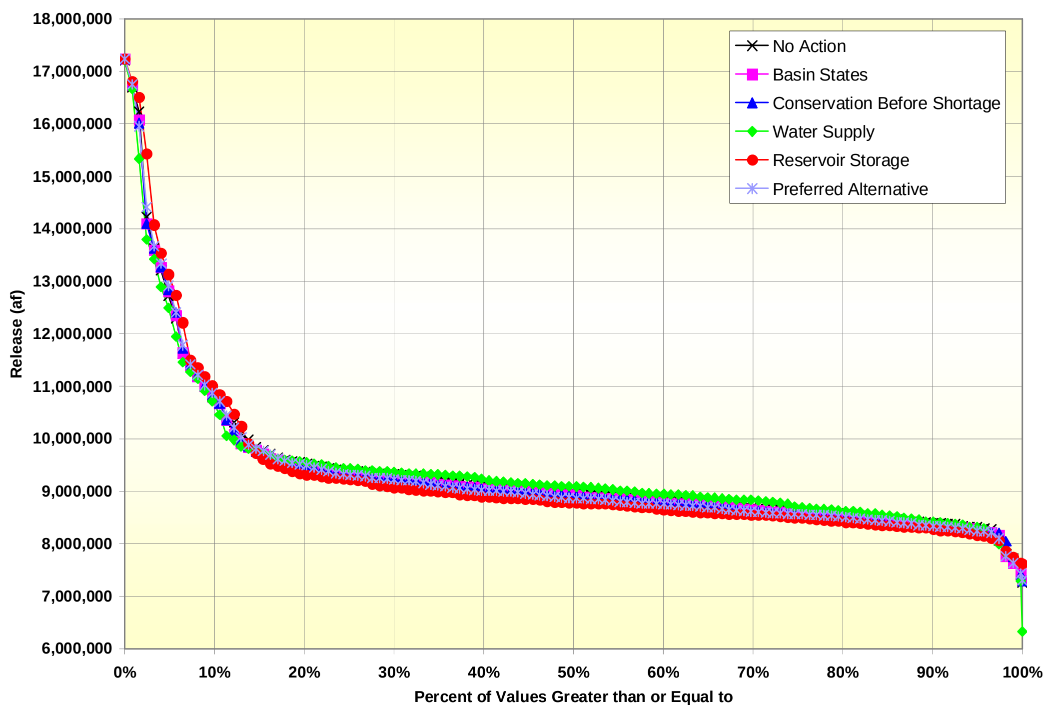
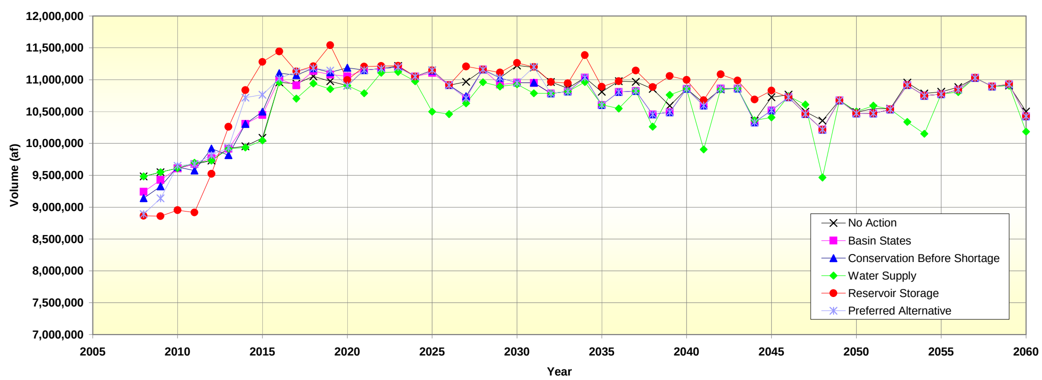
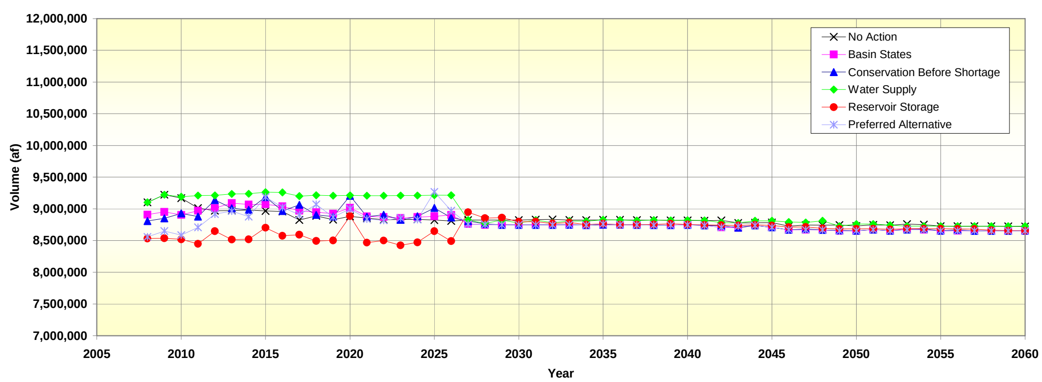


Figure 4.3-35
Colorado River Annual Flow Near Havasu NWR - RM 242.3
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

90th Percentile



50th Percentile



10th Percentile

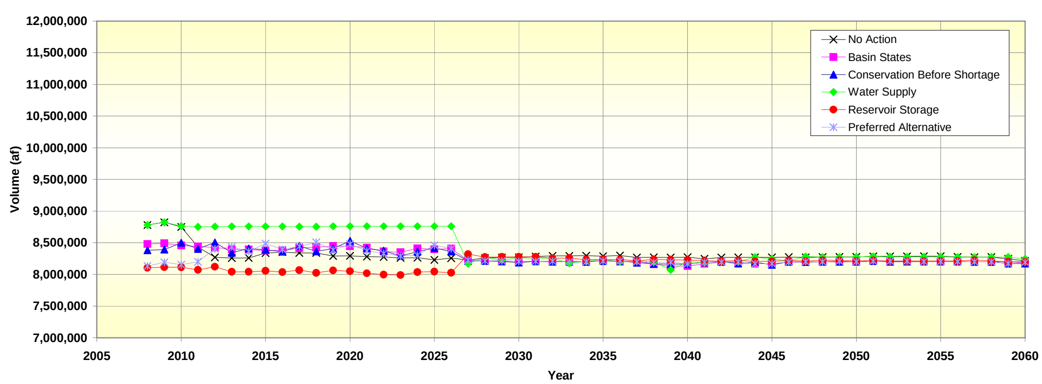


Table 4.3-32 provides a comparison of the 90th, 50th, and 10th percentile annual flow volumes between the action alternatives and the No Action Alternative for selected years.

Table 4.3-32
Colorado River Annual Flow Near Havasu NWR - RM 242.3 (maf)
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Alternative	Year 2016			Year 2026			Year 2040			Year 2060		
	90th	50th	10th	90th	50th	10th	90th	50th	10th	90th	50th	10th
No Action	10.959	8.957	8.350	10.913	8.809	8.256	10.858	8.818	8.271	10.501	8.721	8.214
Basin States	11.010	9.039	8.379	10.913	8.905	8.408	10.858	8.753	8.131	10.426	8.652	8.192
Conservation Before Shortage	11.104	8.967	8.360	10.916	8.862	8.363	10.858	8.746	8.162	10.426	8.654	8.172
Water Supply	10.959	9.260	8.758	10.460	9.215	8.759	10.858	8.821	8.198	10.185	8.727	8.247
Reservoir Storage	11.443	8.576	8.037	10.919	8.491	8.025	10.996	8.753	8.227	10.426	8.654	8.199
Preferred Alternative	11.015	9.023	8.395	10.913	8.971	8.407	10.858	8.746	8.166	10.426	8.652	8.192

4.3.6.3 Groundwater

Flows in the Davis Dam to Parker Dam reach are primarily composed of water released from Davis Dam (Section 3.3). Therefore, the annual median releases are representative of the annual median flows in this reach. When converted to stage, a comparison of the annual median releases for each alternative may be used as the indicator to analyze potential effects to groundwater adjacent to the river in this reach.

Figure 4.3-36 illustrates the annual median releases from Davis Dam for each alternative for the years 2008 through 2060. These are the same data shown in Figure 4.3-32 converted from acre-feet per year to cubic feet per second. In general, the median releases for the Water Supply and Reservoir Storage Alternatives bracket the median releases for the other four alternatives due primarily to the different shortage assumptions for each of the alternatives.

Table 4.3-33 compares the annual median values relative to the No Action Alternative for specific years (each action alternative value less the No Action Alternative value). Using appropriate relationships to convert flow-to-stage (LCR MSCP BA [Reclamation 2004c], Appendix J, Attachment D), these relative flow differences would result in minor reductions in river stage (on the order of 0.5 feet). Based on the relationships used in the LCR MSCP BA, Appendix K, such river stage reductions would result in corresponding reductions in groundwater elevations adjacent to the river (approximately 0.25 feet to 0.5 feet for gaining and losing reaches respectively).

Figure 4.3-36
Davis Dam Annual Releases
Comparison of Action Alternatives to No Action Alternative
Annual Median (50th Percentile) Values

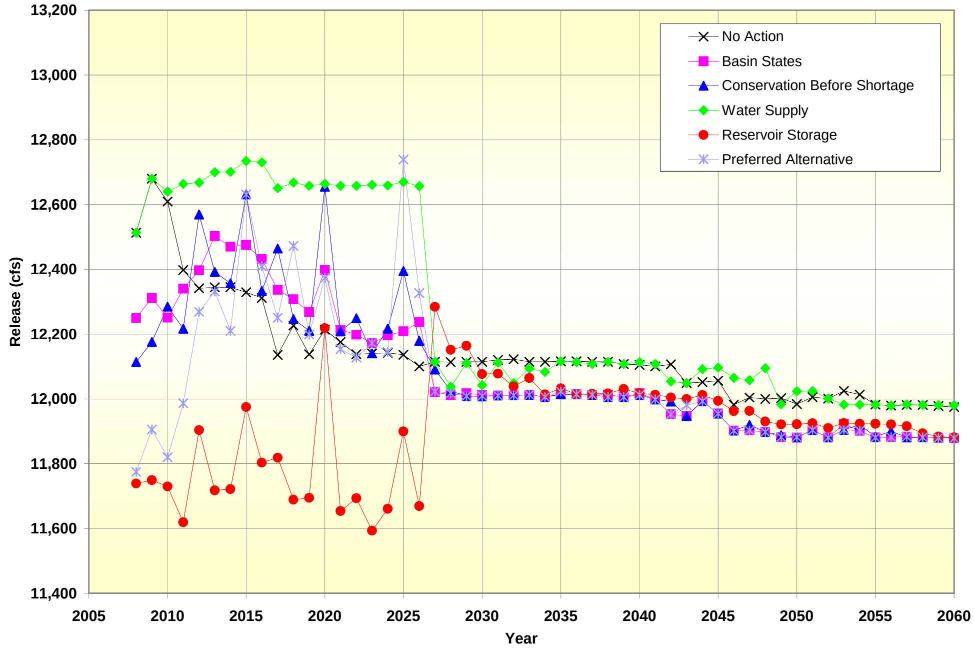


Table 4.3-33
Davis Dam Annual Median Releases
Differences of Action Alternatives Compared to No Action Alternative[1] (cfs)

Year	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008	(264)	(399)	0	(774)	(738)
2011	(57)	(181)	266	(779)	(412)
2016	119	21	418	(509)	97
2017	201	329	515	(318)	114
2026	137	79	557	(431)	227
2027	(93)	(24)	0	170	(91)
2040	(88)	(93)	8	(88)	(93)
2060	(96)	(94)	5	(94)	(96)

1 *Value of the action alternative minus the value from the No Action Alternative provides the difference shown. Values shown in parenthesis indicate that the value under the action alternative is lower than that of the No Action Alternative, i.e. a flow reduction.*

4.3.6.4 Lake Havasu Elevations

Similar to Lake Mohave, Lake Havasu is also operated under a rule curve. This method of operation provides specific target elevations at the end of each month (Section 3.3). The same rule curve would be used and applied in the future operations under the action alternatives and the No Action Alternative. Therefore, end-of-month elevations of Lake Havasu are not affected by the proposed federal action.

4.3.7 Parker Dam to Cibola Gage and Cibola Gage to Imperial Dam

Parker Dam provides the last opportunity to re-regulate Hoover Dam releases because Lake Havasu is the last facility in the lower Colorado River with significant storage (Section 3.3). Releases from Parker Dam are made primarily to meet downstream water demands. Once released from Parker Dam, the flow is essentially unregulated until it reaches Imperial Dam.

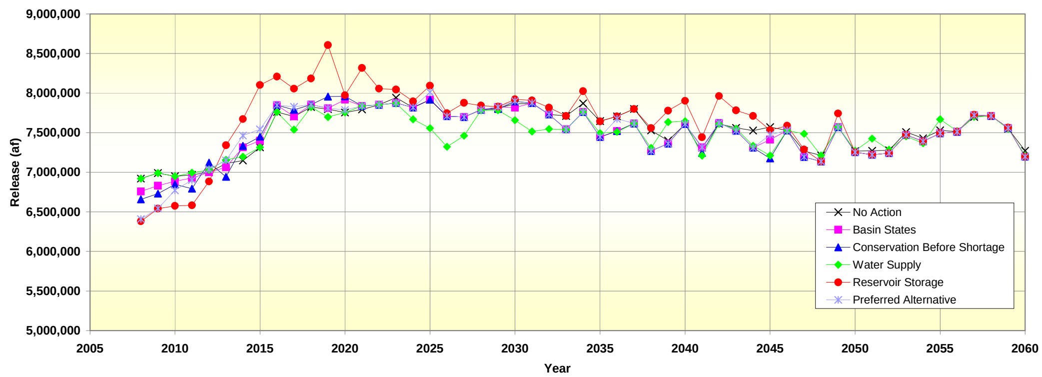
4.3.7.1 River Flows

The river flows in this reach are essentially the releases from Parker Dam. Releases greater than 7.0 maf generally correspond to years when flood flow releases are being made from Hoover Dam and these flows are passed through Davis Dam and Parker Dam. Releases less than 6.0 maf are generally associated with delivery reductions, which occur more frequently under the Conservation Before Shortage and Reservoir Storage Alternatives than under the No Action Alternative.

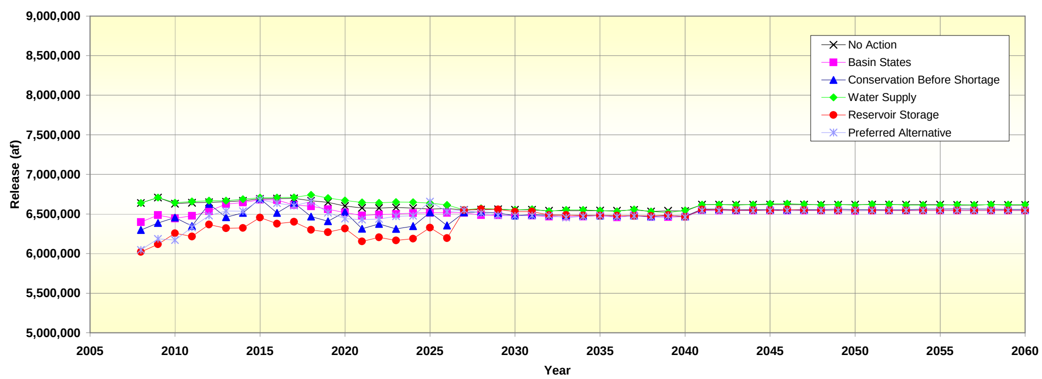
Figure 4.3-37 presents a comparison of the 90^{th}, 50^{th}, and 10^{th} percentile lines for Parker Dam annual releases under the action alternatives and the No Action Alternative. The 90^{th} percentile values represent releases due to flood control operations. The Reservoir Storage Alternative tends to release greater volumes during flood control when compared to the other alternatives since it keeps Lake Mead elevations higher. Beyond year 2045 all flow volumes converged to a release of about 7.40 maf. At the 50^{th} percentile, the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative had less release volume than the No Action Alternative until the year 2026 due to a combination of the assumptions under each of those alternatives with regard to shortages and participation in the storage and delivery mechanism. The Water Supply Alternative generally released more volume over that same period. At year 2027, all alternatives converged to about 6.50 maf, with differences due to the assumption that SNWA would develop additional non-system water supplies that are permanent. The comparison of the 10^{th} percentile showed similar results that mirror the 50^{th} percentile values, except the release volumes were about 6.25 maf.

Figure 4.3-37
Parker Dam Annual Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

90th Percentile



50th Percentile



10th Percentile

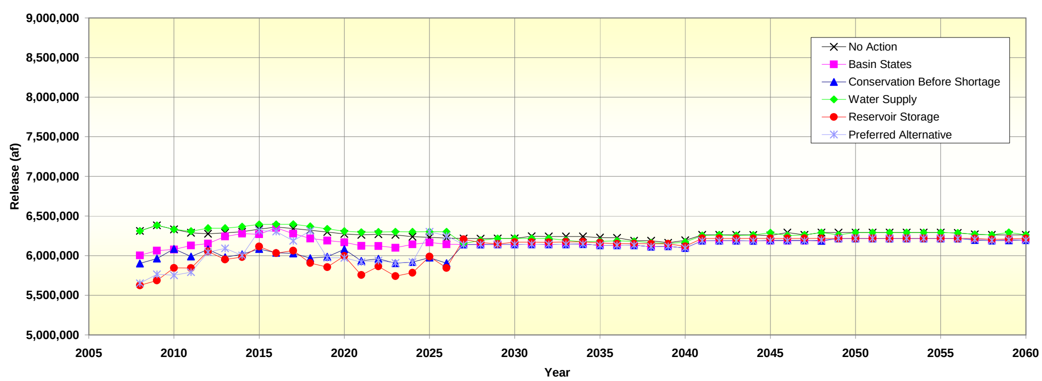


Figure 4.3-38 illustrates the cumulative distribution for Parker Dam annual releases for the interim period (2008 through 2026). The releases under the No Action Alternative range between 14.0 maf to 6.0 maf. The maximum annual releases under the action alternatives are similar to those of the No Action Alternative. The minimum annual release of 5.35 maf is observed under the Reservoir Storage Alternative. The Reservoir Storage Alternative generally provides the lowest annual releases while the Water Supply Alternative generally provides the highest annual releases of the action alternatives.

Figure 4.3-38
Parker Dam Cumulative Annual Releases
Comparison of Action Alternatives to No Action Alternative
Years 2008 through 2026

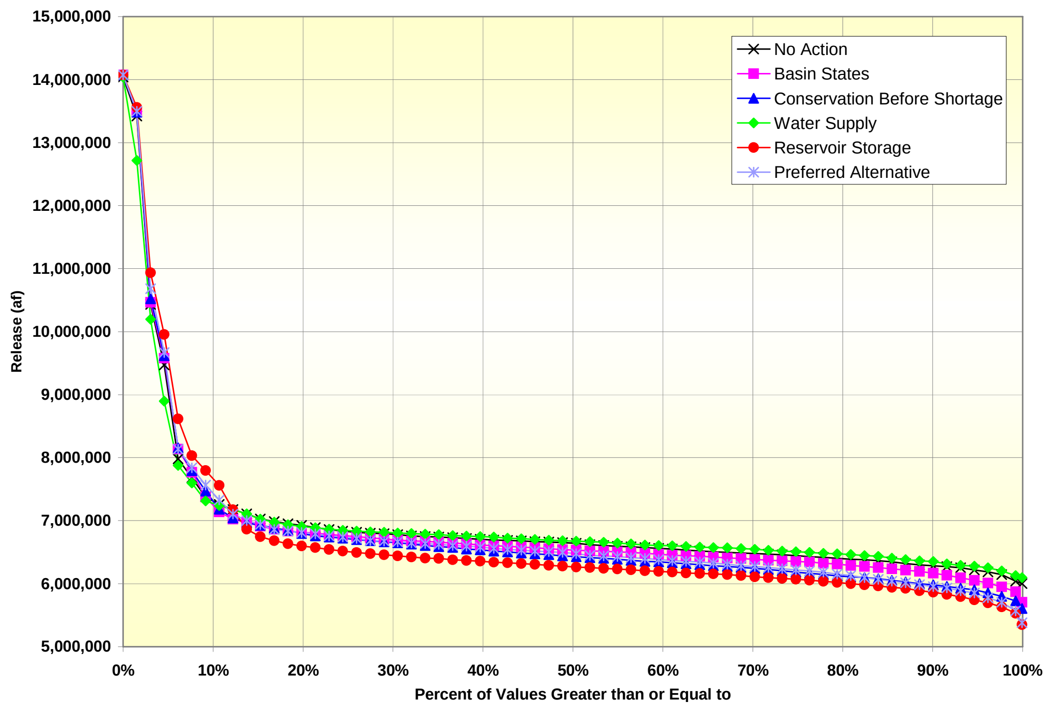
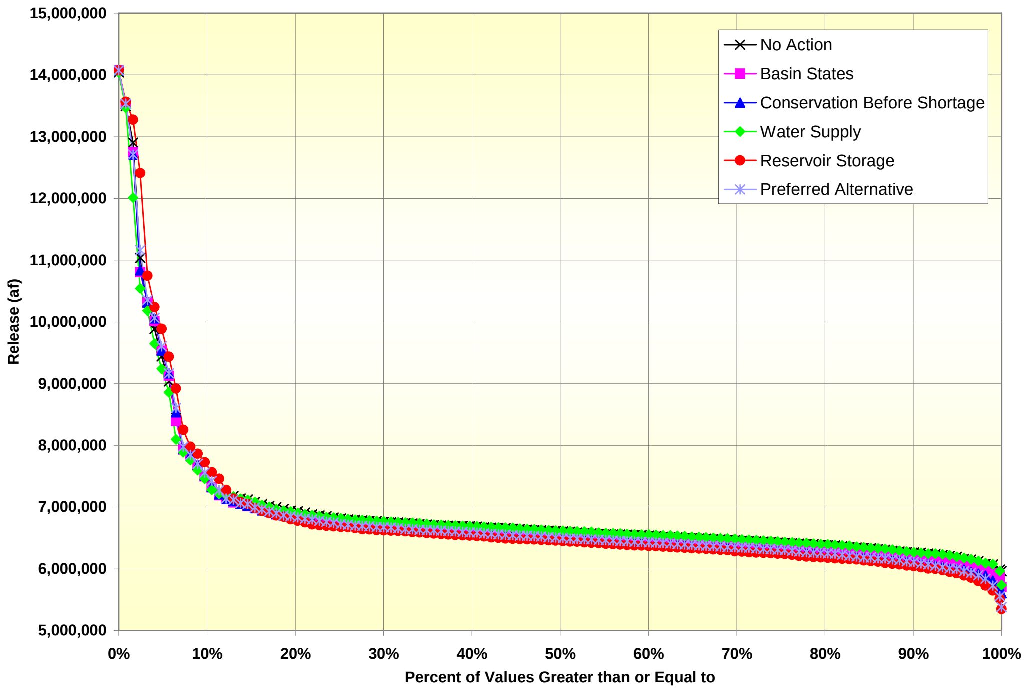


Figure 4.3-39 illustrates the cumulative distribution for the Parker Dam annual releases for the period of 2008 through 2060. The observed annual releases under all alternatives (including the No Action Alternative) fluctuate between approximately 14.0 maf to 5.35 maf. The lowest annual releases of 5.35 maf and 5.38 maf were observed under the Reservoir Storage Alternative and the Preferred Alternative, respectively.

Figure 4.3-39
Parker Dam Cumulative Annual Releases
Comparison of Action Alternatives to No Action Alternative
Years 2008 through 2060



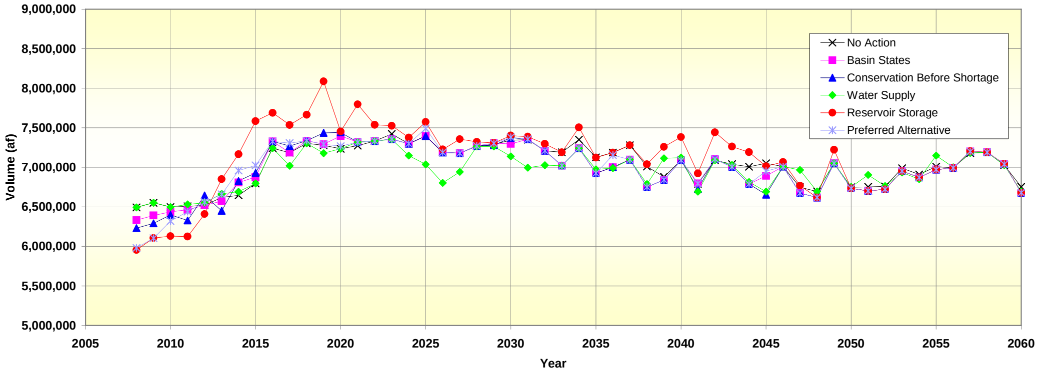
River Flows Near the Colorado River Indian Reservation. Two other points on the Colorado River were used to analyze flows in the reach between Parker Dam and Imperial Dam. These include a point located immediately upstream of the Colorado River Indian Reservation (CRIR) and a point located immediately downstream of the Palo Verde Diversion Dam.

The CRIR diversion is located at Headgate Rock Dam, approximately 14 miles downstream of Parker Dam. Flows in this reach of the river result primarily from releases at Parker Dam and would be affected by delivery reductions to water users located downstream from this location.

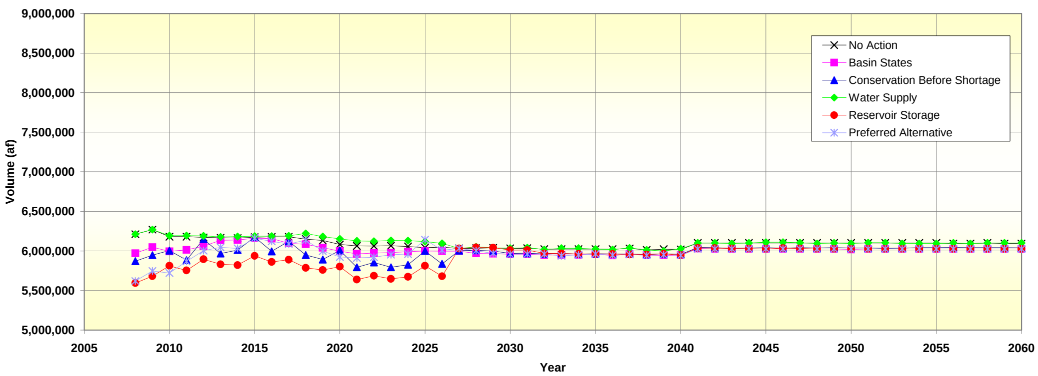
Figure 4.3-40 illustrates that the 90th, 50th, and 10th percentile annual flow values at this location generally reflect the releases from Parker Dam, as shown on Figure 4.3-38 and Figure 4.3-39. Since there is no significant storage capacity above Headgate Rock Dam, the differences between the flows at this location and the Parker Dam releases are due only to the attenuation of the flows that occurs in the 14 miles of river within this reach.

Figure 4.3-40
Colorado River Annual Flow Upstream of CRIR Diversion - RM 180.8
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

90th Percentile



50th Percentile



10th Percentile

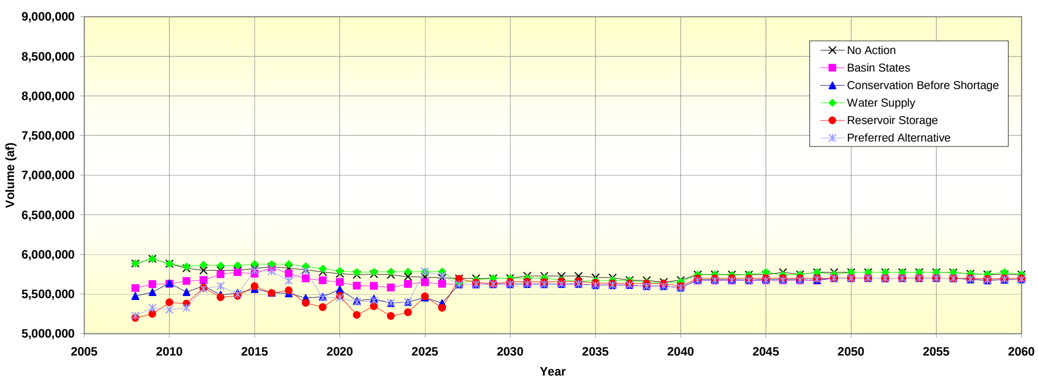


Table 4.3-34 provides a comparison of the 90th, 50th, and 10th percentile annual flow volumes upstream of the CRIR Diversion among the alternatives for selected years.

Table 4.3-34
Colorado River Annual Flow Upstream of CRIR Diversion - RM 180.8 (mafy)
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Alternative	Year 2016			Year 2026			Year 2040			Year 2060		
	90th	50th	10th	90th	50th	10th	90th	50th	10th	90th	50th	10th
No Action	7.242	6.177	5.845	7.188	6.048	5.703	7.089	6.019	5.676	6.753	6.093	5.746
Basin States	7.328	6.156	5.836	7.188	5.998	5.628	7.089	5.945	5.580	6.678	6.025	5.687
Conservation Before Shortage	7.328	5.993	5.517	7.188	5.837	5.386	7.089	5.956	5.582	6.678	6.040	5.686
Water Supply	7.242	6.187	5.876	6.802	6.094	5.782	7.123	6.026	5.655	6.693	6.100	5.746
Reservoir Storage	7.688	5.680	5.513	7.226	5.679	5.325	7.381	5.946	5.601	6.678	6.025	5.699
Preferred Alternative	7.328	6.119	5.787	7.188	6.009	5.733	7.089	5.944	5.580	6.678	6.025	5.686

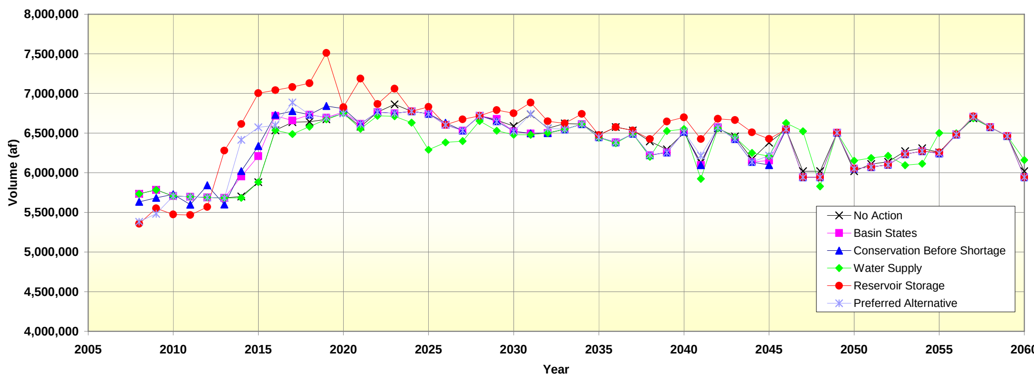
River Flows Downstream of the Palo Verde Diversion Dam. The flow of the Colorado River between Palo Verde Diversion Dam and Imperial Dam is normally the amount needed to meet both the consumptive use requirements in the United States downstream of the Palo Verde Diversion Dam and deliveries to Mexico. The river location that was used to analyze the flows in the reach of the river between Palo Verde Diversion and Imperial Dam is located immediately downstream of the Palo Verde Diversion.

The 90th, 50th, and 10th percentile annual flow volumes for the Colorado River at this point are shown on Figure 4.3-41. The greatest variability between alternatives occurs during the interim period (2008 through 2026). After 2026, the action alternatives converge to the No Action Alternative.

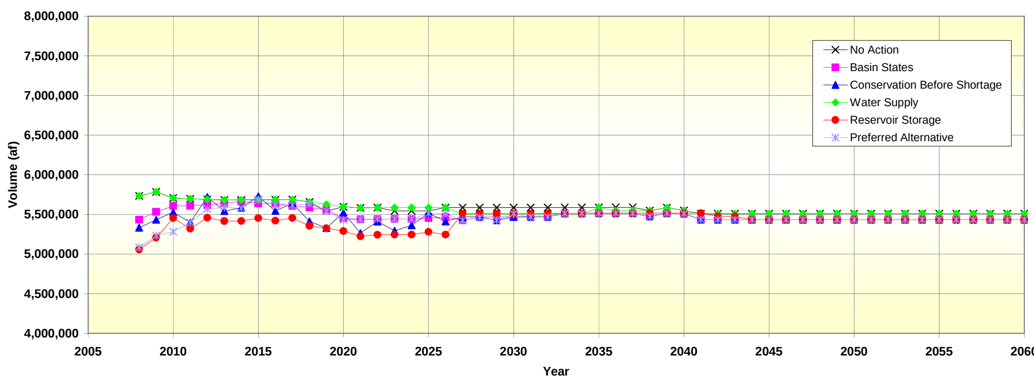
The 90th percentile flow volumes for the action alternatives were generally similar to those of the No Action Alternative, although there was some variability observed under the Water Supply and Reservoir Storage Alternatives. The greatest variability occurs during the interim period and reflects the difference in the assumptions with regard to shortage and water conservation. The 50th percentile annual flow volumes for all alternatives are generally similar with the Reservoir Storage Alternative having the lowest values. At the 10th percentile level, the Water Supply Alternative shows slightly higher flow volumes compared to the No Action Alternative. The Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative show progressively lower flow volumes than the No Action Alternative.

Figure 4.3-41
Colorado River Annual Flow Downstream of Palo Verde Diversion Dam - RM 133.8
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

90th Percentile



50th Percentile



10th Percentile

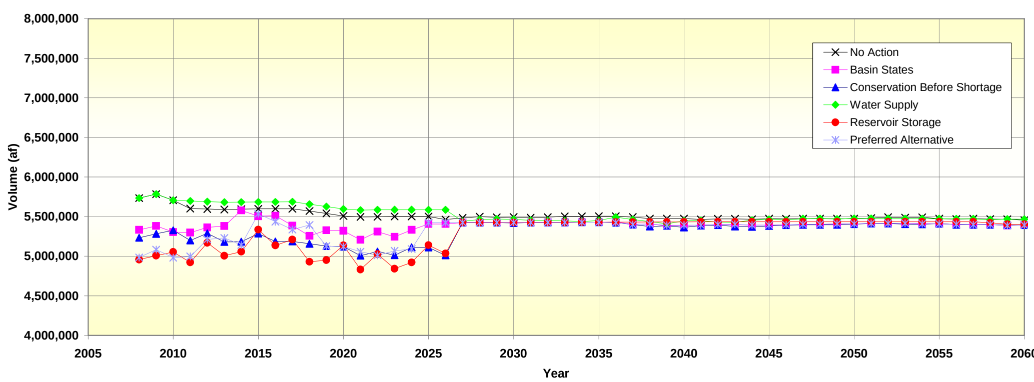


Table 4.3-35 provides a comparison of the 90th, 50th, and 10th percentile annual flow volumes downstream of the Palo Verde Diversion Dam.

Table 4.3-35
Colorado River Annual Flow Downstream of Palo Verde Diversion Dam - RM 133.8 (mafy)
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Alternative	Year 2016			Year 2026			Year 2040			Year 2060		
	90th	50th	10th	90th	50th	10th	90th	50th	10th	90th	50th	10th
No Action	6.536	5.685	5.598	6.605	5.586	5.463	6.506	5.549	5.475	6.019	5.509	5.455
Basin States	6.717	5.639	5.510	6.602	5.465	5.406	6.516	5.510	5.388	5.944	5.434	5.393
Conservation Before Shortage	6.730	5.544	5.185	6.631	5.411	5.011	6.516	5.510	5.363	5.944	5.434	5.393
Water Supply	6.536	5.685	5.685	6.382	5.586	5.586	6.550	5.549	5.446	6.160	5.509	5.466
Reservoir Storage	7.041	5.419	5.137	6.605	5.244	5.034	6.699	5.514	5.432	5.943	5.434	5.403
Preferred Alternative	6.598	5.616	5.435	6.602	5.511	5.423	6.516	5.510	5.392	5.944	5.434	5.393

4.3.7.2 Groundwater

Flows in the Parker Dam to Imperial Dam reach are primarily composed of water released from Parker Dam and therefore, the annual median releases are representative of the annual median flows in each reach (Section 3.3). When converted to stage, a comparison of the annual median releases for each alternative may be used as the indicator to analyze potential effects to groundwater adjacent to the river in this reach.

Figure 4.3-42 illustrates the annual median releases from Parker Dam for the action alternatives and the No Action Alternative for 2008 through 2060. As was the case for the Davis Dam releases, the median releases for the Water Supply and Reservoir Storage Alternatives bracket the median releases for the other four alternatives due primarily to the different shortage assumptions for each of the alternatives. Table 4.3-36 compares the annual median values of the action alternatives relative to the No Action Alternative for specific years (each action alternative value less the No Action Alternative value). Using appropriate relationships to convert flow-to-stage (LCR MSCP BA, Appendix J, Attachment D), these relative flow differences would result in minor reductions in river stage (on the order of 0.25 feet). Based on the relationships used in the LCR MSCP BA, Appendix K, such river stage reductions would result in corresponding reductions in groundwater elevations adjacent to the river (approximately 0.15 feet to 0.30 feet reduction for gaining and losing reaches, respectively).

Figure 4.3-42
Parker Dam Annual Releases
Comparison of Action Alternatives to No Action Alternative
Annual Median (50th Percentile) Values

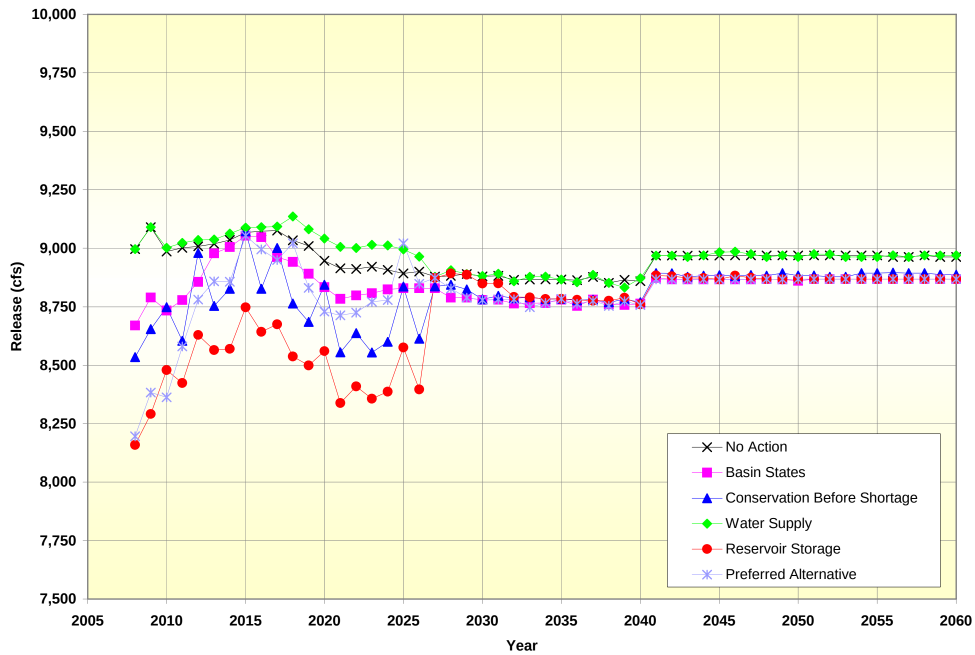


Table 4.3-36
Parker Dam Annual Median Releases
Differences of Action Alternatives Compared to No Action Alternative[1], (cfs)

Year	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008	(327)	(462)	0	(837)	(801)
2011	(224)	(398)	21	(578)	(422)
2016	(25)	(246)	17	(430)	(78)
2017	(114)	(75)	17	(401)	(126)
2026	(72)	(288)	64	(504)	(52)
2027	(50)	(420)	(1)	(6)	(6)
2040	(96)	(90)	13	(99)	(102)
2060	(95)	(76)	7	(95)	(95)

1 Value of the action alternative minus the value from the No Action Alternative provides the difference shown. Values shown in parenthesis indicate that the value under the action alternative is lower than that of the No Action Alternative, i.e. a flow reduction.

4.3.8 Imperial Dam to NIB

Most of the water delivered to Mexico is diverted at Imperial Dam, conveyed via the AAC, and then returned to the Colorado River through the Pilot Knob and Siphon Drop Powerplants and their respective wasteway channels, 2.1 miles and 7.6 miles upstream of the NIB, respectively (Section 3.3). The proposed federal action will not alter the operation of these diversions and wasteways and therefore, will not have an effect on this river reach.

4.3.9 NIB to SIB

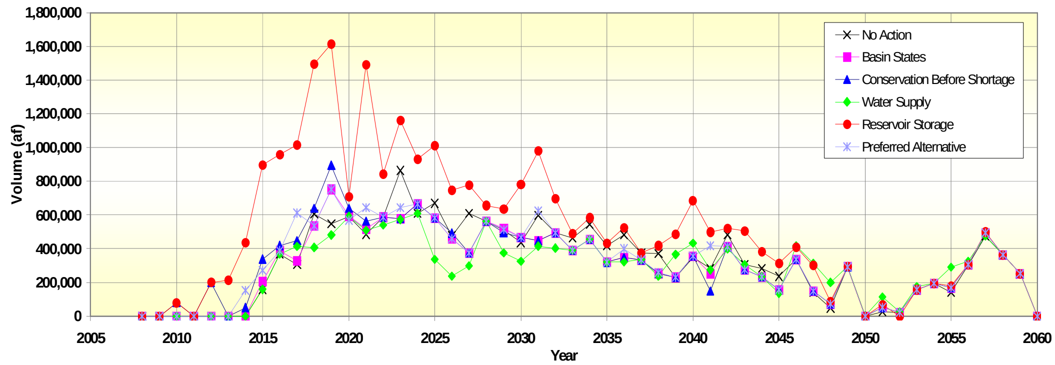
Mexico diverts most of its Colorado River water supply at the Morelos Diversion Dam, and except during flood control operations, only limited flows actually pass Morelos Diversion Dam (Section 3.3). During flood control operations, releases are made from Hoover Dam as dictated by the flood control criteria established with the USACE (Section 3.3). These releases are dependent upon the amount of available storage in the system (including Lake Powell and Lake Mead) and the hydrologic inflow forecast. The proposed federal action could potentially change the volume of water in storage in Lake Powell and Lake Mead, thereby affecting the frequency and/or volume of flood control releases.

In addition, the modeling assumptions used to model the storage and delivery mechanism for the Conservation Before Shortage and Reservoir Storage Alternatives could potentially alter the flows in this reach. It was assumed that water conservation activities in Mexico would result in conserved water that would be stored in Lake Mead and delivered on a periodic basis to Mexico through the NIB to the SIB reach. These modeling assumptions (described in Appendix M) were used in this Final EIS in order to analyze the potential impacts to resources of the storage and delivery mechanism, particularly with regard to reservoir elevations and river flow impacts. The use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, any storage/delivery arrangements would actually be implemented in the future. These modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. Details of these assumptions are discussed in Section 4.2 and Appendix M.

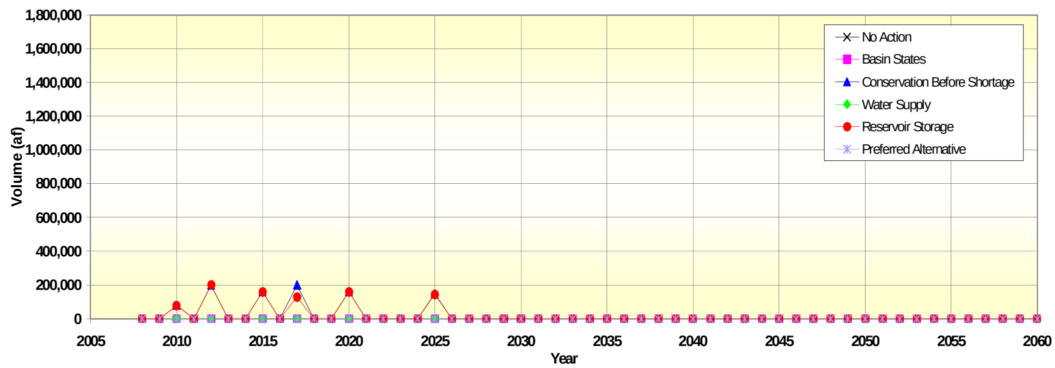
The 90th, 50th, and 10th percentile annual flow volumes for this reach are shown in Figure 4.3-43.

Figure 4.3-43
Colorado River Annual Flow Below Mexico Diversion at Morelos Diversion Dam - RM 21.1
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

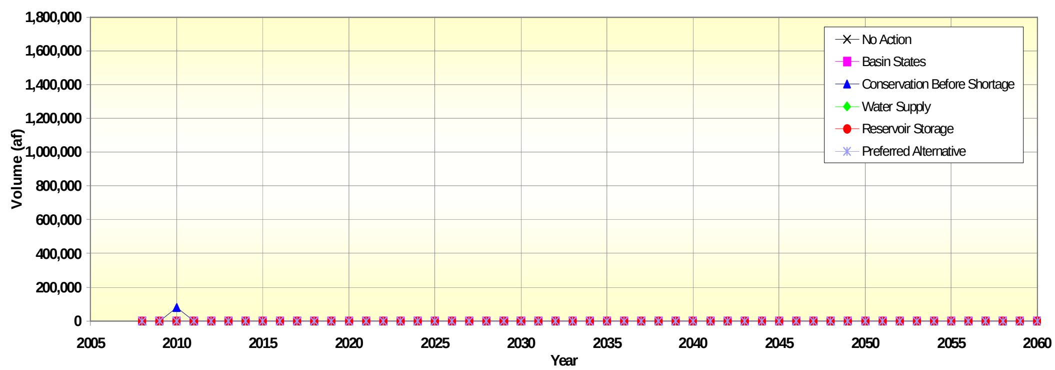
90th Percentile



50th Percentile



10th Percentile



Flows at the 90th percentile are produced by flood control operations. The values for the Reservoir Storage Alternative were generally greater than for the other alternatives due to higher reservoir levels. After 2048, the 90th percentile annual flow volumes are all similar. The 90th percentile annual flow volumes for the Water Supply Alternative were generally lower than the other alternatives through about 2030, whereas the volumes for the Reservoir Storage Alternative were higher through about 2045. Flows at the 50th percentile are comprised solely of non-flood control flows. The Basin States and Water Supply alternatives, and the No Action Alternative assume no activity with regard to delivery of conserved water to Mexico. The 50th percentile flows for the Conservation Before Shortage and Reservoir Storage Alternatives show intermittent annual flow volumes of from about 40 kaf to 200 kaf during the interim period. At the 10th percentile, the Conservation Before Shortage is the only alternative that shows an annual flow value that is greater than zero, in the year 2010 at a volume of 80 kaf.

Table 4.3-37 provides a comparison of the 90th, 50th, and 10th percentile annual flow volumes below the Mexico diversion at Morelos Diversion Dam between the action alternatives and No Action Alternative for selected years.

Table 4.3-37
Colorado River Annual Flow Below Mexico Diversion at Morelos Diversion Dam - RM 21.1 (maf)
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Alternative	Year 2016			Year 2026			Year 2040			Year 2060		
	90th	50th	10th	90th	50th	10th	90th	50th	10th	90th	50th	10th
No Action	0.367	0.000	0.000	0.477	0.000	0.000	0.347	0.000	0.000	0.000	0.000	0.000
Basin States	0.388	0.000	0.000	0.459	0.000	0.000	0.355	0.000	0.000	0.000	0.000	0.000
Conservation Before Shortage	0.418	0.000	0.000	0.493	0.000	0.000	0.355	0.000	0.000	0.000	0.000	0.000
Water Supply	0.367	0.000	0.000	0.237	0.000	0.000	0.432	0.000	0.000	0.000	0.000	0.000
Reservoir Storage	0.957	0.000	0.000	0.747	0.000	0.000	0.686	0.000	0.000	0.000	0.000	0.000
Preferred Alternative	0.388	0.000	0.000	0.459	0.000	0.000	0.355	0.000	0.000	0.000	0.000	0.000

Figure 4.3-44 shows the cumulative distribution for annual volumes of excess flows occurring below the Mexico diversion at the Morelos Diversion Dam for the interim period (2008 through 2026). At flows less than about 250 kaf, the differences are mostly due to the assumed delivery of conserved water to Mexico under the Conservation Before Shortage and Reservoir Storage Alternatives. Flows greater than about 250 kaf are the result of flood control operations at Lake Mead. As shown in Figure 4.3-44, the probability of excess flows of any magnitude under the No Action Alternative, Preferred Alternative, and the Basin States and Water Supply alternatives during the interim period are approximately nine to ten percent. The probability of excess flows of any magnitude under the Conservation Before Shortage and Reservoir Storage Alternatives are 33 and 30 percent, respectively.

Figure 4.3-44
Excess Flows Below Mexico Diversion at Morelos Diversion Dam
Comparison of Action Alternatives to No Action Alternative
Cumulative Distribution - Years 2008 through 2026

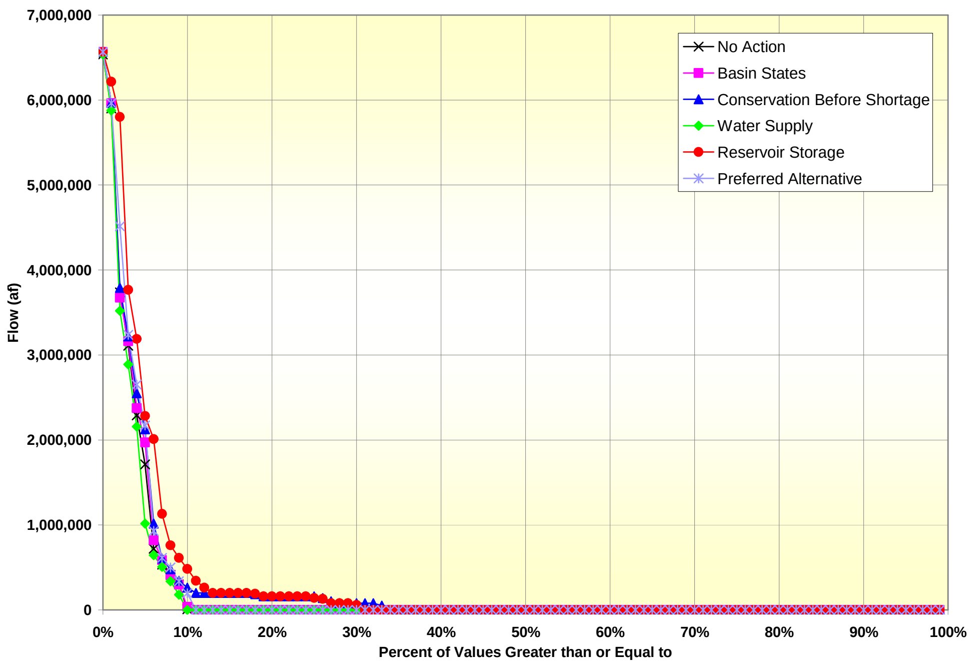
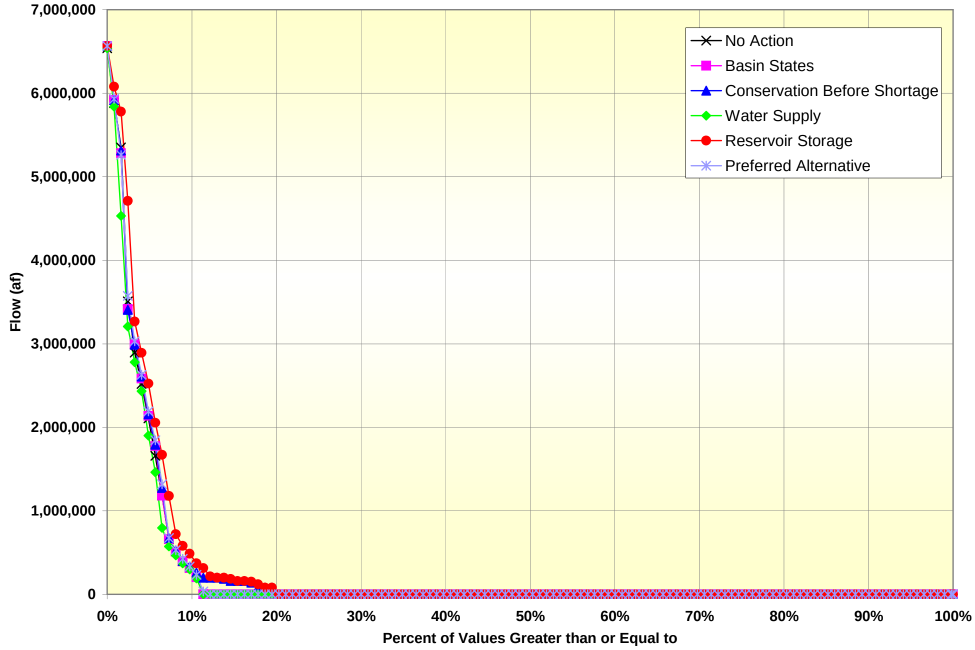


Figure 4.3-45 shows the cumulative distribution for annual volumes of excess flows below the Mexico diversion at Morelos Diversion Dam for the period between 2008 through 2060. Again, flows less than about 250 kaf are due to the assumed delivery of conserved water to Mexico under the Conservation Before Shortage and Reservoir Storage Alternatives and occur during the interim period only.

Figure 4.3-45
Excess Flows Below Mexico Diversion at Morelos Diversion Dam
Comparison of Action Alternatives to No Action Alternative
Cumulative Distribution - Years 2008 through 2060



4.3.10 Summary

The following conclusions were drawn from the analyses of hydrologic resources.

4.3.10.1 Reservoir Storage

The Water Supply Alternative generally provides lower Lake Powell elevations than the No Action Alternative. Conversely, the Reservoir Storage Alternative provides higher Lake Powell elevations than the No Action Alternative. The observed Lake Powell elevations under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative are similar to each other because these action alternatives assume the same operation at Lake Powell. The 50th and 10th percentile values of these three alternatives vary less than those of the Water Supply and Reservoir Storage Alternatives. The greatest difference in Lake Powell elevation between the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative relative to the No Action Alternative in any one year is about 33 feet occurring at the 10th percentile.

The Lake Mead 50th percentile elevations under the Water Supply Alternative are generally lower than those under the No Action Alternative. However, the Lake Mead 10th percentile elevations under the Water Supply Alternative vary and are sometimes higher and sometimes lower than those under the No Action Alternative. These fluctuations are due to balancing releases from Lake Powell that are greater than releases under the No Action Alternative (resulting in higher Lake Mead elevations) and shortage amounts that are less than those in the No Action Alternative (resulting in lower Lake Mead elevations). The Reservoir Storage Alternative generally provides higher Lake Mead elevations than the No Action Alternative. The observed Lake Mead elevations under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative are similar to each other because these alternatives assume the same operation at Lake Powell and the same release reductions corresponding to the same Lake Mead elevations. The 50th and 10th percentile values of these three alternatives vary less than those of the Water Supply and Reservoir Storage Alternatives. Both the 50th and 10th percentile values of the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative vary from being higher and sometimes lower than those of the No Action Alternative.

Lake Mohave and Lake Havasu are operated on a rule curve and have target end-of-month elevations. This manner of operation will continue in the future and would apply to operations under any of the action alternatives. Therefore, future Lake Mohave and Lake Havasu elevations would be expected to be similar between the action alternatives and the No Action Alternative.

4.3.10.2 Reservoir Releases

During the interim period (2008 through 2026), Glen Canyon Dam releases less than the annual minimum objective release of 8.23 maf occurred less than one percent of the time under the No Action Alternative, approximately ten percent of the time under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, and approximately 17 percent of the time under the Reservoir Storage Alternative. Over the interim period, releases greater than the annual minimum objective release of 8.23 maf occurred approximately 42 percent of the time under the No Action Alternative, approximately 62 percent of the time under the Basin States and Conservation Before Shortage Alternatives, 69 percent of the time under the Water Supply Alternative, 44 percent of the time under the Reservoir Storage Alternative, and 59 percent of the time under the Preferred Alternative.

During the interim period (2008 through 2026), the observed minimum and maximum Hoover Dam annual releases under the No Action Alternative are 7.46 maf and 17.13 maf, respectively. By comparison, the minimum annual release under the action alternatives is 7.3 maf and occurs under the Conservation Before Shortage Alternative. The maximum annual release of 17.16 maf occurs under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative. In general, the annual release volumes under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative are similar to those under the No Action Alternative. The Hoover Dam annual releases under the Water Supply Alternative are generally higher than under the No Action Alternative. The Hoover Dam annual releases under the Reservoir Storage Alternative are generally lower than under the No Action Alternative.

The releases from Davis Dam and Parker Dam generally reflect the same pattern of releases under the different action alternatives as those from Hoover Dam. The differences in the release volumes are mostly attributed to the depletions that occur upstream of each respective dam.

4.3.10.3 River Flows

The river flows that occur between Glen Canyon Dam and Lake Mead result mostly from controlled releases from Glen Canyon Dam. Since the gains from tributaries in this reach on average are less than three percent of the total flow and would not be affected by the proposed federal action, the relative comparison of annual river flows would be essentially the same as the comparison made for the annual releases from Glen Canyon Dam. Daily and hourly releases from Glen Canyon Dam would continue to be made consistent with the 1996 Grand Canyon ROD pending the outcome of the long-term experiment program.

The river flows that occur downstream of Hoover Dam also result mostly from controlled releases from Hoover, Davis, and Parker dams. For all reaches, the projected river flows are bound by the Water Supply Alternative (at the high end) and the Reservoir Storage Alternative (at the low end). Differences in river flows for each alternative relative to this No Action Alternative are small (less than 1 percent).

4.3.10.4 Groundwater

The river flow reductions were determined to have no effect on the groundwater resources within the river reach that extends from Glen Canyon Dam to Lake Mead. The river flow reductions that occur below Hoover Dam could potentially affect groundwater resources within the different river reaches where they occur. However, the potential changes in median flows, river stage reductions, and corresponding potential effects on groundwater elevations relative to the No Action Alternative were shown to be small (less than 0.5 feet).

4.4 Water Deliveries

This section compares water deliveries from the Colorado River mainstream to the Lower Division states and Mexico under the No Action Alternative and the action alternatives. In addition, potential impacts of shortages to water user categories (agricultural, M&I, and Tribal) within Arizona are compared. The allocation of shortages to California and Nevada generally affect single entities within each state (MWD in California and SNWA in Nevada) and therefore analyses of potential impacts to other Colorado River water users within these two states were not performed. Additional details with regard to potential shortages to specific water users within each Lower Division state are presented in Appendix G.

4.4.1 Methodology

The methodology used to analyze total water deliveries to each Lower Division state and Mexico for each alternative is based on the hydrologic model CRSS described in Section 4.2 and in Appendix A. Modeling assumptions with respect to the distribution of shortages and related water delivery reductions to the Lower Division states and Mexico are summarized in Section 2.2 and Section 4.2.

4.4.1.1 Shortage Allocation Model

To analyze the potential impacts of shortages to water users within each Lower Division state, a more detailed model, the Shortage Allocation Model, was developed. The Shortage Allocation Model was used to estimate delivery of water to Colorado River water entitlement holders within the Lower Division states under varying levels of shortages. The entitlements, along with consumptive use schedules and established priorities within each Lower Division state, were included as parameters in the Shortage Allocation Model. In addition, the shortage distribution within the CAP is consistent with the Arizona Water Settlements Act (AWSA).

The Shortage Allocation Model allocates shortages to the Lower Division states consistent with the shortage sharing assumptions used in the CRSS model. The Shortage Allocation Model then distributes Colorado River water to entitlement holders within each state based on the priority of water rights within each respective state using the assumption that shortages will be shared on a pro-rata basis by users of the same priority. Within Arizona, certain modeling assumptions were adjusted between the Draft EIS and the Final EIS based on information received from the ADWR during the public comment period. A detailed description of the Shortage Allocation Model and the methodologies used to distribute the shortages is provided in Appendix G. A list of each Lower Division state's Colorado River water entitlement holders, listed by priority, is included in Appendix E.

Total Lower Basin shortages of 100 kaf to 2.5 maf (in increments of 100 kaf) were analyzed in the Shortage Allocation Model, covering the range of total Lower Basin shortages projected to occur under the No Action Alternative and the action alternatives[1]. The output for each model run shows how shortages were distributed to each entitlement holder within each state. The Shortage Allocation Model also summarized shortages into three water user categories in Arizona (agricultural, M&I, and Tribal), which are presented in Section 4.4.5. Detailed output from the Shortage Allocation Model is provided in Appendix G.

4.4.2 Apportionments to the Upper Division States

The proposed federal action will not affect the apportionments to the Upper Division states nor their ability to use their Compact apportionments. Therefore no resource impact analysis was considered necessary.

4.4.3 Apportionments to the Lower Division States and Water Entitlements within Each State

The proposed federal action will not affect the apportionments to the Lower Division states or the water entitlements to water users within those states and therefore no resource impact analysis was considered necessary. However, water deliveries to each state and to users within each state may be affected and are analyzed in the following sections.

4.4.4 Lower Division States Water Supply Determination

The proposed federal action would provide guidance to the Secretary's annual determination of the water supply condition (Surplus, Normal, or Shortage) for the Lower Division states. This section compares the probabilities of the determinations that would be made under each alternative.

4.4.4.1 Shortage Conditions

A Shortage Condition exists in a particular year when the Secretary determines that there is insufficient mainstream water available to satisfy the 7.5 maf of consumptive use in the Lower Division states. The elements of the proposed federal action include shortage guidelines and each alternative assumes a specific formulation for determining a Shortage Condition (Chapter 2).

[1] As a result of updating the CRSS initial conditions to reflect the June 2007 projections of January 1, 2008 reservoir contents, water delivery reductions with volumes greater than 2.5 maf were observed in four out of 100 hydrologic sequences under the Water Supply Alternative and only in year 2027. These shortage volumes were primarily the result of the assumption that operations would revert back to the assumptions made under the No Action Alternative after the interim period. Consequently, analysis of shortages greater than 2.5 maf in the Final EIS was not considered necessary due to their low probability of occurrence.

Probability of Involuntary and Voluntary Shortage. The Conservation Before Shortage proposal suggested an approach to the management of shortages in the Lower Basin whereby voluntary water delivery reductions would occur at specific Lake Mead elevations in order to delay the onset of larger, involuntary water reductions. The voluntary water reductions would occur through a compensation program whereby willing Lower Basin Colorado River water users, including Mexico, would be paid to voluntarily and temporarily reduce their water use (Section 2.4). Conversely, involuntary water delivery reductions might be imposed by the Secretary through the determination of a Shortage Condition pursuant to Article II(B)(3) of the Consolidated Decree.

Although the mechanism for voluntary and involuntary water delivery reductions would be different, the potential hydrologic impacts of voluntary or involuntary shortages would be the same. Similarly, the potential impacts to other environmental resources would be the same with the possible exception of socioeconomic impacts (Section 4.14). In this and in subsequent sections of the Final EIS, voluntary water delivery reductions proposed by the Conservation Before Shortage Alternative are termed “voluntary shortages”, and involuntary water delivery reductions imposed by a Secretarial determination of a Shortage Condition are termed “involuntary shortages”. Voluntary and involuntary shortages are analyzed separately or together in subsequent analyses as appropriate.

The probability of the determination of a Shortage Condition and associated involuntary shortages for all alternatives is illustrated in Figure 4.4-1. Under the No Action Alternative, the probability of involuntary shortage increases throughout the interim period from four percent in 2010 to about 50 percent in 2026. All action alternatives have lower probabilities of involuntary shortage when compared to the No Action Alternative from 2013 through 2026, with the Water Supply and Conservation Before Shortage Alternatives showing the lowest probabilities. Table 4.4-1 provides a comparison of the alternatives with respect to the first year of involuntary shortage and the probability of occurrence. Table 4.4-2 provides the probability of any amount of involuntary Lower Basin shortage for specific years.

The Conservation Before Shortage and Water Supply alternatives result in relatively infrequent, involuntary shortages during the interim period due to quite different reasons. The Conservation Before Shortage Alternative assumes that voluntary shortages would occur prior to the onset of involuntary shortages, whereas the Water Supply Alternative imposes involuntary shortages only if Lake Mead storage approaches the top of the dead pool elevation or when Lake Mead’s elevation falls below 1,000 feet msl (the current limit of SNWA’s lower intake). Figure 4.4-1 shows that the probability of involuntary shortages ranges from zero to 12 percent over the interim period for the Water Supply Alternative. Figure 4.4-1 also shows that the probability of involuntary shortages under the Conservation Before Shortage Alternative is similar (approximately zero to nine percent over the interim period) since involuntary shortages are imposed under that alternative only to protect Lake Mead from falling below elevation 1,000 feet msl.

Figure 4.4-1
Involuntary Lower Basin Shortages
Comparison of Action Alternatives to No Action Alternative
Probability of Occurrence of Any Involuntary Shortage Volume

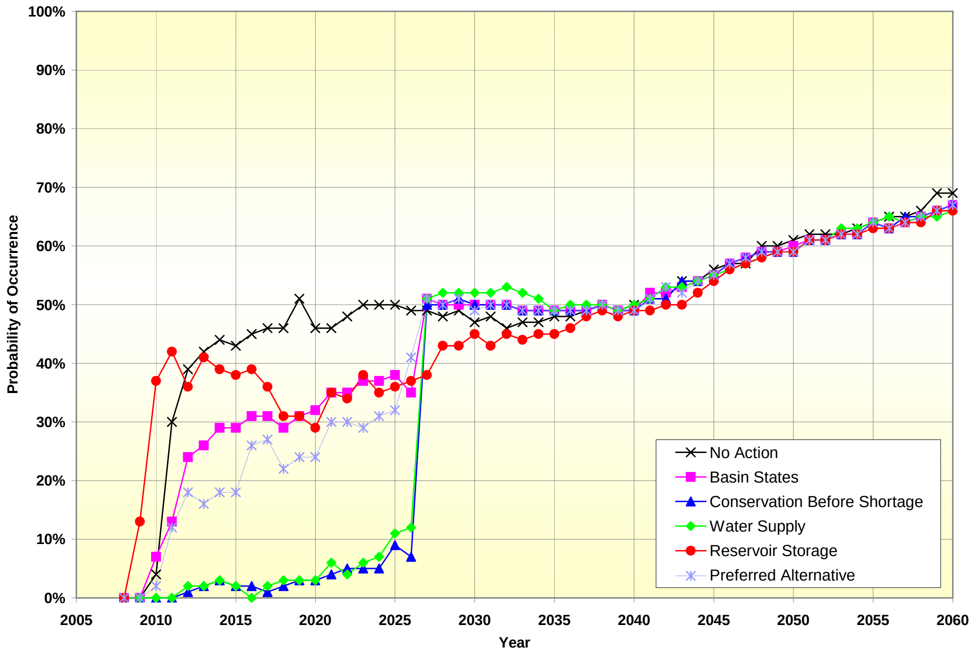


Table 4.4-1
First Year of Involuntary Shortage and Probability of Occurrence
Comparison of Action Alternatives to No Action Alternative

Alternative	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Year	2010	2010	2012	2012	2009	2010
Probability (%)	4	7	1	2	13	2

Table 4.4-2
Probability of Occurrence of Any Amount of Involuntary Shortage for Specific Years (percent)
Comparison of Action Alternatives to No Action Alternative

Year	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008	0	0	0	0	0	0
2017	46	31	1	2	36	27
2026	49	35	7	12	37	41
2027	49	51	50	51	38	51
2040	50	49	49	50	49	49
2060	69	67	67	66	66	67

Figure 4.4-2, Table 4.4-3, and Table 4.4-4 present comparisons for all alternatives when both involuntary and voluntary shortages are considered. When both involuntary and voluntary shortages are considered, the occurrence of the first shortage in 2010 is identical for the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative. The probability of shortages in 2010 differs (seven percent, four percent, and two percent for the Basin States Alternative, Conservation Before Shortage Alternative, and the Preferred Alternative, respectively) due to the different assumptions with regard to the participation in the storage and delivery mechanism for those alternatives. The Preferred Alternative also shows lower probabilities (up to approximately ten percent) of voluntary and involuntary shortage over the entire interim period when compared to the Basin States and Conservation Before Shortage Alternatives.

Figure 4.4-2
Involuntary and Voluntary Lower Basin Shortages
Comparison of Action Alternatives to No Action Alternative
Probability of Occurrence of Any Shortage Volume

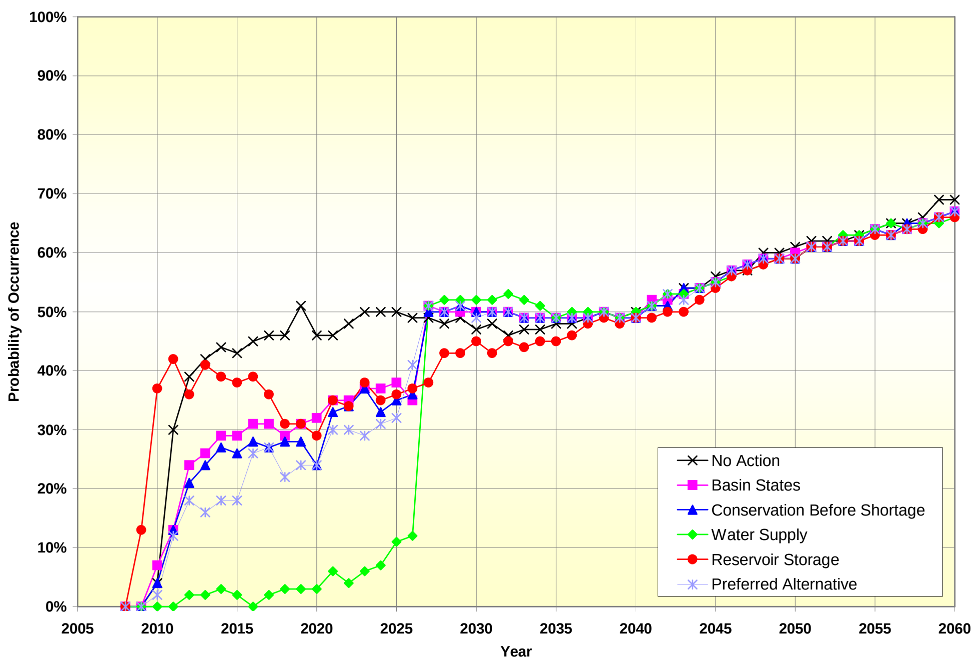


Table 4.4-3
First Year of Involuntary or Voluntary Shortage and Probability of Occurrence
Comparison of Action Alternatives to No Action Alternative

Alternative	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Year	2010	2010	2010	2012	2009	2010
Probability (%)	4	7	4	2	13	2

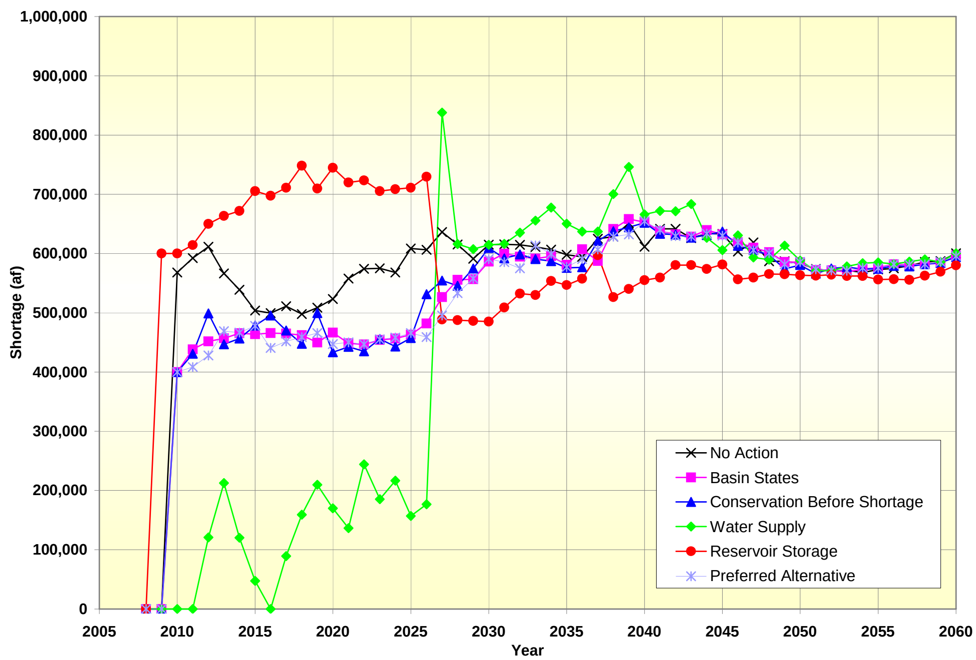
Table 4.4-4
Probability of Occurrence of Involuntary and Voluntary Shortages of Any Amount for Specific Years (percent)
Comparison of Action Alternatives to No Action Alternative

Year	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008	0	0	0	0	0	0
2017	46	31	27	2	36	27
2026	49	35	36	12	37	41
2027	49	51	50	51	38	51
2040	50	49	49	50	49	49
2060	69	67	67	66	66	67

Magnitude of Involuntary and Voluntary Shortages. Although the probability of a shortage occurring is an important factor, the magnitude of the shortage is also important. Each alternative has specific assumptions with regard to when and by how much deliveries would be reduced.

The average shortage volumes for each year provide a weighted measure that considers both the frequency and magnitude of the potential shortages. The average shortage volumes for each year are calculated by multiplying the observed volumes of shortages by their respective frequency of occurrence and summing those values (or alternatively, by simply summing the shortages for all traces and dividing by the total number of traces). A comparison of the average shortage volumes (of both involuntary and voluntary shortages) under the action alternatives to those of the No Action Alternative is provided in Figure 4.4-3.

Figure 4.4-3
Involuntary and Voluntary Lower Basin Shortage
Comparison of Action Alternatives to No Action Alternative
Average Shortage Volumes

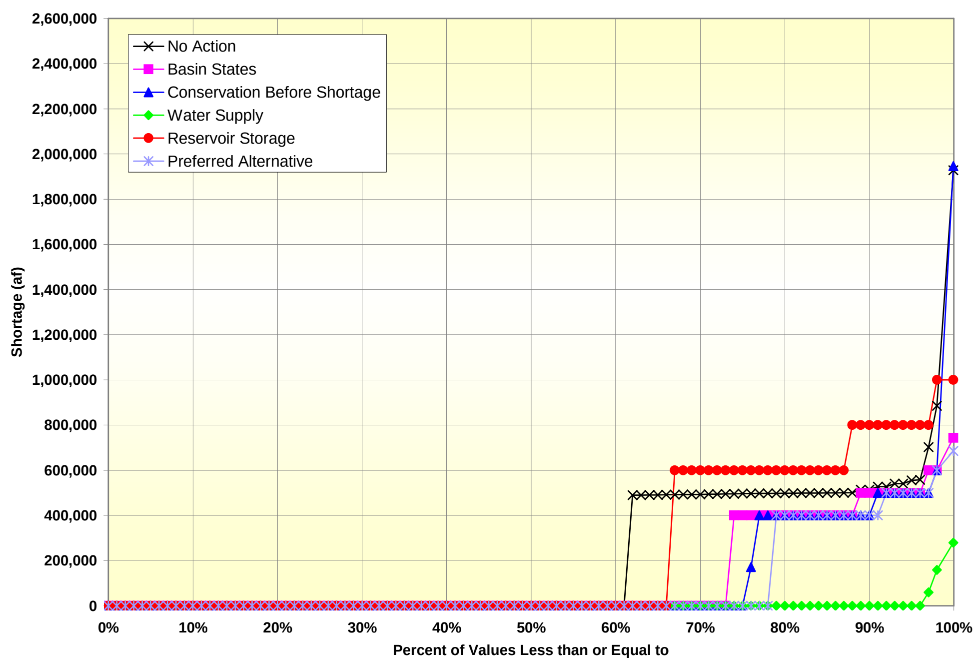


The average shortage volumes under the No Action Alternative from 2010 (the year of first shortage occurrence) through the interim period range between about 500 and 610 kafy and are reflective of the occurrence of the more frequent shortages which are on the order of 400 to 500 kafy based on Lake Mead trigger elevations (Section 2.2) as well as infrequent but larger shortages (on the order of 800 kafy to 2,000 kafy) necessary to keep Lake Mead above elevation 1,000 feet msl. The average shortages volume under the Water Supply Alternative from 2012 (the year of first shortage occurrence) through the interim period are between zero and 240 kafy and are indicative of the strategy which essentially determines no shortage except when Lake Mead elevation approaches the top of the dead pool elevation or is below 1,000 feet msl and there is no delivery to SNWA. The Reservoir Storage Alternative from 2009 (the year of first shortage occurrence) through the interim period shows average shortage volume between 600 and 750 kafy since shortages are applied both more often and at higher magnitudes. The Conservation Before Shortage Alternative shows average shortage volumes between 400 and about 530 kafy over the interim period with shortages first appearing in 2010. These average shortage volumes are lower than the average values under the No Action Alternative since the shortages under this alternative, although similar in magnitude, are applied less often than those under the No Action Alternative. The same factors underlie the average shortage volumes between 400 and 480 kafy associated with the Basin States Alternative and the Preferred Alternative. Shortages under these two alternatives also first appear in 2010.

The Conservation Before Shortage Alternative shows higher average shortage volumes in the latter years of the interim period when compared to the Basin States Alternative and the Preferred Alternative. This is due to involuntary shortages of higher magnitudes occurring at higher frequencies in the latter years under the Conservation Before Shortage Alternative to keep Lake Mead above elevation 1,000 feet msl. Conversely, the Basin States Alternative and the Preferred Alternative assume that when Lake Mead is at or below elevation 1,025 feet msl, additional consultations will occur in order to determine what further actions might be necessary. For modeling purposes, it was assumed that shortages with a magnitude of 600 kaf would continue for Lake Mead elevations below 1,025 feet msl for the Basin States Alternative and the Preferred Alternative.

An alternate way to analyze the probability and magnitude of shortages between alternatives is to compare the cumulative distribution of shortages over a period of time. Figure 4.4-4 presents the cumulative distribution of both voluntary and involuntary shortages for the interim period, 2008 through 2026.

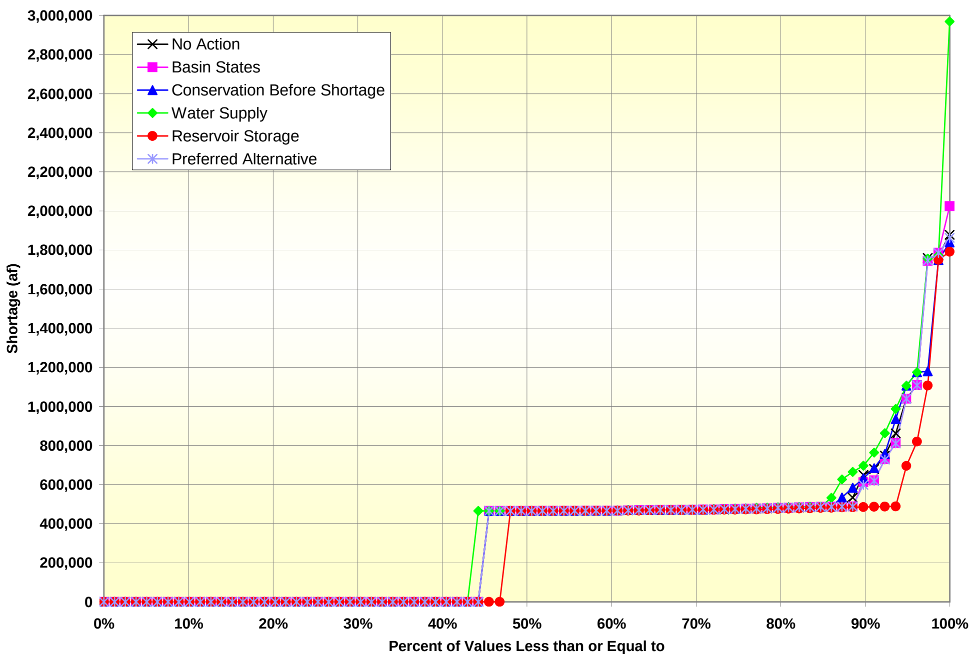
Figure 4.4-4
Involuntary and Voluntary Lower Basin Shortages
Comparison of Action Alternatives to No Action Alternative
Years 2006 through 2026



Under the No Action Alternative, shortages between 490 and 560 kafy would be applied about 35 percent of the time, with shortages of greater magnitudes occurring about three percent of the time over the interim period. Under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative, shortages occur less often than under the No Action Alternative (about 26, 24, and 21 percent of the time, respectively), with the slightly lower probability of the Preferred Alternative due to the assumption of larger volumes of conserved water being stored in Lake Mead. The Reservoir Storage Alternative shows that shortages of magnitudes greater than 600 kafy would occur about 12 percent of the time.

Figure 4.4-5 provides the cumulative distribution of shortages for the period between 2027 through 2060. Although all alternatives were assumed to revert back to the modeled operational criteria used under the No Action Alternative in 2027, the differences in the cumulative distribution are attributed to differences in Lake Powell and Lake Mead elevations between the alternatives at the end of the interim period (2026). For example, the occurrence of large shortages (up to 2.97 maf) at low probabilities under the Water Supply Alternative is due to large shortages that must be applied in order to return Lake Mead to above elevation 1,000 feet msl for some traces in 2027 and 2028.

Figure 4.4-5
Involuntary and Voluntary Lower Basin Shortages
Comparison of Action Alternatives to No Action Alternative
Years 2027 through 2060



Tables 4.4-5 through 4.4-9 present the probability of occurrence of shortages of various magnitudes for years 2017, 2026, 2027, 2040, and 2060 for each alternative. Also shown are the probabilities of involuntary shortages only and the probabilities of both voluntary and involuntary shortages for the Conservation Before Shortage Alternative.

Table 4.4-5
Distribution of Shortages, Year 2017 (percent)

Shortage (kaf)	No Action	Basin States	Conservation Before Shortage		Water Supply	Reservoir Storage	Preferred Alternative
			Involuntary	Voluntary & Involuntary Shortage			
< 400	0	0	0	0	2	0	0
400 - 499	45	15	0	14	0	0	16
500 - 599	0	13	0	11	0	0	8
600 - 799	0	3	0	1	0	18	3
800 - 999	0	0	1	1	0	16	0
1,000 – 1,199	1	0	0	0	0	2	0
1,200 – 1,399	0	0	0	0	0	0	0
1,400 – 1,599	0	0	0	0	0	0	0
1,600 – 1,799	0	0	0	0	0	0	0
1,800 – 1,999	0	0	0	0	0	0	0
2,000 – 2,499	0	0	0	0	0	0	0
> 2,500	0	0	0	0	0	0	0

Table 4.4-6
Distribution of Shortages, Year 2026 (percent)

Shortage (kaf)	No Action	Basin States	Conservation Before Shortage		Water Supply	Reservoir Storage	Preferred Alternative
			Involuntary	Voluntary & Involuntary Shortage			
< 400	0	0	0	0	12	0	0
400 – 499	34	15	1	19	0	0	24
500 – 599	0	13	0	10	0	0	11
600 – 799	7	7	3	4	0	18	6
800 – 999	6	0	2	2	0	14	0
1,000 – 1,199	1	0	0	0	0	5	0
1,200 – 1,399	0	0	0	0	0	0	0
1,400 – 1,599	0	0	0	0	0	0	0
1,600 – 1,799	0	0	0	0	0	0	0
1,800 – 1,999	1	0	1	1	0	0	0
2,000 – 2,499	0	0	0	0	0	0	0
> 2,500	0	0	0	0	0	0	0

Table 4.4-7
Distribution of Shortages, Year 2027 (percent)

Shortage (kaf)	No Action	Basin States	Conservation Before Shortage		Water Supply	Reservoir Storage	Preferred Alternative
			Involuntary	Voluntary & Involuntary Shortage			
< 400	0	0	0	0	0	0	0
400 – 499	38	48	44	44	37	38	50
500 – 599	1	0	0	0	1	0	0
600 – 799	3	2	2	2	3	0	0
800 – 999	2	0	2	2	2	0	1
1,000 – 1,199	1	0	1	1	0	0	0
1,200 – 1,399	0	0	0	0	0	0	0
1,400 – 1,599	0	0	0	0	0	0	0
1,600 – 1,799	3	0	0	0	0	0	0
1,800 – 1,999	1	0	1	1	1	0	0
2,000 – 2,499	0	1	0	0	3	0	0
> 2,500	0	0	0	0	4	0	0

Table 4.4-8
Distribution of Shortages, Year 2040 (percent)

Shortage (kaf)	No Action	Basin States	Conservation Before Shortage		Water Supply	Reservoir Storage	Preferred Alternative
			Involuntary	Voluntary & Involuntary Shortage			
< 400	0	0	0	0	0	0	0
400 – 499	37	35	33	33	34	44	36
500 – 599	2	0	2	2	1	0	0
600 – 799	4	5	3	3	5	0	4
800 – 999	2	2	2	2	3	2	1
1,000 – 1,199	2	3	7	7	3	1	4
1,200 – 1,399	0	0	0	0	0	0	0
1,400 – 1,599	0	0	0	0	0	0	0
1,600 – 1,799	3	3	2	2	3	2	3
1,800 – 1,999	0	1	0	0	1	0	1
2,000 – 2,499	0	0	0	0	0	0	0
> 2,500	0	0	0	0	0	0	0

Table 4.4-9
Distribution of Shortages, Year 2060 (percent)

Shortage (kaf)	No Action	Basin States	Conservation Before Shortage: Involuntary	Conservation Before Shortage: Voluntary & Involuntary Shortage	Water Supply	Reservoir Storage	Preferred Alternative
< 400	0	0	0	0	0	0	0
400 – 499	54	52	50	50	51	53	52
500 – 599	1	1	3	3	2	1	1
600 – 799	4	6	6	6	4	4	6
800 – 999	3	1	1	1	2	1	1
1,000 – 1,199	3	3	4	4	3	4	3
1,200 – 1,399	0	0	0	0	0	0	0
1,400 – 1,599	0	0	0	0	0	0	0
1,600 – 1,799	3	3	3	3	3	3	3
1,800 – 1,999	1	1	0	0	1	0	1
2,000 – 2,499	0	0	0	0	0	0	0
> 2,500	0	0	0	0	0	0	0

The maximum amount of shortage for each alternative for each year is presented in Figure 4.4-6. Table 4.4-10 lists the maximum values for specific years. The large shortages in 2027 and 2028 shown for the Water Supply Alternative (Figure 4.4-6) are due to shortages that must be applied in order to return Lake Mead to above elevation 1,000 feet msl after the interim period. By contrast, the Reservoir Storage Alternative has the lowest maximum shortage of any of the alternatives in 2027 because the reservoirs would be maintained at relatively higher elevations. By 2040, all alternatives have converged essentially to the No Action Alternative values.

Sensitivity of Shortage Conditions to Storage and Delivery Mechanism. The mechanism to store and deliver conserved system and non-system water assumed as part of the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative, could potentially affect the probability of shortages. Because a potential effect of the storage and delivery mechanism is an increase in the volume of water in Lake Mead, a Shortage Condition is likely to occur less often with the storage and delivery mechanism in place.

Figure 4.4-6
Involuntary and Voluntary Lower Basin Shortages
Comparison of Action Alternatives to No Action Alternative
Maximum Shortage Volumes

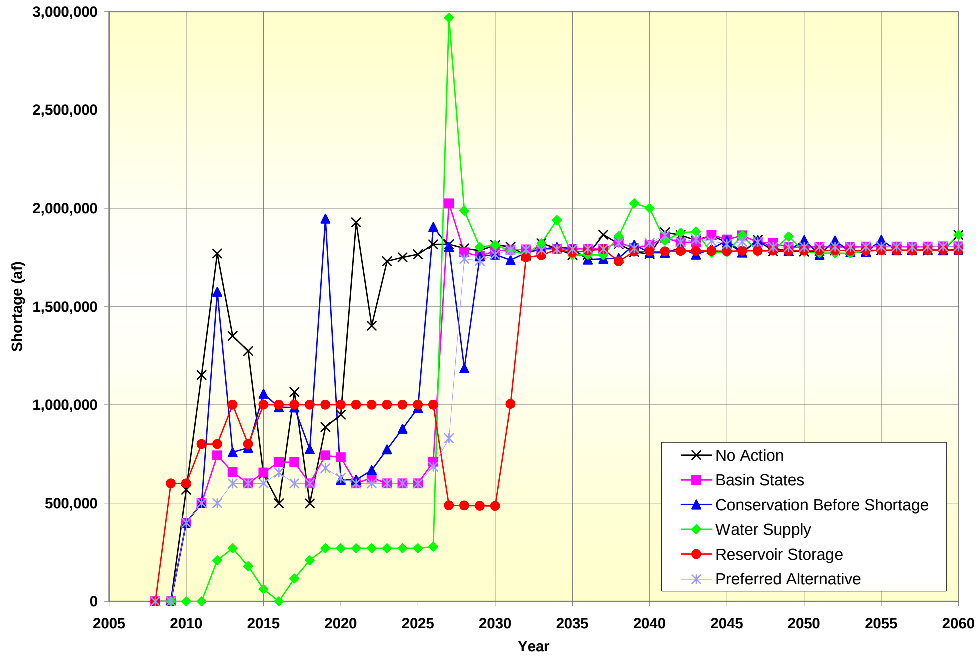


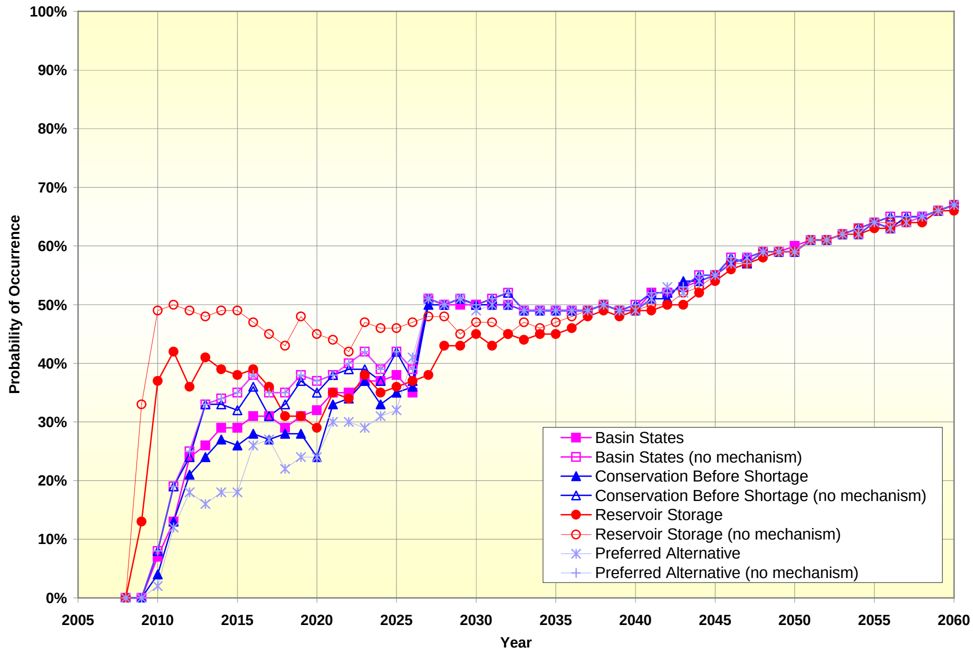
Table 4.4-10
Maximum Volume of Involuntary and Voluntary Shortage to the Lower Basin for Specific Years (af)
Comparison of Action Alternatives to No Action Alternative

Year	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008	0	0	0	0	0	0
2017	1,065,961	707,930	987,421	116,530	1,000,000	600,000
2026	1,816,439	711,370	1,904,067	279,000	1,000,000	685,470
2027	1,817,357	2,024,093	1,803,329	2,969,371	488,644	829,717
2040	1,766,650	1,812,428	1,774,108	1,999,447	1,779,919	1,823,325
2060	1,864,875	1,805,591	1,788,498	1,864,875	1,787,346	1,805,591

An analysis of the sensitivity of the occurrence of a Shortage Condition to the storage and delivery mechanism was performed by comparing these four alternatives with and without the mechanism in place. Without the mechanism in place, it was assumed that the voluntary shortages (i.e., reduced water deliveries due to conservation proposed to occur at Lake Mead elevations at and below 1,075 feet msl) proposed in the Conservation Before Shortage Alternative would occur. Under this assumption, the conserved water would remain in Lake Mead. All other conservation activities assumed to be associated with the storage and delivery mechanism as described in Appendix M were assumed not to exist for the Conservation Before Shortage, Basin States and Reservoir Storage Alternatives, and the Preferred Alternative.

Figure 4.4-7 presents the probability of involuntary and voluntary shortages for each of the four alternatives with and without the mechanism in place. For each alternative, the inclusion of the mechanism has the effect of decreasing the probability of shortages. Under the Basin States and Conservation Before Shortage Alternatives, the probability of shortage is reduced an average of about five percent from 2010 through 2026. Although the Conservation Before Storage Alternative assumes a greater participation in the storage and delivery mechanism relative to the Basin States Alternative, these results are similar due to the assumption that voluntary conservation would occur under the Conservation Before Storage Alternative even without the mechanism in place. Under the Reservoir Storage Alternative and the Preferred Alternative, the reduction in the probability of shortage is greater, an average of approximately ten percent from 2010 through 2026. Without the storage and delivery mechanism, the probabilities under the Preferred Alternative and the Basin States Alternative are identical because the other modeled operational assumptions are identical.

Figure 4.4-7
Involuntary and Voluntary Lower Basin Shortages
Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism
Probability of Occurrence of Any Shortage Volume



Probability of Multi-year Shortages. It is possible that under some hydrologic conditions, water supply in the Colorado River system may be insufficient to satisfy 7.5 maf of consumptive use in the Lower Division states in two or more consecutive years. In this and subsequent sections, these occurrences of shortages in consecutive years are termed "multi-year shortages". In this section, an analysis of the probability of multi-year shortages is presented. Two factors were considered in this analysis: 1) the frequency of occurrence of multi-year shortages of specific durations; and 2) the magnitude of the shortages observed in those consecutive years.

Multi-year shortages with volumes per year greater than or equal to 400 kafy, 500 kafy, and 600 kafy with durations of two or more years, five or more years, ten or more years, and fifteen or more years were analyzed. No multi-year shortages with volumes per year equal to or greater than 1.0 mafy were observed to occur under any of the alternatives. The results of analyses of multi-year shortages with annual shortage volumes greater than or equal to 400 kafy of durations of two or more years, five or more years, ten or more years and 15 or more years, are shown in Figures 4.4-8 through 4.4-11. The figures and tables that present the results of the analyses of multi-year shortages with annual shortage volumes greater than or equal to 500 kafy and 600 kafy are provided in Appendix P.

Figure 4.4-8
Consecutive Shortages of Two Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

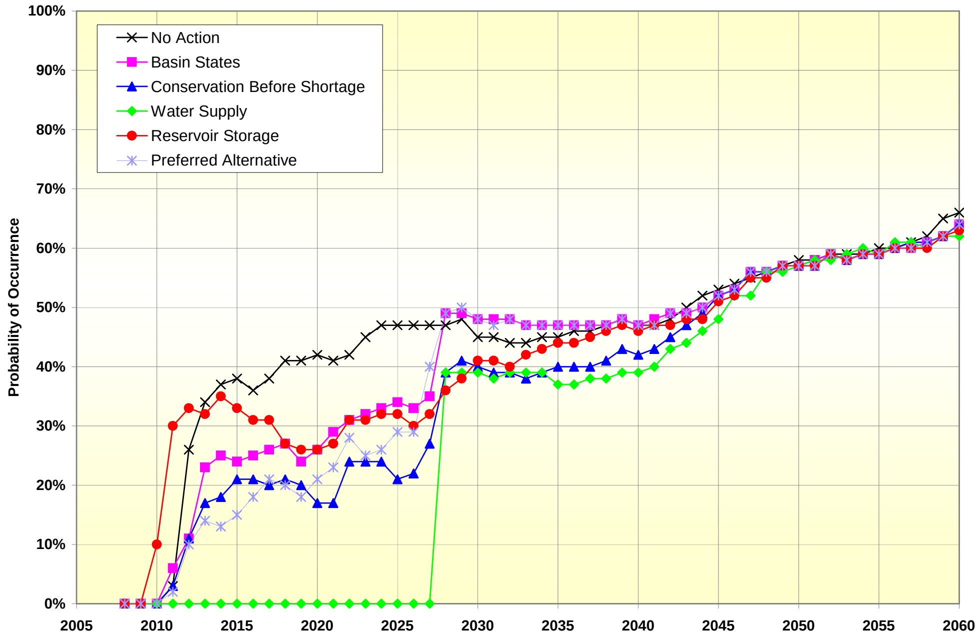


Figure 4.4-9
Consecutive Shortages of Five Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

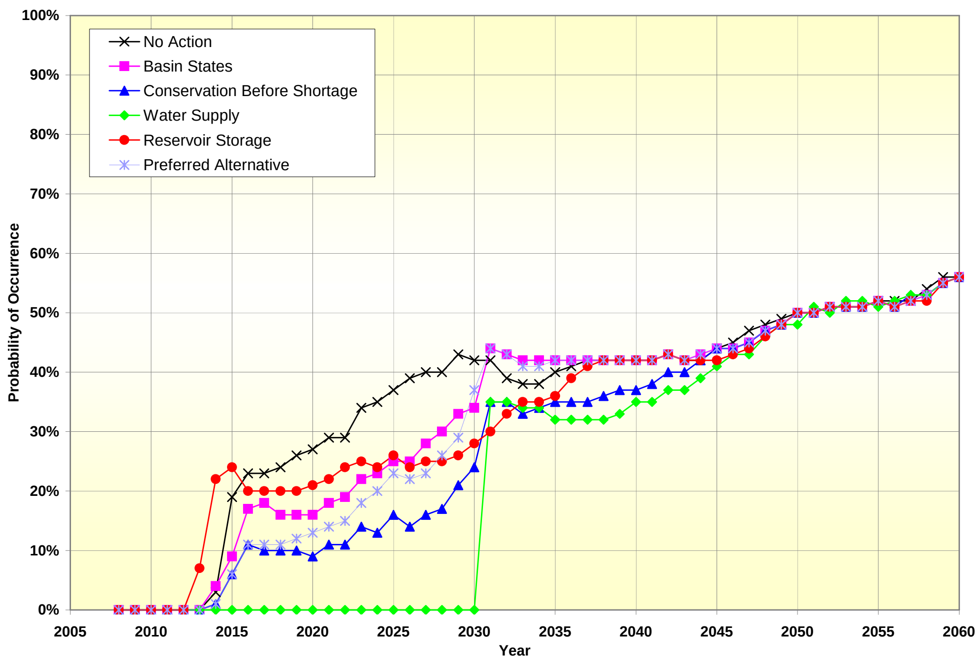


Figure 4.4-10
Consecutive Shortages of Ten Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

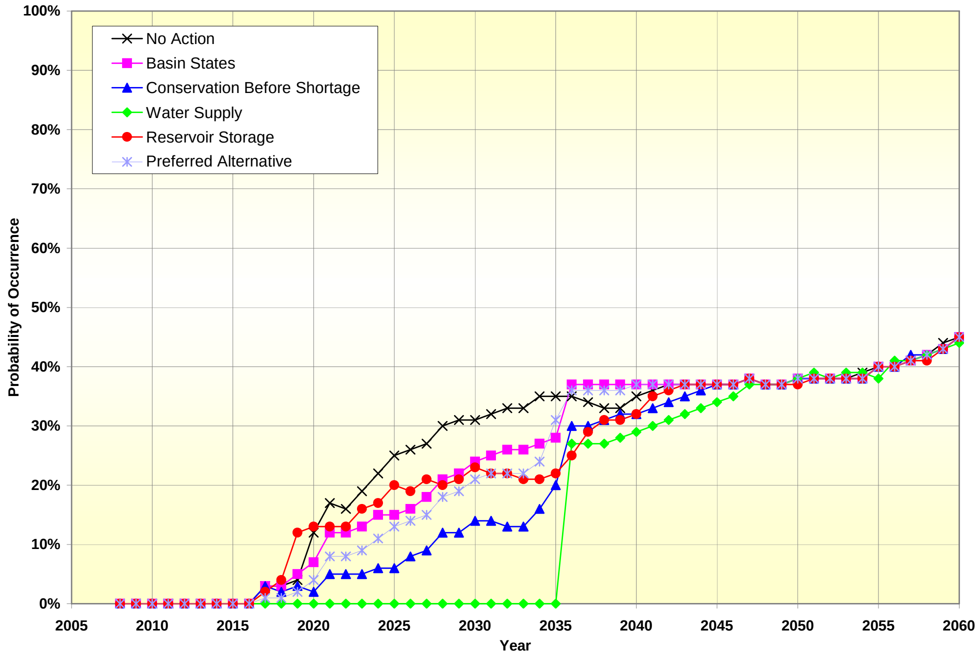
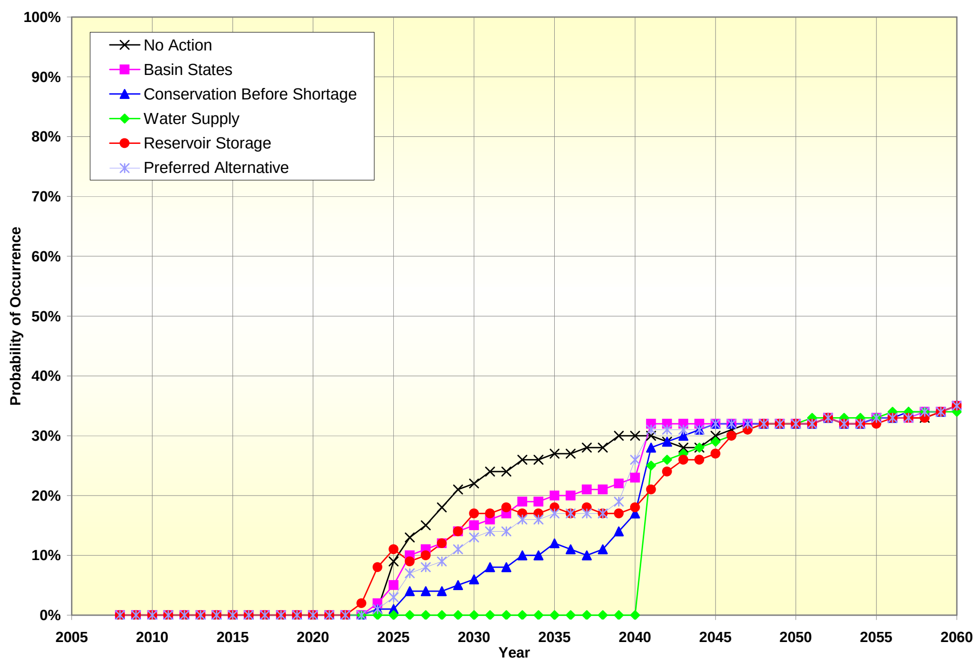


Figure 4.4-11
Consecutive Shortages of 15 Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf



As shown in Figures 4.4-8 through 4.4-11, the probability of multi-year shortages for volumes greater than or equal to 400 kafy decreases as the duration of the multi-year shortage increases for all alternatives. For all durations (greater than or equal to two, five, ten and 15 years), the No Action Alternative has the highest probability of multi-year shortages and the Water Supply Alternative has the lowest probability (zero) during the interim period. The Conservation Before Shortage Alternative and the Preferred Alternative have lower probabilities of multi-year shortages of greater than 400 kafy for all durations than the Basin States Alternative, due primarily to the assumption of increased participation in the storage and delivery mechanism.

Table 4.4-11 presents the probabilities of occurrence depicted in Figures 4-4.8 through 4.4-11 for various durations of selected years during the interim period. The Preferred Alternative and the Conservation Before Shortage Alternative show an approximately 11 percent probability of a multi-year shortage with annual shortage volumes greater than or equal to 400 kaf lasting for five or more years by the year 2016 as compared to 17 percent, 20 percent, and 23 percent for the Basin States and Reservoir Storage Alternatives, and the No Action Alternative, respectively.

The results of the analyses of multi-year shortages with annual shortage volumes greater than or equal to 500 kafy are presented in Table P-WD2 and Figures P-WD-5 through P-WD-8 in Appendix P; a summary is presented here. Multi-year shortages with annual shortage volumes equal to or greater than 500 kaf are most likely to occur under the Reservoir Storage Alternative with probabilities of approximately 35 percent for durations of two or more years and 26 percent for durations of five or more years. Multi-year shortages with annual shortage volumes greater than 500 kaf also occur under the No Action Alternative at durations of two and five or more years, but only in the years up to about 2015 due to the assumptions regarding shortages under the No Action Alternative and the assumed decreasing 4th priority schedules (Appendix D). These assumptions result in shortages of less than 500 kafy in years after 2015. Multi-year shortages of 500 kafy or greater also occur under the Basin States, Conservation Before Shortage, and Water Supply alternatives, with relatively low probabilities of one to four percent over the interim period. Multi-year shortages of 500 kafy or greater were not observed under the Preferred Alternative.

The results of the analyses of multi-year shortages with annual shortage volumes greater than or equal to 600 kafy are shown in Table P-WD-3 and Figures P-WD-9 through P-WD-12 in Appendix P; a summary is presented here. Multi-year shortages with annual shortage volumes equal to or greater than 600 kafy are likely to occur only under the Reservoir Storage Alternative. The probabilities of shortages occurring in two or more consecutive years are identical to the probabilities seen at the 400 and 500 kaf level because 600 kaf is the lowest shortage level in the Reservoir Storage Alternative. For the No Action Alternative, and the Conservation Before Shortage and Water Supply alternatives, multi-year shortages with annual shortage volumes greater than 600 kaf are only observed for durations of two or more years and with very small probabilities (one to three percent in just a few years during the interim period). Multi-year shortages of 600 kafy or greater were not observed under the Basin States Alternative and the Preferred Alternative.

Table 4.4-11
Multi-year Shortages with Durations of Two or More Years, Five or More Years, Ten or More Years, and 15 or More Years
Comparison of Action Alternatives to No Action Alternative, Probability of Shortage per Year Greater Than or Equal to 400 kaf

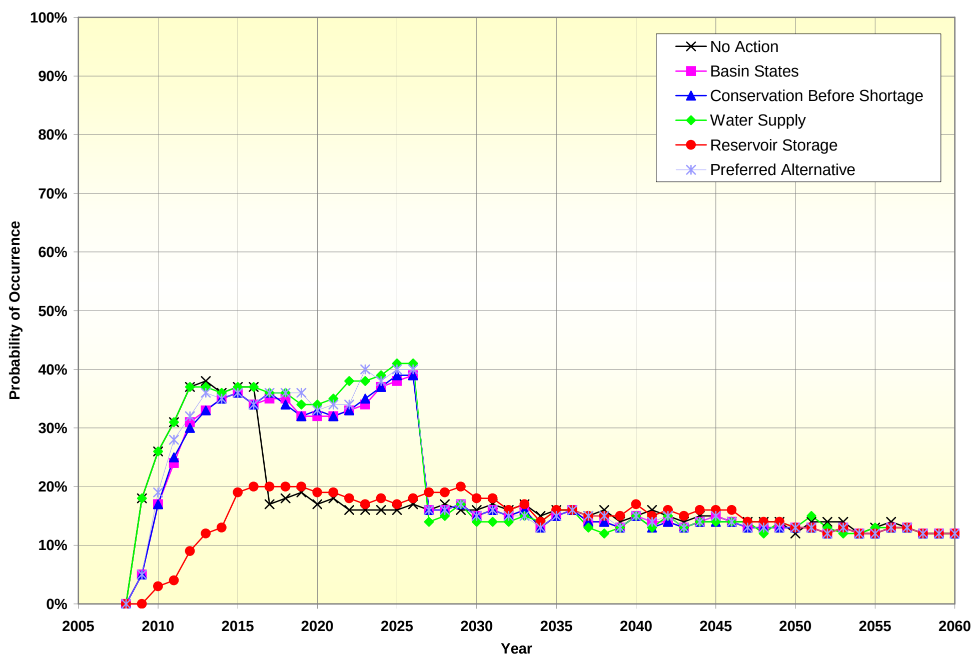
	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Probability of Annual Shortage Volume Equal to or Greater Than to 400 kaf Occurring in Two or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	10.0	0.0
2016	36.0	25.0	21.0	0.0	31.0	18.0
2020	42.0	26.0	17.0	0.0	26.0	21.0
2026	47.0	33.0	22.0	0.0	30.0	29.0
2030	45.0	48.0	40.0	39.0	41.0	48.0
2035	45.0	47.0	40.0	37.0	44.0	47.0
2040	47.0	47.0	42.0	39.0	46.0	47.0
2050	58.0	57.0	57.0	57.0	57.0	57.0
2060	66.0	64.0	64.0	62.0	63.0	64.0
Probability of Annual Shortage Volume Equal to or Greater Than 400 kaf Occurring in Five or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	23.0	17.0	11.0	0.0	20.0	11.0
2020	27.0	16.0	9.0	0.0	21.0	13.0
2026	39.0	25.0	14.0	0.0	24.0	22.0
2030	42.0	34.0	24.0	0.0	28.0	37.0
2035	40.0	42.0	35.0	32.0	36.0	42.0
2040	42.0	42.0	37.0	35.0	42.0	42.0
2050	50.0	50.0	50.0	48.0	50.0	50.0
2060	56.0	56.0	56.0	56.0	56.0	56.0
Probability of Annual Shortage Volume Equal to or Greater Than 400 kaf Occurring in Ten or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0
2020	12.0	7.0	2.0	0.0	13.0	4.0
2026	26.0	16.0	8.0	0.0	19.0	14.0
2030	31.0	24.0	14.0	0.0	23.0	21.0
2035	35.0	28.0	20.0	0.0	22.0	31.0
2040	35.0	37.0	32.0	29.0	32.0	37.0
2050	38.0	38.0	38.0	38.0	37.0	38.0
2060	45.0	45.0	45.0	44.0	45.0	45.0
Probability of Annual Shortage Volume Equal to or Greater Than 400 kaf Occurring in 15 or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0
2020	0.0	0.0	0.0	0.0	0.0	0.0
2026	13.0	10.0	4.0	0.0	9.0	7.0
2030	22.0	15.0	6.0	0.0	17.0	13.0
2035	27.0	20.0	12.0	0.0	18.0	17.0
2040	30.0	23.0	17.0	0.0	18.0	26.0
2050	32.0	32.0	32.0	32.0	32.0	32.0
2060	35.0	35.0	35.0	34.0	35.0	35.0

4.4.4.2 Surplus Conditions

A Surplus Condition exists in a particular year when the Secretary determines that there is sufficient mainstream water available to satisfy in excess of 7.5 maf of consumptive use in the Lower Division states. The elements of the proposed federal action include a modification and/or extension of the ISG and each alternative expresses a particular assumption for determining Surplus conditions (Chapter 2).

Probability of Surplus of Any Amount. Figure 4.4-12 compares the probabilities of a Surplus Condition between the alternatives. For the No Action Alternative, the probability of surplus drops from 37 percent to 17 percent in 2017 due to the expiration of the ISG. For the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, the probabilities of surplus are between 30 percent and 40 percent through 2026 since they assume an extension of some provisions of the ISG. Probabilities for the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative are lower compared to the Water Supply Alternative since all three alternatives assume that the ISG would be modified and the more permissive provisions (e.g., Partial Domestic Surplus) would be eliminated. For the Reservoir Storage Alternative, surplus determinations are limited to Quantified Surplus (70R Strategy) and Flood Control Surplus Conditions, beginning in 2008, and that assumption is reflected in the lower probabilities compared to the other action alternatives throughout the interim period. The probabilities for all alternatives converge to around 15 percent after the interim period since they all revert to the modeled operational assumptions used under the No Action Alternative after 2026.

Figure 4.4-12
Surplus Conditions
Comparison of Action Alternatives to No Action Alternative
Probability of Occurrence



Probability of Various Types of Surplus. Figure 4.4-13 presents a comparison of the probability of occurrence of the Partial Domestic Surplus Condition for each alternative. The probability is zero for the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative since no provisions for Partial Domestic Surplus are contained in those alternatives. The probability of Partial Domestic Surplus for the No Action Alternative and the Water Supply Alternative are identical through 2016. After 2016, the probability of Partial Domestic Surplus under the No Action Alternative drops to zero since the ISG expire, while the Water Supply Alternative assumes an extension of the existing ISG through 2026.

Figure 4.4-13
Partial Domestic Surplus Deliveries to Lower Basin States
Comparison of Action Alternatives to No Action Alternative
Probability of Occurrence

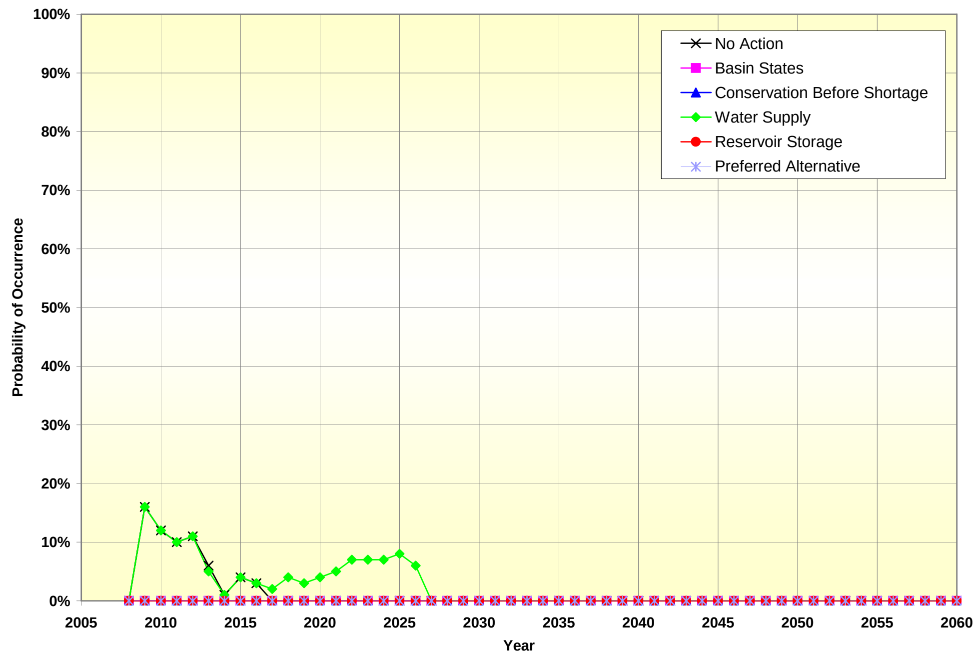


Figure 4.4-14 presents a comparison of the probability of occurrence of the Full Domestic Surplus Condition for each alternative. The probability is zero for the Reservoir Storage Alternative since it does not include a provision for this condition. The probability of Full Domestic Surplus for the No Action Alternative and the Water Supply Alternative are nearly identical through 2016 since they have the same assumptions during that period, with the Water Supply Alternative continuing the Full Domestic Surplus provision through 2026. The Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative, also have nearly identical probabilities through 2026 since they have the same assumptions during that period. The probabilities for the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative are slightly higher than the No Action Alternative and the Water Supply Alternative since they do not have a provision for Partial Domestic Surplus. This keeps the reservoir elevations slightly higher, increasing the chances of a Full Domestic Surplus determination.

Figure 4.4-14
Full Domestic Surplus Deliveries to Lower Basin States
Comparison of Action Alternatives to No Action Alternative
Probability of Occurrence

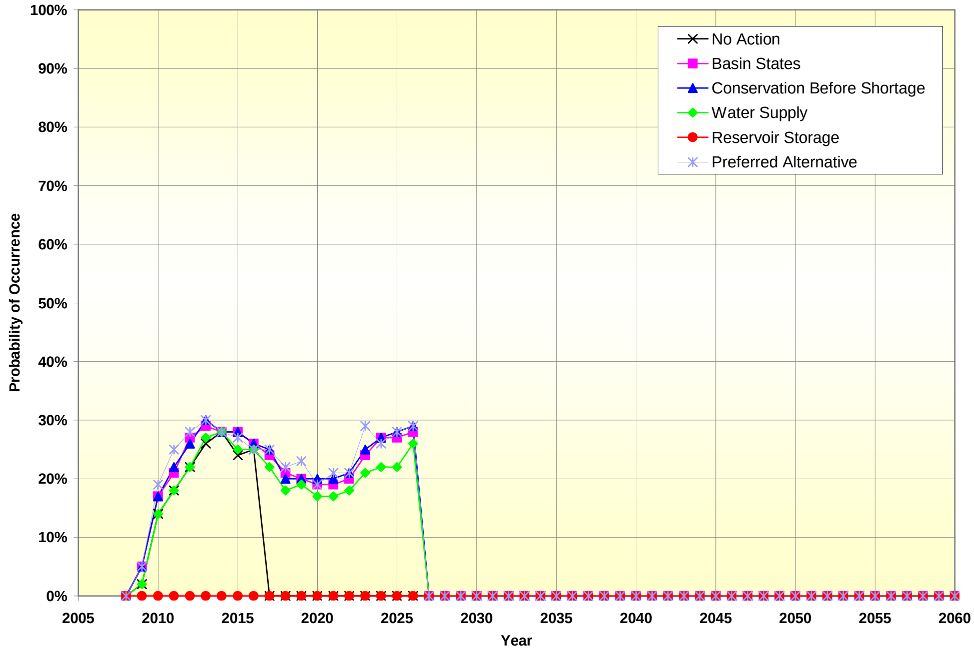


Figure 4.4-15 presents a comparison of the probability of the Quantified (70R) Surplus Condition for each alternative. The probabilities for the No Action Alternative, the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, are nearly identical, with the Reservoir Storage Alternative being slightly higher since it tends to keep the reservoir at higher elevations.

Figure 4.4-15
Quantified Surplus (70R Strategy) Deliveries to Lower Basin States
Comparison of Action Alternatives to No Action Alternative
Probability of Occurrence

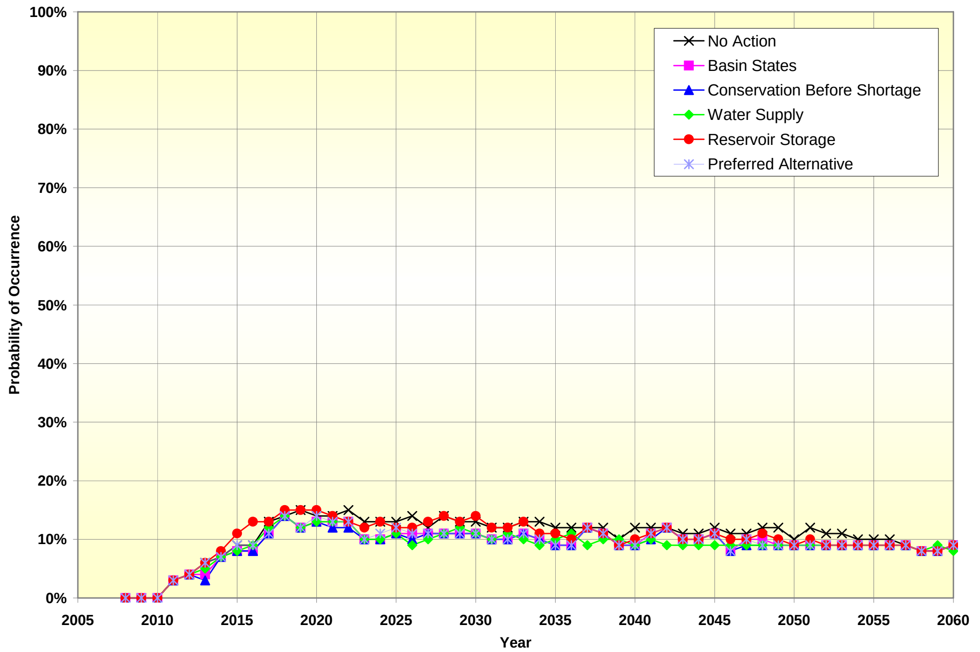
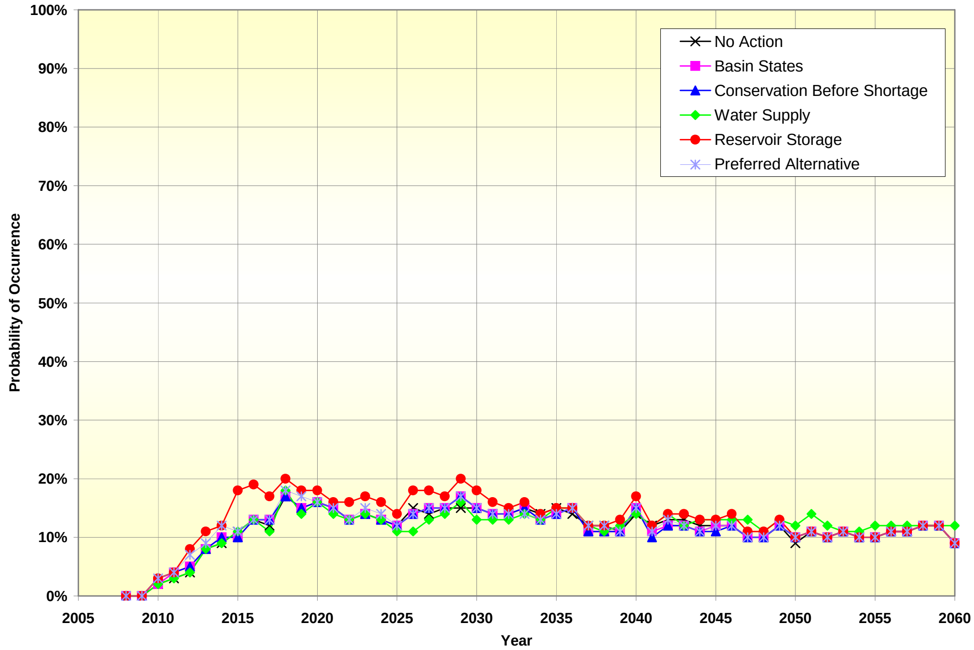


Figure 4.4-16 presents a comparison of the probability of the Flood Control Surplus Condition for each alternative. The probabilities for the No Action Alternative, the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, are nearly identical, with the Reservoir Storage Alternative being slightly higher since it tends to keep the reservoir at higher elevations.

Figure 4.4-16
Flood Control Surplus Deliveries to Lower Basin States
Comparison of Action Alternatives to No Action Alternative
Probability of Occurrence



Sensitivity of Surplus Conditions to Storage and Delivery Mechanism. The mechanism to deliver and store conserved system and non-system water assumed as part of the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative could potentially have an effect on the probability of surplus occurrences. Because a potential outcome of the storage and delivery mechanism is an increase in the volume of water in Lake Mead, a Surplus Condition is likely to occur more often with the storage and delivery mechanism in place.

Figure 4.4-17 presents the sensitivity of the occurrence of a Surplus Condition to the storage and delivery mechanism by comparing these four alternatives with and without the mechanism in place. For each alternative, the inclusion of the mechanism has the effect of slightly increasing the probability of a surplus. An increase of about five percent under the Basin States and Reservoir Storage Alternatives occurs in 2011 and 2015, respectively. The maximum increase under the Conservation Before Shortage Alternative is four percent occurring in 2011. The overall maximum increase in the occurrence of a Surplus Condition is seven percent occurring under the Preferred Alternative in 2011 and 2023.

4.4.4.3 Normal Conditions

The probability of a Normal Condition is shown in Figure 4.4-18. Under the assumption of an initial Lake Mead elevation of 1,114.85 feet msl on January 1, 2008, a Normal Condition would occur for all alternatives with a 100 percent probability in 2008.

Figure 4.4-17
Surplus Deliveries to Lower Basin States
Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism
Probability of Occurrence

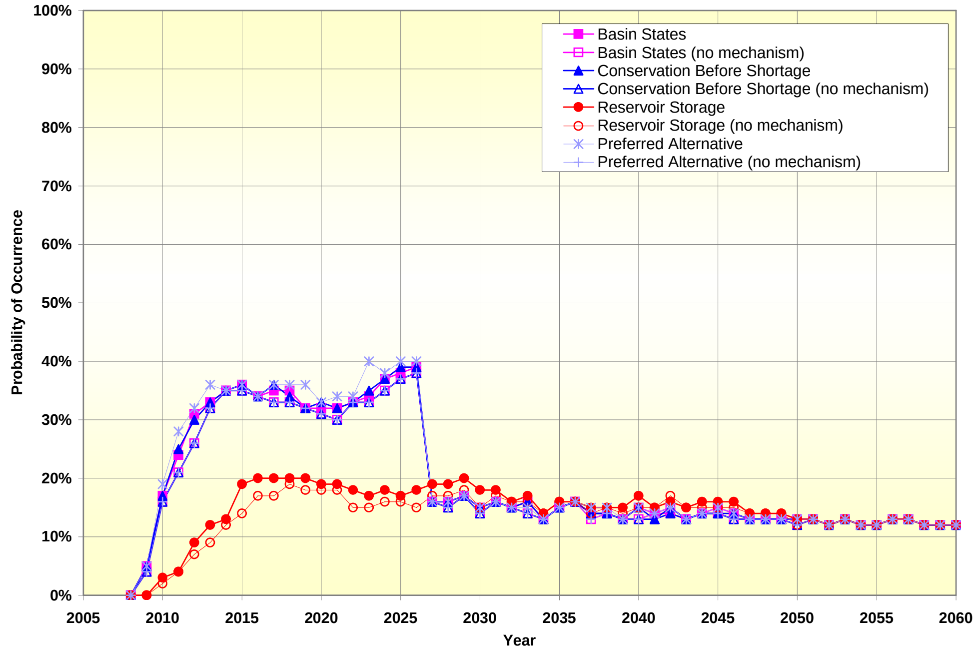
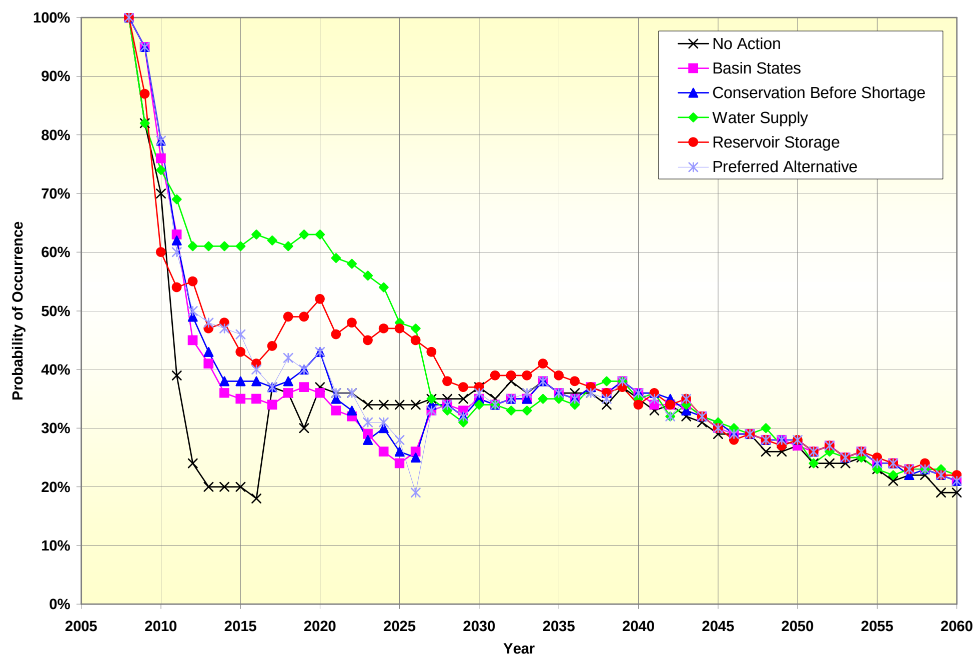


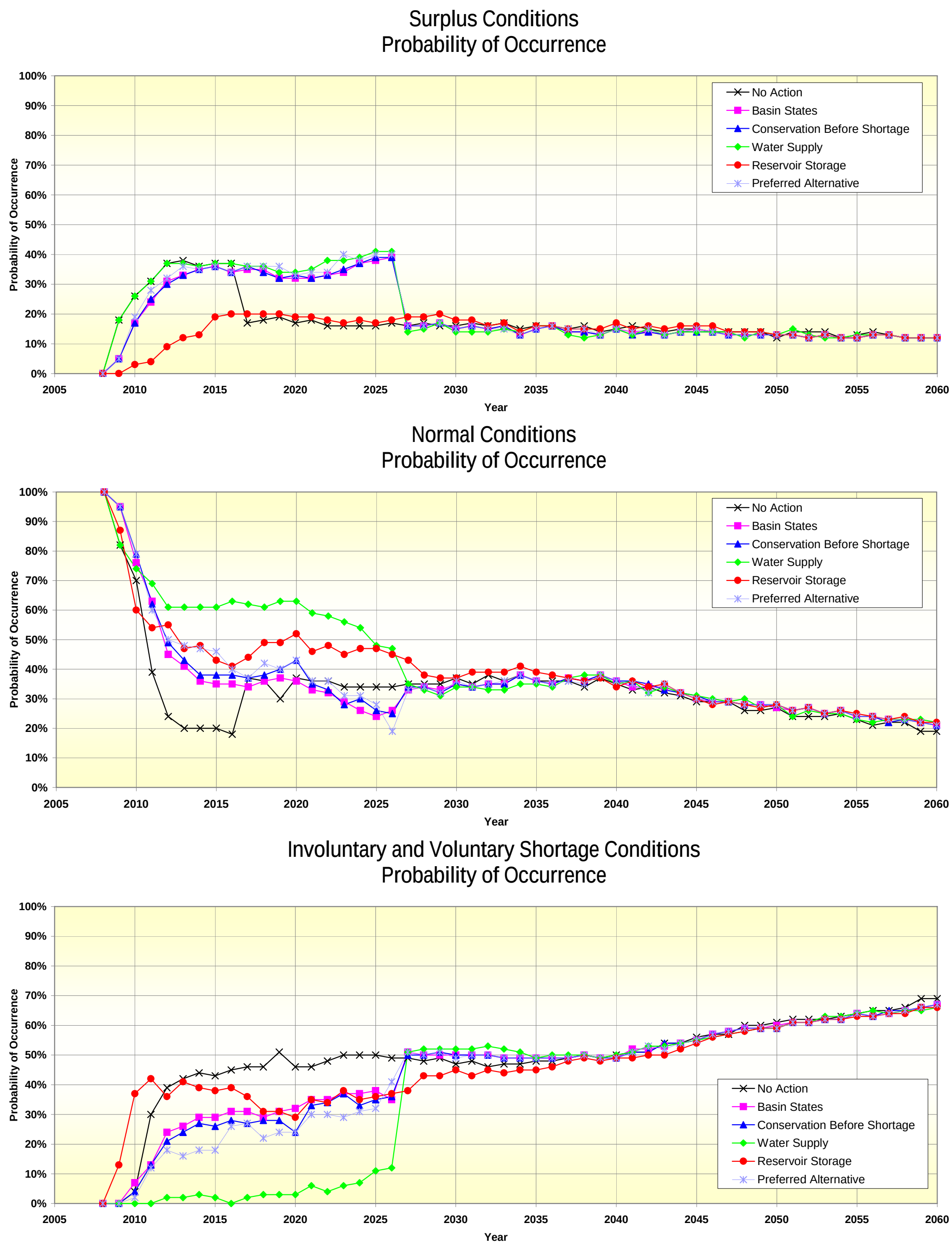
Figure 4.4-18
Normal Conditions
Comparison of Action Alternatives to No Action Alternative
Probability of Occurrence



4.4.4.4 Summary of Water Supply Conditions

Figure 4.4-19 illustrates the probabilities of occurrence for the three water supply conditions (Surplus, Normal, and Shortage) under all alternatives.

Figure 4.4-19
Surplus, Normal, and Shortage (Involuntary and Voluntary) Conditions
Comparison of Action Alternatives to No Action Alternative



4.4.5 Total Water Deliveries to the Lower Division States

This section presents the simulated water deliveries to the three Lower Division states. Deliveries to each state may deviate from a state's normal apportionment due to Surplus or Shortage conditions as well as the storage and delivery of conserved water to and from Lake Mead. For the alternatives that do not include some form of a storage and delivery mechanism (the No Action Alternative and the Water Supply Alternative), water deliveries above or below a state's apportionment occur only during Surplus conditions or Shortage conditions respectively. Water deliveries under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative in excess of a state's apportionment can occur due to a Surplus Condition as well as when conserved water previously stored in Lake Mead is delivered. Also under these alternatives, water deliveries less than a state's apportionment can occur due to a Shortage Condition as well as when water is being conserved within that state and stored in Lake Mead. In the following sections, the modeled water deliveries are presented with and without the storage and delivery mechanism to facilitate understanding of the differences.

4.4.5.1 Total Water Deliveries to Arizona

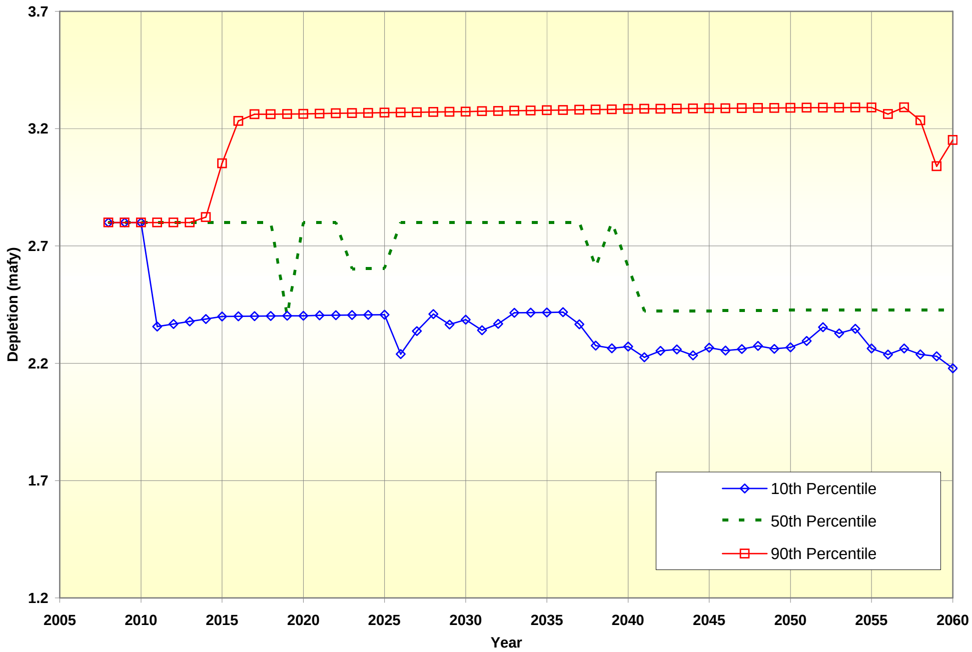
This section presents the simulated water deliveries to Arizona under the No Action Alternative and the action alternatives.

No Action Alternative. Water deliveries to Arizona are projected to fluctuate throughout the 53-year period of analysis reflecting variations in hydrologic conditions. The 90th, 50th, and 10th percentile ranking of modeled water deliveries to Arizona under the No Action Alternative are presented in Figure 4.4-20. Since the No Action Alternative does not include a storage and delivery mechanism, deviations from annual deliveries of 2.8 mafy are due to Shortage and Surplus conditions.

The 90th percentile line generally coincides with Arizona's depletion schedule during full surplus water supply conditions. The exceptions to this are the periods from 2008 through 2015 and 2056 through 2060. As indicated by this 90th percentile line, the probability that the No Action Alternative would provide Arizona's Full Surplus depletion schedule is at least ten percent for the period 2016 through 2055.

The 50th percentile line represents the median annual depletion values. This 50th percentile line generally coincides with Arizona's projected depletion schedule under Normal conditions through year 2018. After 2018, the median annual Arizona modeled depletion values fluctuate between 2.40 maf and 2.80 maf.

Figure 4.4-20
Arizona Modeled Annual Depletions
No Action Alternative
90th, 50th, and 10th Percentile Values



The 10th percentile line represents the depletion values above which 90 percent of the annual depletion values were observed. The 10th percentile annual depletion values were 2.80 maf from 2008 through 2010 and approximately 2.4 maf from 2011 through 2025. Between 2025 and 2037, the 10th percentile annual depletion values fluctuated between 2.24 maf and 2.42 maf, and after 2037, the annual depletion values fluctuated between 2.18 maf and 2.35 maf.

Comparison of Action Alternatives Without the Storage and Delivery Mechanism to No Action Alternative. Figure 4.4-21 provides a comparison of the cumulative distribution of Arizona's depletions under the action alternatives without the storage and delivery mechanism to depletions under the No Action Alternative during the interim period, 2008 through 2026. The results presented in Figure 4.4-21 can be used to compare how often Arizona might expect deliveries above and below its 2.8 mafy apportionment due to surplus and shortage conditions under the different alternatives. The relatively larger shortages occurring at probabilities of about five percent or less under the Conservation Before Shortage Alternative and the No Action Alternative are the result of shortages implemented to keep Lake Mead elevation above 1,000 feet msl.

Figure 4.4-21
Arizona Modeled Annual Depletions
Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative
Years 2008 through 2026

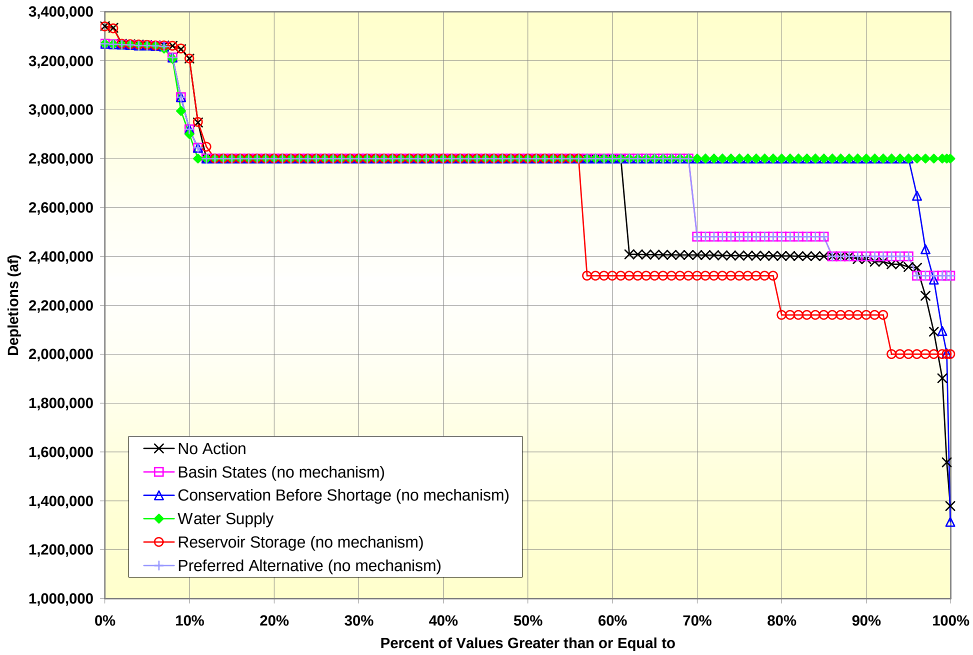


Figure 4.4-22 provides a similar comparison of the cumulative distribution of water deliveries to Arizona under the action alternatives without the storage and delivery mechanism to depletions under the No Action Alternative for the 34-year period 2027 through 2060, that would follow the interim period.

Sensitivity of Total Water Deliveries to Arizona to Storage and Delivery Mechanism. Arizona water deliveries under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative are impacted by the modeling assumptions made to postulate potential future participation in a storage and delivery mechanism (Appendix M). This section isolates the impacts of those assumptions on Arizona's modeled depletions.

Figure 4.4-22
Arizona Modeled Annual Depletions
Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative
Years 2027 through 2060

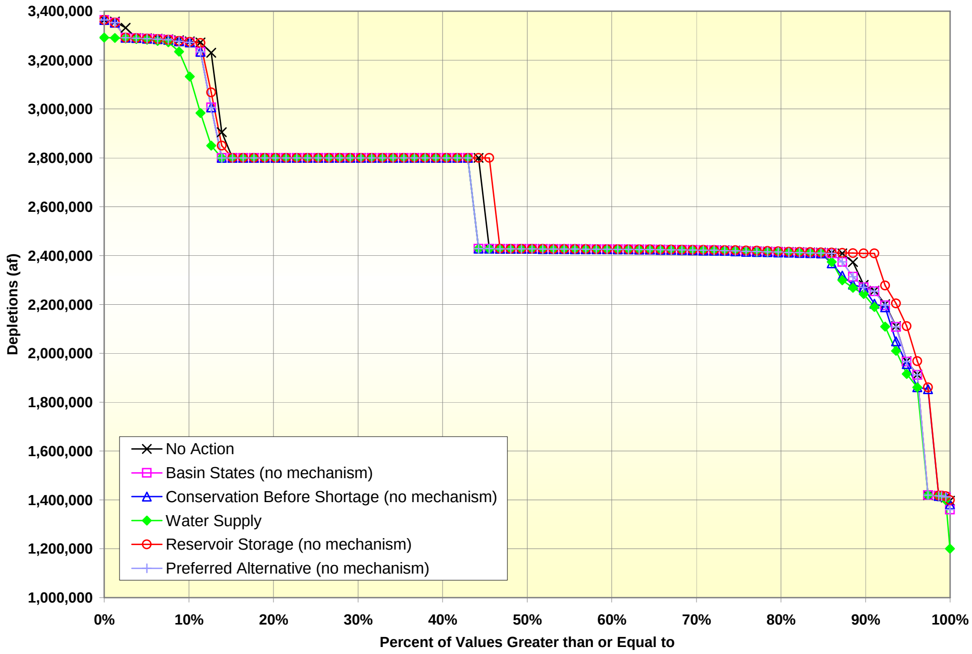


Figure 4.4-23 provides a comparison of the cumulative distribution of Arizona's depletions under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative, with and without the mechanism in place during the interim period. With the mechanism in place, deliveries of 2.7 mafy are due to the storage of conserved water. With the mechanism removed, occurrences of deliveries less than 2.8 mafy or greater than 2.8 mafy reflect only shortage or surplus conditions respectively. These observations mirror the effects of the mechanism on the probability of voluntary and involuntary total Lower Basin Shortage and Surplus conditions presented in the previous subsection.

Figure 4.4-23
Arizona Modeled Annual Depletions
Comparison of Action Alternatives With and Without Storage and Delivery Mechanism
Years 2008 through 2026

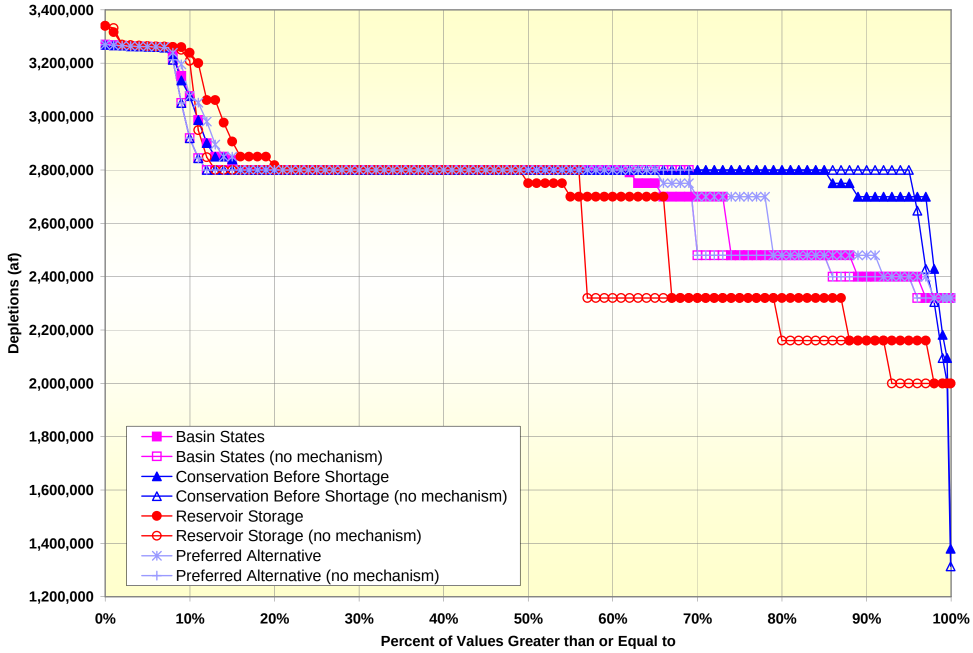
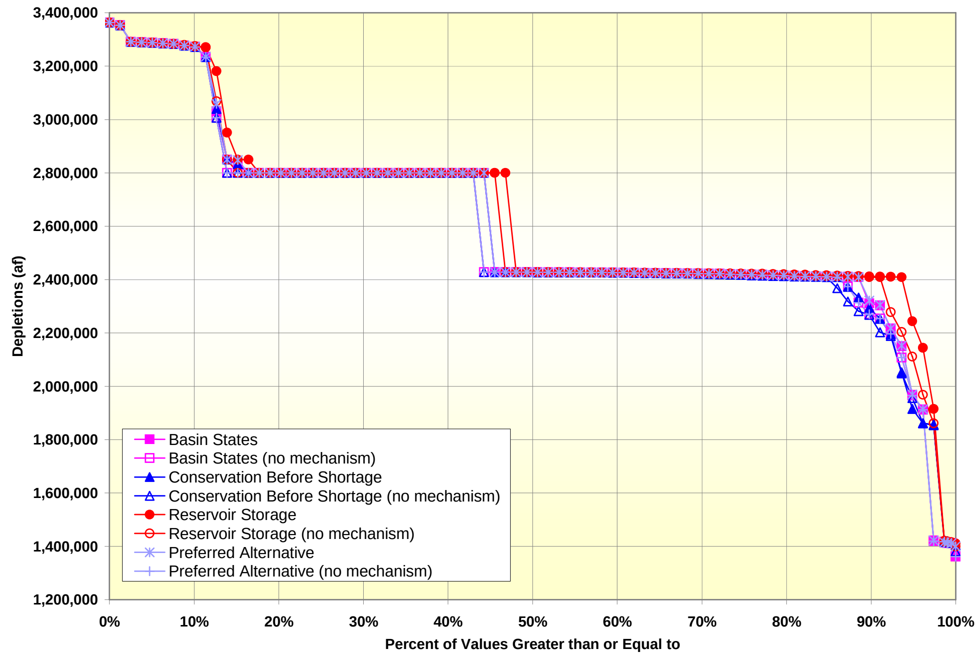


Figure 4.4-24 provides a comparison of the cumulative distribution of Arizona's depletions under the action alternatives that include a storage and delivery mechanism, with and without the mechanism in place for the 34-year period that would follow the interim period. There is almost no effect of the mechanism during these years as it is assumed that only conserved water previously stored in Lake Mead may be delivered during this period.

Figure 4.4-24
Arizona Modeled Annual Depletions
Comparison of Action Alternatives With and Without Storage and Delivery Mechanism
Years 2027 through 2060

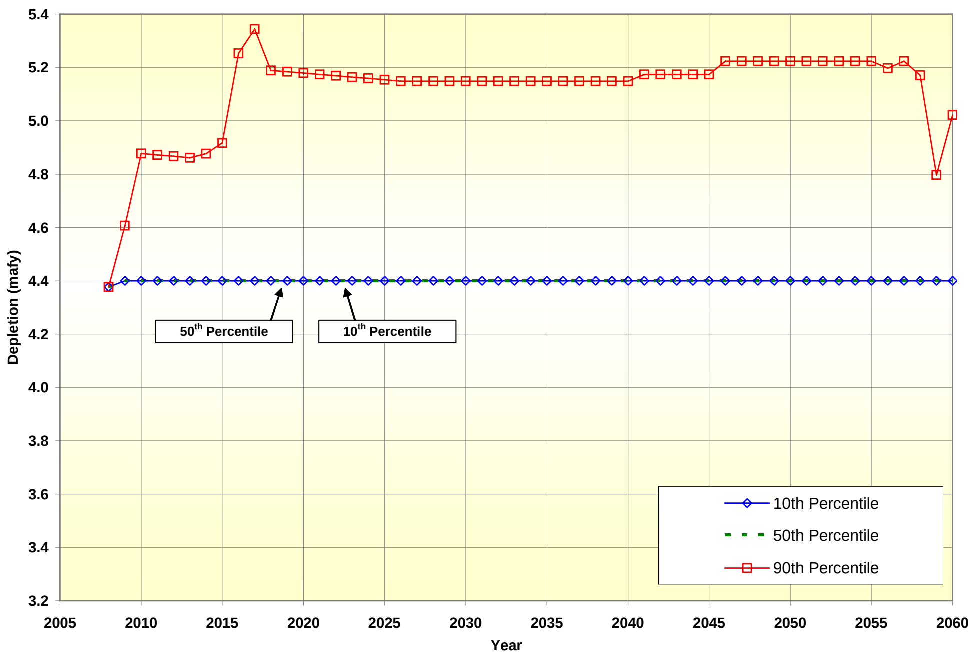


4.4.5.2 Total Water Deliveries to California

This section presents the simulated water deliveries to California under the No Action Alternative and the action alternatives.

No Action Alternative. Water deliveries to California are projected to fluctuate throughout the 53-year period of analysis reflecting variations in hydrologic conditions. The 90th, 50th, and 10th percentile ranking of modeled water deliveries to California under the No Action Alternative are presented in Figure 4.4-25. Since the No Action Alternative does not include a storage and delivery mechanism, deviations from annual deliveries of 4.4 mafy are due to Shortage and Surplus conditions.

Figure 4.4-25
California Modeled Annual Depletions
No Action Alternative
90th, 50th, and 10th Percentile Values



The 90th percentile line generally coincides with California's depletion schedule during full surplus water supply conditions. The exceptions to this are the periods from 2008 through 2015 and from 2056 through 2060. As indicated by this 90th percentile line, the probability that the No Action Alternative would provide California's Full Surplus depletion schedule is at least ten percent for the period from 2016 through 2055.

The 50th percentile line represents the median annual depletion values. This 50th percentile line coincides with California's projected depletion schedule under Normal conditions throughout the 53-year period of analysis.

The 10th percentile line represents the depletion values above which 90 percent of the annual depletion values were observed. The 10th percentile annual depletion values also coincide with California's projected depletion schedule under a Normal Condition throughout the 53-year period of analysis. This means that there is at least a 90 percent probability that California will receive its normal deliveries from 2008 through 2060.

Comparison of Action Alternatives Without the Storage and Delivery Mechanism to No Action Alternative. Figure 4.4-26 provides a comparison of the cumulative distribution of California's depletions under the action alternatives without the storage and delivery mechanism to those of the No Action Alternative during the interim period, 2008 through 2026. The results presented in Figure 4.4-26 can be used to compare how often California might expect deliveries above and below its 4.4 mafy apportionment due to Surplus and Shortage conditions under the different alternatives. Very infrequent (less than one percent of the time) shortages are observed only for the No Action Alternative and the Conservation Before Shortage Alternative due to the assumption that shortages are implemented to keep Lake Mead above elevation 1,000 feet msl. The five percent occurrence of deliveries less than 4.4 mafy when the mechanism is not in place reflects California's scheduled delivery of less than 4.4 maf in 2008 which coincides with scheduled repayment of overruns by IID and CVWD.

Figure 4.4-26
California Modeled Annual Depletions
Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative
Years 2008 through 2026

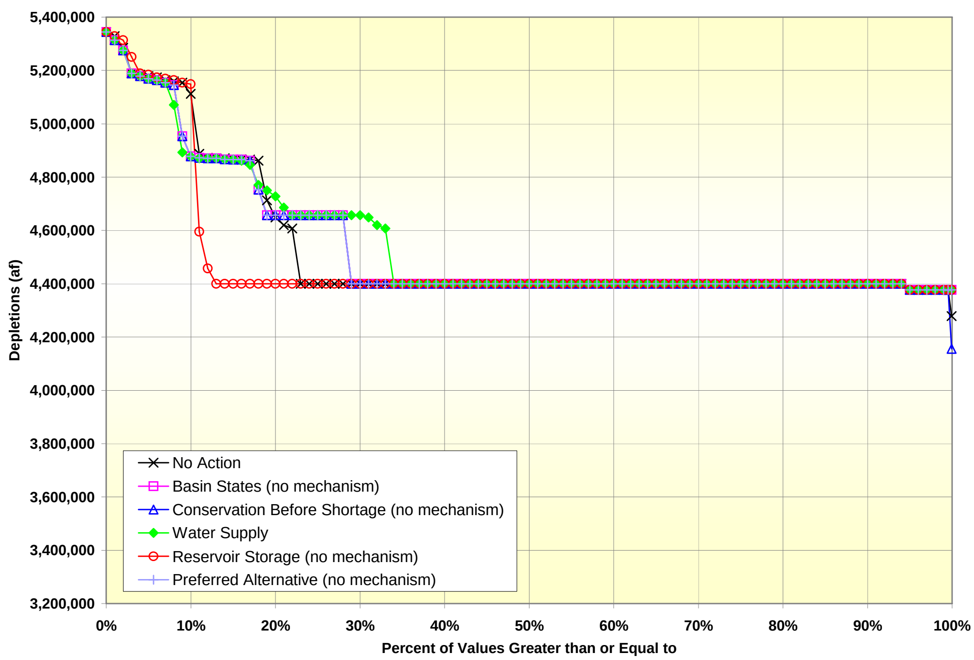
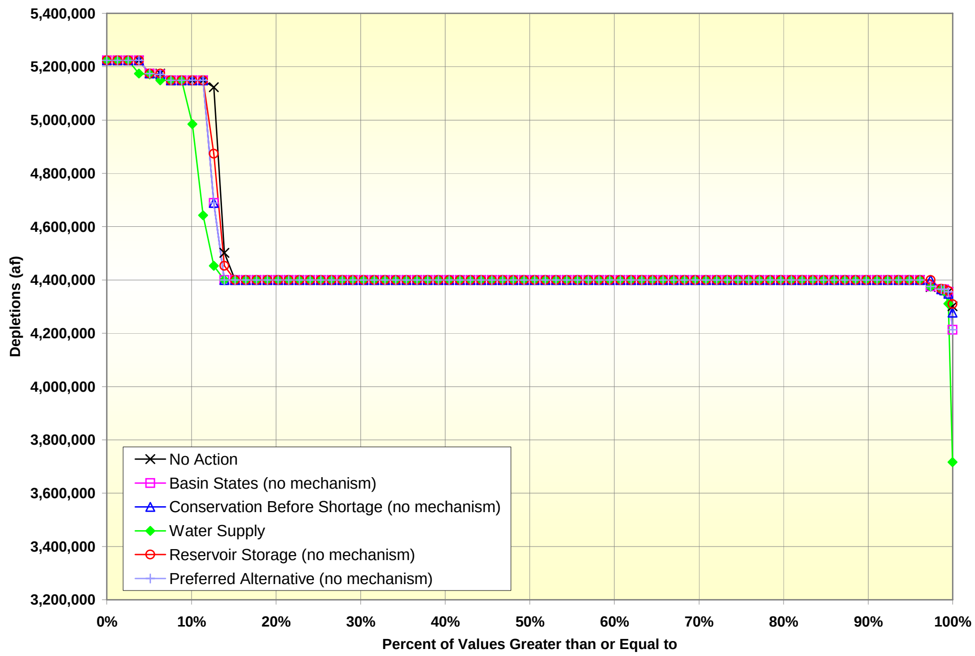


Figure 4.4-27 provides a similar comparison of the cumulative distribution of water deliveries to California under the action alternatives without the storage and delivery mechanism to those of the No Action Alternative for the 34-year period, 2027 through 2060, that would follow the interim period.

Figure 4.4-27
California Modeled Annual Depletions
Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative
Years 2027 through 2060



Sensitivity of Total Water Deliveries to California to Storage and Delivery Mechanism. California water deliveries under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative are impacted by modeling assumptions made to postulate potential future participation in a storage and delivery mechanism (Appendix M). This section isolates the impacts of those assumptions on California's depletions.

Figure 4.4-28 provides a comparison of the cumulative distribution of California's depletions under the action alternatives with and without a storage and delivery mechanism in place during the interim period. For alternatives with the mechanism removed, occurrences of deliveries less than 4.4 mafy reflect only Shortage conditions. Removing the mechanism shows that there is almost no occurrence of deliveries less than 4.4 mafy due to shortage conditions. The five percent occurrence of deliveries less than 4.4 mafy when the mechanism is not in place reflects California's scheduled delivery of less than 4.4 maf in 2008 which coincides with scheduled repayment of overruns by IID and CVWD.

Figure 4.4-28
California Modeled Annual Depletions
Comparison of Action Alternatives With and Without Storage and Delivery Mechanism
Years 2008 through 2026

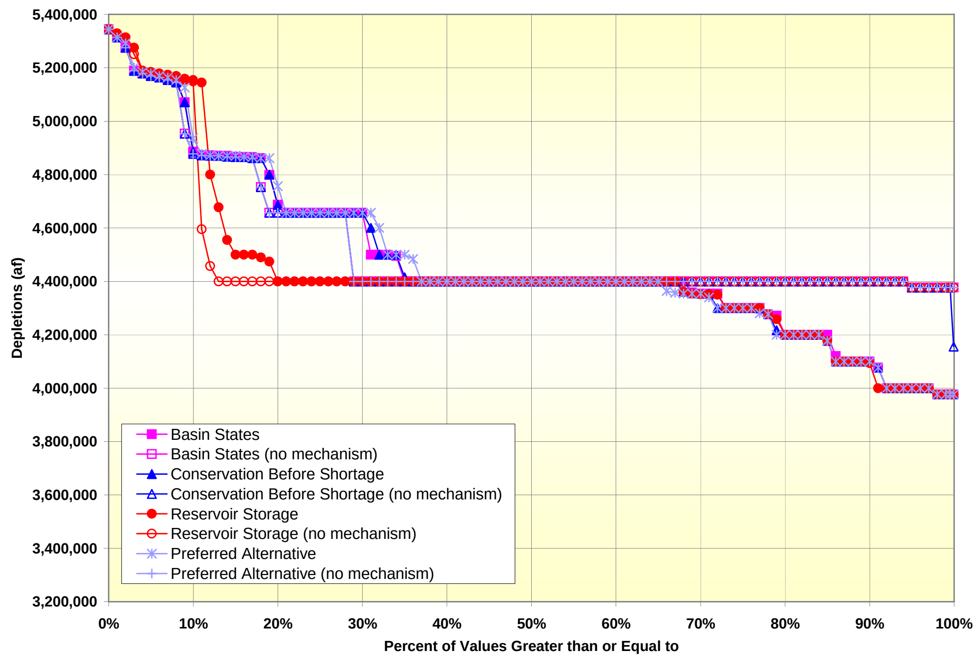
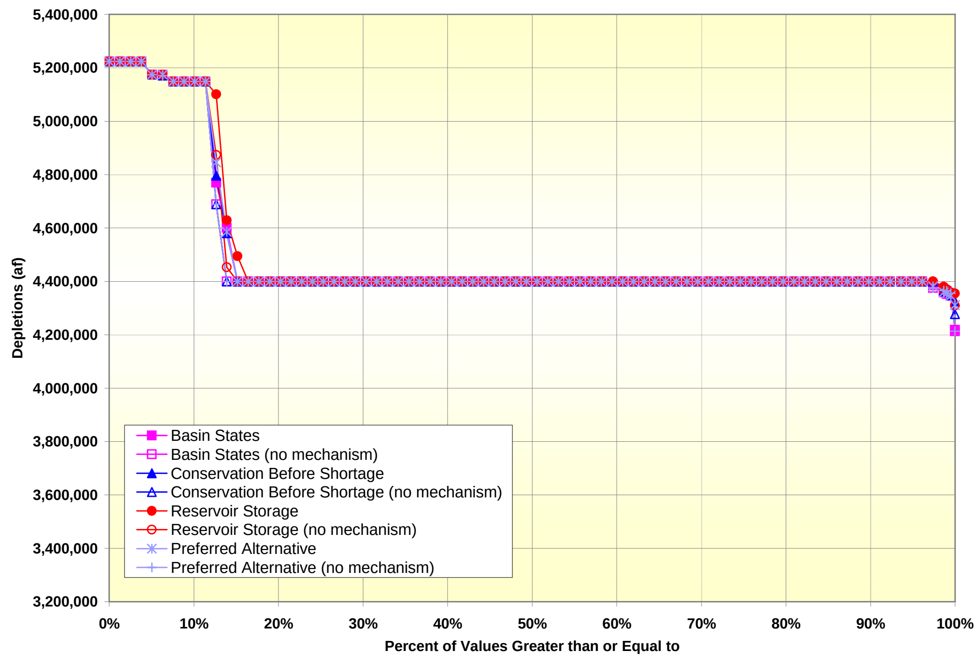


Figure 4.4-29 provides a comparison of the cumulative distribution of California's depletions under the action alternatives that include a storage and delivery mechanism, with and without the mechanism in place for the 34-year period that would follow the interim period. There is almost no effect of the mechanism during these years as it is assumed only conserved water previously stored in Lake Mead may be delivered during this period.

Figure 4.4-29
California Modeled Annual Depletions
Comparison of Action Alternatives With and Without Storage and Delivery Mechanism
Years 2027 through 2060

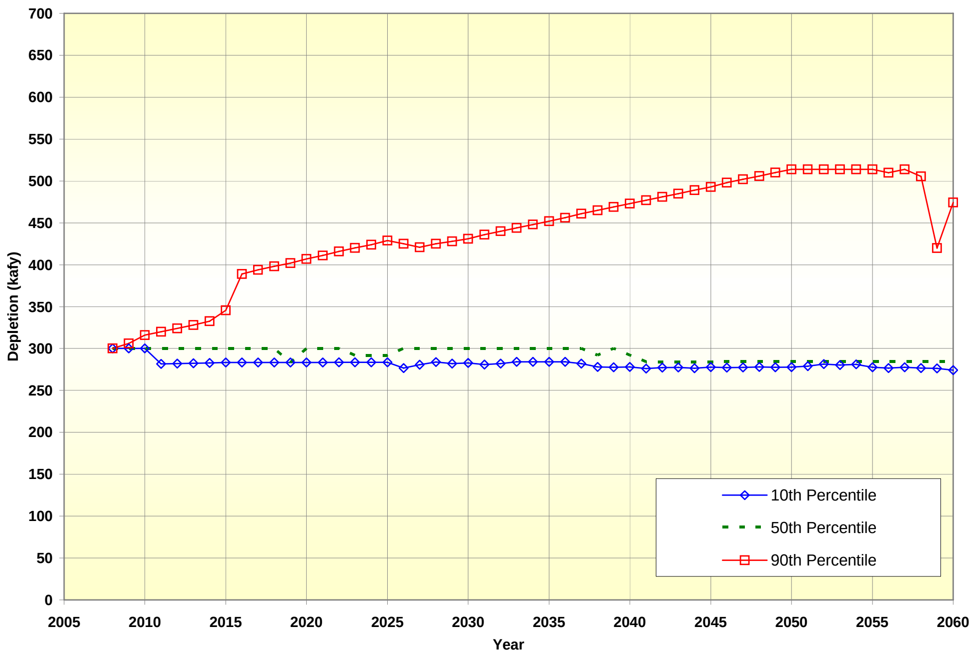


4.4.5.3 Total Water Deliveries to Nevada

This section presents the simulated water deliveries to Nevada under the No Action Alternative and the action alternatives.

No Action Alternative. Water deliveries to Nevada are projected to fluctuate throughout the 53-year period of analysis reflecting variations in hydrologic conditions. The 90th, 50th, and 10th percentile ranking of modeled water deliveries to Nevada under the No Action Alternative are presented in Figure 4.4-30. Since the No Action Alternative does not include a storage and delivery mechanism, deviations from annual deliveries of 300 kafy are due to Shortage and Surplus conditions.

Figure 4.4-30
Nevada Modeled Annual Depletions
No Action Alternative
90th, 50th, and 10th Percentile Values



The 90th percentile line generally coincides with Nevada's depletion schedule during full surplus water supply conditions. The exception to this is the period of 2056 through 2060. As indicated by this 90th percentile line, the probability that the No Action Alternative would provide Nevada's Full Surplus depletion schedule is at least ten percent for the period of 2008 through 2055.

The 50th percentile line represents the median annual depletion values. This 50th percentile line generally coincides with Nevada's projected depletion schedule under a Normal Condition throughout the 53-year period of analysis.

The 10th percentile line represents the depletion values above which 90 percent of the annul depletion values were observed. The 10th percentile annual depletion values were 300 kaf from 2008 to 2010 and fluctuated between 274.1 kaf and 284.1 kaf for the remainder of the 53-year period.

Comparison of Action Alternatives Without the Storage and Delivery Mechanism to No Action Alternative. Figure 4.4-31 provides a comparison of the cumulative distribution of Nevada's depletions under the action alternatives without the storage and delivery mechanism to those of the No Action Alternative during the interim period, 2008 through 2026. The results presented in Figure 4.4-31 can be used to compare how often Nevada might expect deliveries above and below its 300 kafy apportionment due to Surplus and Shortage conditions under the different alternatives. Deliveries of less than 250 kafy observed infrequently under the Basin States and Water Supply alternatives, as well as under the Preferred Alternative, are the result of Lake Mead elevation declining below 1,000 feet msl. Deliveries of less than 250 kafy observed infrequently under the Conservation Before Shortage Alternative, as well as the No Action Alternative, are the result of Lake Mead larger shortages to keep Lake Mead above elevation 1,000 feet msl.

Figure 4.4-31
Nevada Modeled Annual Depletions
Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative
Years 2008 through 2026

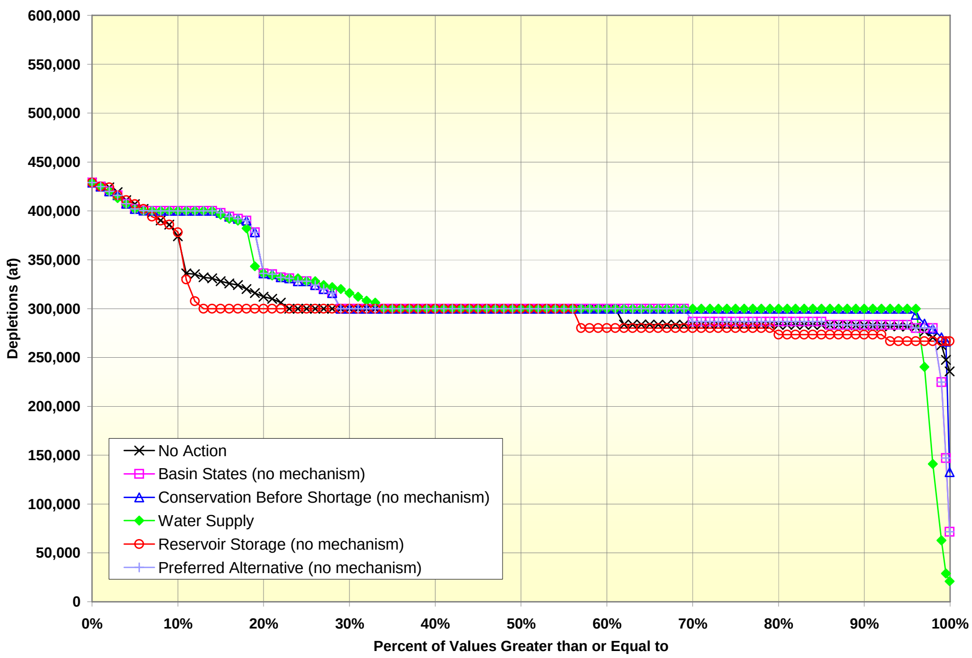
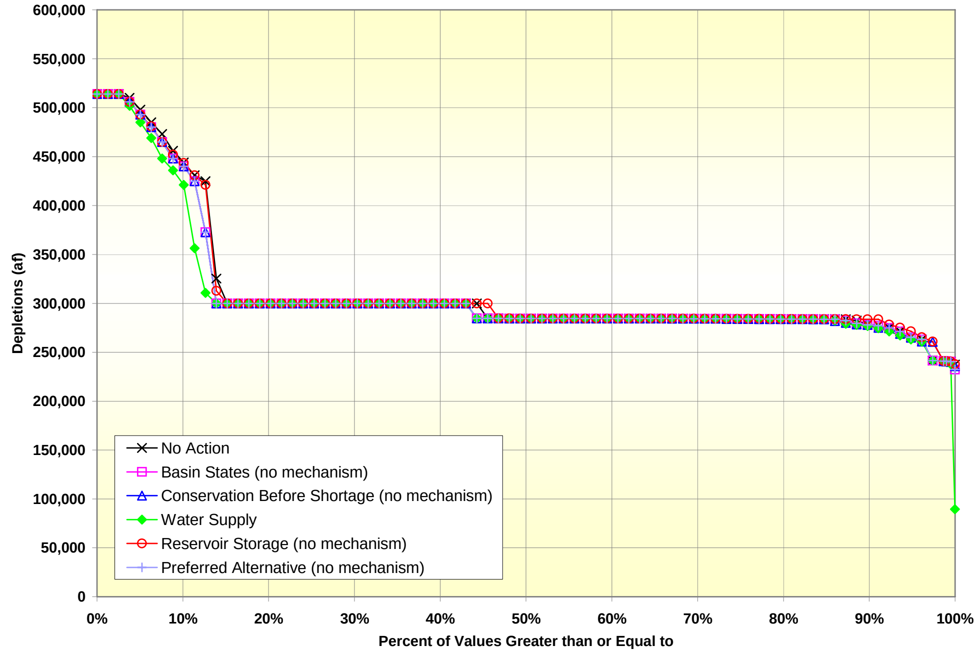


Figure 4.4-32 provides a similar comparison of the cumulative distribution of water deliveries to Nevada under the action alternatives without the storage and delivery mechanism to those of the No Action Alternative for the 34-year period, 2027 through 2060, that would follow the interim period.

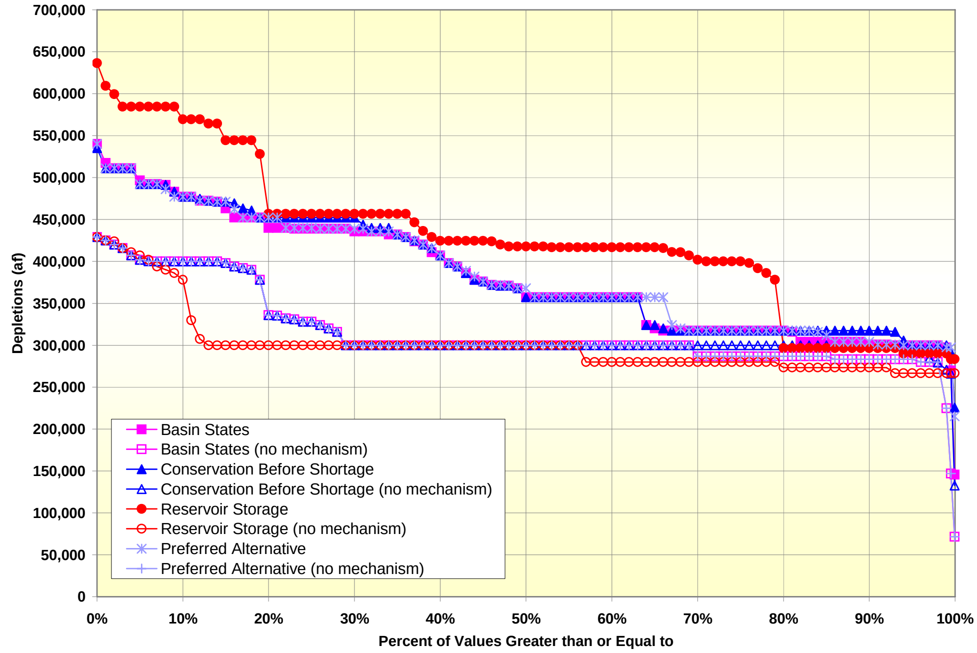
Figure 4.4-32
Nevada Modeled Annual Depletions
Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative
Years 2027 through 2060



Sensitivity of Total Water Deliveries to Nevada to Storage and Delivery Mechanism. Nevada water deliveries under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative are impacted by the modeling assumptions made to postulate potential future participation in a storage and delivery mechanism (Appendix M). This section isolates the impacts of those assumptions on Nevada's modeled depletions.

Figure 4.4-33 provides a comparison of the cumulative distribution of Nevada's depletions under the action alternatives with and without a storage and delivery mechanism in place during the interim period. With the mechanism removed the occurrence of deliveries greater than 300 kafy is about 65 percent less under the Reservoir Storage and Conservation Before Shortage Alternatives. Under the Basin States Alternative and the Preferred Alternative, the occurrence of deliveries above 300 kafy is about 55 percent less with the mechanism removed. This indicates that the majority of the occurrences of deliveries above 300 kafy under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative can be attributed to the delivery of conserved system and non-system water to Nevada. Also, the magnitude of deliveries above 300 kafy is less with the storage and delivery mechanism not in place. Under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative, deliveries range from about 55 kaf to 140 kaf less. Under the Reservoir Storage Alternative, deliveries range from about 100 kaf to 265 kaf less.

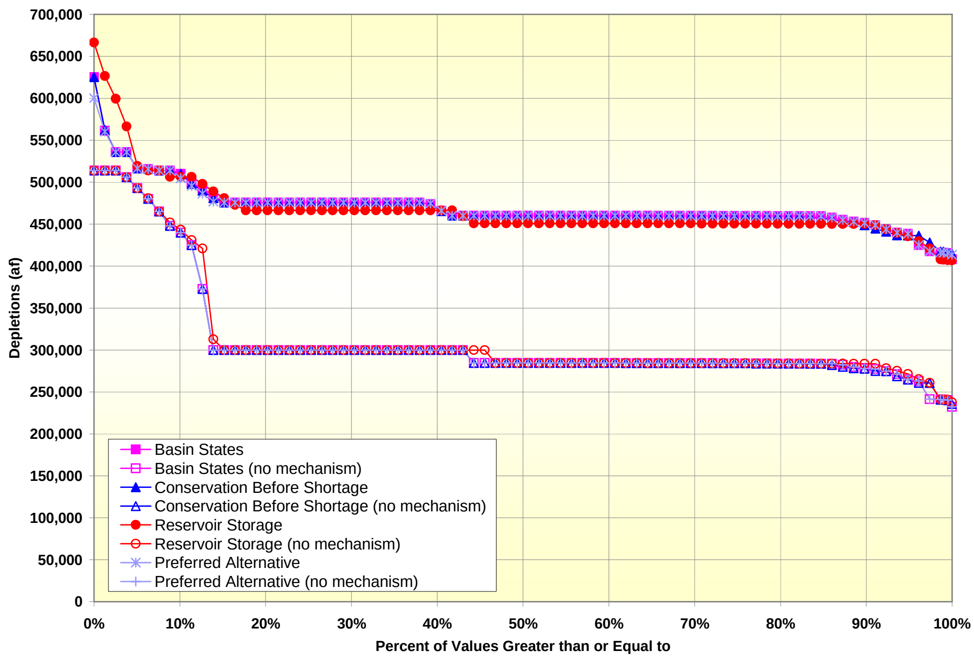
Figure 4.4-33
Nevada Modeled Annual Depletions
Comparison of Action Alternatives With and Without Storage and Delivery Mechanism
Years 2008 through 2026



With the mechanism removed the occurrence of deliveries less than 300 kafy is about 30 percent greater under the Basin States Alternative, two percent greater under the Conservation Before Shortage Alternative, about 40 percent greater under the Reservoir Storage Alternative, and about 30 percent greater under the Preferred Alternative. This indicates that as a result of the delivery of conserved system and non-system water, Nevada does not often receive deliveries less than 300 kafy.

Figure 4.4-34 provides a comparison of the cumulative distribution of Nevada's depletions under the action alternatives that include a storage and delivery mechanism, with and without the mechanism in place for the 34-year period that would follow the interim period. The results of the mechanism removed emphasize the modeling assumption that there is about 170 kafy of conserved system and non-system water available to Nevada after the interim period under these alternatives (Appendix M).

Figure 4.4-34
Nevada Modeled Annual Depletions
Comparison of Action Alternatives With and Without Storage and Delivery Mechanism
Years 2027 through 2060

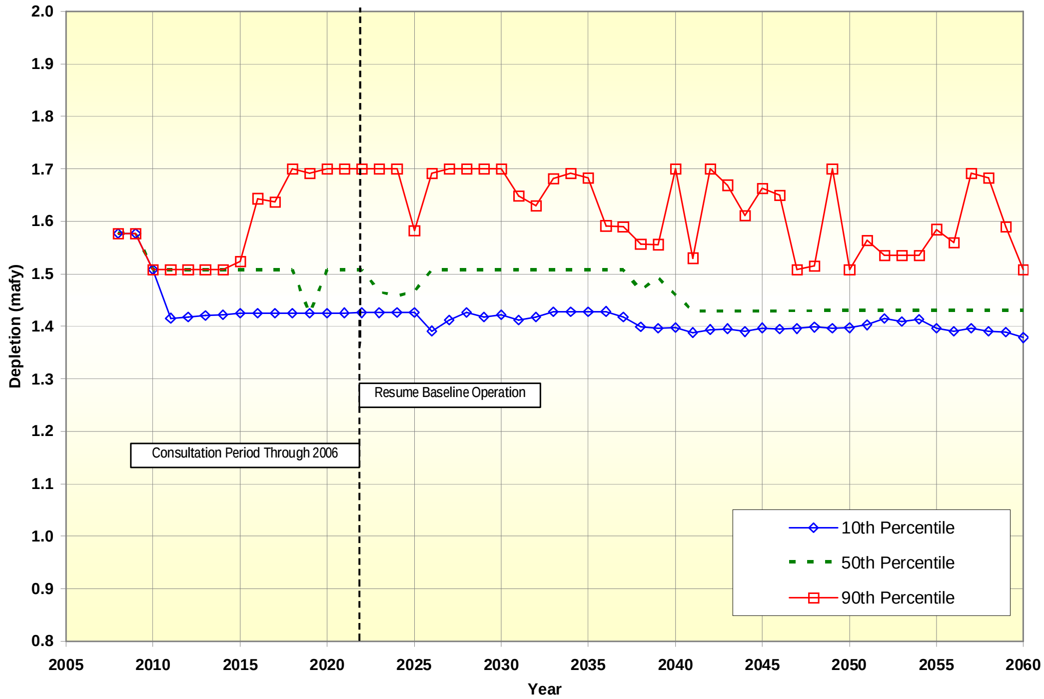


4.4.6 Water Deliveries to Mexico

This section presents the simulated water deliveries to Mexico under the No Action Alternative and the action alternatives. The model assumes a delivery to Mexico of 1.5 mafy with additional deliveries of up to 200 kaf when Lake Mead is in flood control operations. Reductions in deliveries to Mexico are simulated consistent with the modeling assumptions noted in Section 2.2, Section 4.2, and Appendix A. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The sensitivity of water deliveries to Mexico and other hydrologic variables (e.g., Lake Mead elevation) to these modeling assumptions was analyzed and the results of this analysis are presented in Appendix Q.

No Action Alternative. Water deliveries to Mexico are projected to fluctuate throughout the 53-year period of analysis reflecting variations in hydrologic conditions. The 90th, 50th, and 10th percentile ranking of modeled water deliveries to Mexico under the No Action Alternative are presented in Figure 4.4-35. Since the No Action Alternative does not include a storage and delivery mechanism, deviations from annual deliveries of 1.5 mafy are due to the modeling assumptions with respect to water delivery reductions and additional deliveries to Mexico as described in Section 2.2, Section 4.2, and Appendix A.

Figure 4.4-35
Mexico Modeled Annual Depletions
No Action Alternative
90th, 50th, and 10th Percentile Values



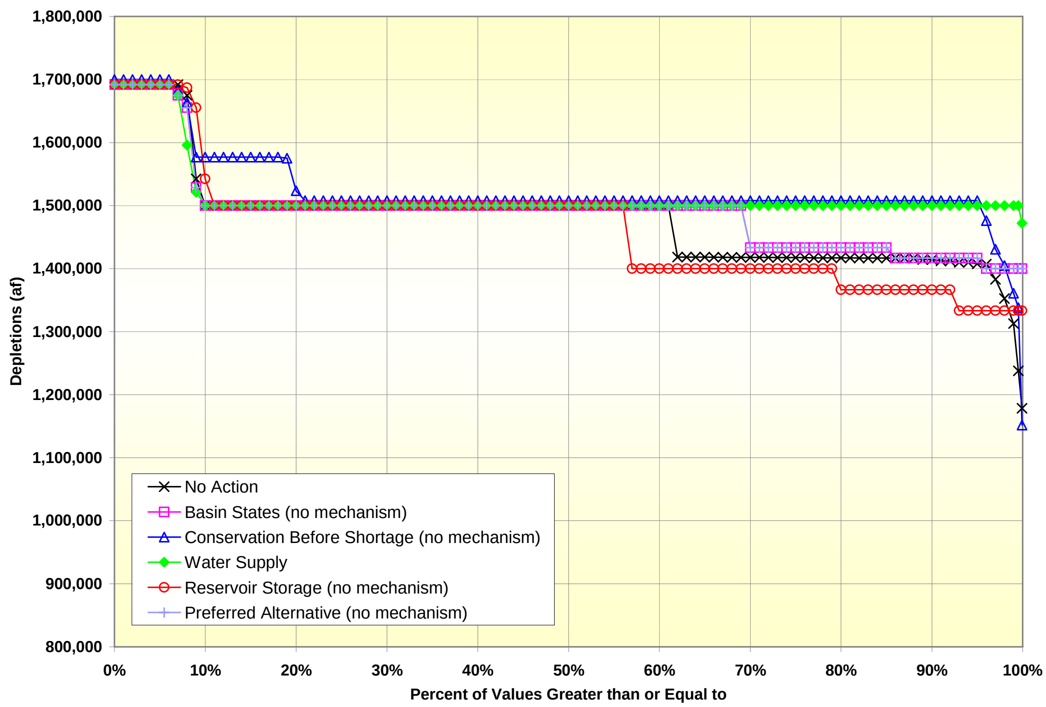
The upper range of 90th percentile annual depletion values shown on Figure 4.4-35 generally coincides with Mexico's depletion schedule during Lake Mead flood control operations. The 90th percentile values fluctuate between 1.5 mafy to 1.7 mafy between 2008 through 2060.

The 50th percentile line represents the median annual depletion values (1.5 mafy) from 2008 through 2018. After 2018, the 50th percentile annual depletion values fluctuate between 1.425 maf and 1.5 maf. The drop in the modeled water deliveries to Mexico below Mexico's 1.5 maf allotment reflects the modeling assumptions with respect to reductions in water deliveries.

The 10th percentile line coincides with the median annual depletion values (1.5 mafy) from 2008 through 2009 and falls to 1.416 mafy in 2011. After 2011, the annual depletion values fluctuate between 1.378 mafy and 1.428 mafy. The drop in the modeled water deliveries to Mexico below Mexico's 1.5 maf allotment reflects the modeling assumptions with respect to reductions in water deliveries.

Comparison of Action Alternatives Without the Storage and Delivery Mechanism to No Action Alternative. Figure 4.4-36 provides a comparison of the cumulative distribution of Mexico's depletions under the action alternatives without the storage and delivery mechanism to those of the No Action Alternative during the interim period, 2008 through 2026. The results presented in Figure 4.4-36 can be used to compare how often Mexico might expect deliveries above and below its 1944 Treaty allocation of 1.5 mafy under the different alternatives. The occurrences of deliveries greater than 1.5 mafy reflect times when Hoover Dam is under flood control operations (Mexico can order additional water up to 1.7 mafy).

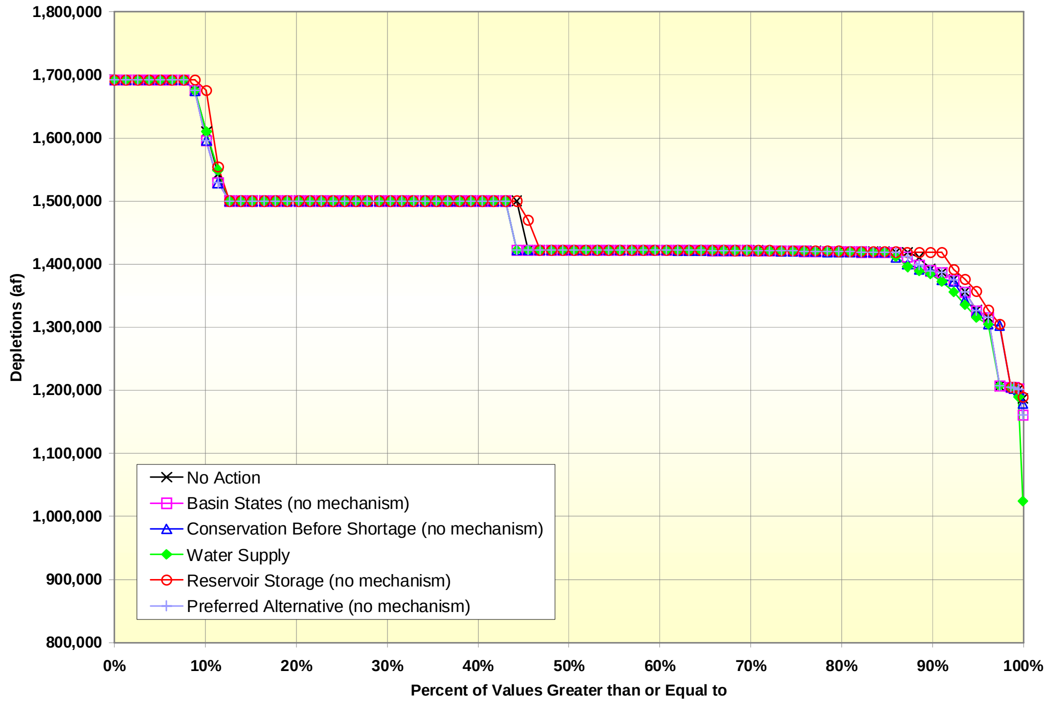
Figure 4.4-36
Mexico Modeled Annual Depletions
Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative
Years 2008 through 2026



The occurrences of deliveries less than 1.5 mafy reflect the modeling assumptions with regard to reductions in water deliveries to Mexico (Section 2.2 and Appendix Q).

Figure 4.4-37 provides a similar comparison of the cumulative distribution of the water deliveries to Mexico under the action alternatives without the storage and delivery mechanism to those of the No Action Alternative for the 34-year period, years 2027 through 2060, that would follow the interim period.

Figure 4.4-37
Mexico Modeled Annual Depletions
Comparison of Action Alternatives With and Without Storage and Delivery Mechanism
Years 2027 through 2060



4.4.7 Distribution of Shortages to and within the Lower Division States

Although the Consolidated Decree and the CRBPA provide some direction to the Secretary with regard to the distribution of shortages to the Lower Division states, no specific guidelines exist with regard to exactly how those shortages would be distributed. Furthermore, although priority systems exist within each state, exactly how shortages would be distributed to water users of equal priority within a state is unknown. Therefore, specific modeling assumptions were made in order to facilitate the comparison of each alternative. These assumptions, discussed in Section 4.2, Appendix A, and Appendix G are consistent among all alternatives.

Total Lower Basin shortages of 200 kaf to 2.5 maf were analyzed to consider how shortages within this range would be distributed among and within the Lower Division states. Because the shortage sharing assumptions are identical under all alternatives, the distribution of the shortage volumes would be identical under the different alternatives. The factor that changes is the probability or frequency that the different shortage volumes would occur under the different alternatives.

Table 4.4-12 and Table 4.4-13 provide the probability of occurrence of the total Lower Basin shortage volumes that are less than or equal to those shown in Table 4.4-12 for two periods, 2008 through 2026 and 2027 through 2060, respectively. The probability of shortages with a magnitude of zero includes periods when a Surplus Condition or a Normal Condition are in effect.

Table 4.4-12
Probability of Occurrence of Shortages Less Than or Equal to, Years 2008 through 2026 (percent)

Alternative	Total Voluntary or Involuntary Lower Basin Shortage (af)									
	0	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
No Action	61.6	61.6	61.6	86.4	96.3	97.5	98.5	99.3	99.8	100.0
Basin States	73.7	73.7	88.5	96.5	99.4	100.0	100.0	100.0	100.0	100.0
Conservation Before Shortage	75.8	76.2	90.4	97.3	98.3	99.2	99.7	99.8	99.8	100.0
Water Supply	96.5	98.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Reservoir Storage	66.9	66.9	66.9	66.9	87.4	97.6	97.6	100.0	100.0	100.0
Preferred Alternative	78.9	78.9	91.4	97.3	99.7	100.0	100.0	100.0	100.0	100.0

Table 4.4-13
Probability of Occurrence of Shortages Less Than or Equal to, Years 2027 through 2060 (percent)

Alternative	Total Voluntary or Involuntary Lower Basin Shortage (af)									
	0	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
No Action	44.59	44.59	44.59	88.26	89.21	93.03	94.35	96.62	99.59	100.00
Basin States	44.44	44.44	44.44	88.71	89.59	93.15	94.62	96.59	99.12	100.00
Conservation Before Shortage	44.47	44.47	44.47	86.71	89.12	92.44	93.88	97.97	99.74	100.00
Water Supply	43.94	43.94	43.94	85.85	86.97	91.29	93.76	96.15	99.21	99.85
Reservoir Storage	46.82	46.82	46.82	93.94	94.35	95.35	96.71	97.74	100.00	100.00
Preferred Alternative	44.50	44.50	44.50	88.85	89.79	93.47	94.71	96.82	99.18	100.00

4.4.7.1 Distribution of Shortages within Arizona

Table 4.4-14 provides Lower Basin shortage volumes up to 2.5 maf and the portions of these shortage amounts that were assumed to be distributed to Arizona. This table shows the shortage distribution in different years because the distribution changes at the higher magnitudes of shortage due to the changes in the scheduled use of the Arizona 4th Priority water users (Appendix G).

Table 4.4-14
Shortage Allocation to Arizona (af)

Year	Total Lower Basin Shortage								
	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
2008	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,440,000	1,587,484
2017	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,397,578	1,533,925
2026	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,394,205	1,530,879
2027	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,393,837	1,530,547
2040	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,388,281	1,525,531
2060	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,388,281	1,525,531

Under most circumstances, the probabilities of involuntary and voluntary shortages being allocated to Arizona are the same as the probability of shortage allocations to the Lower Basin under the No Action Alternative for each of the action alternatives. The overall probabilities are presented in Table 4.4-12 and Table 4.4-13. Table 4.4-15 presents the maximum observed reductions in water deliveries to Arizona under the No Action Alternative and the five action alternatives for selected years.

Table 4.4-15
Maximum Observed Reductions in Water Deliveries to Arizona for Selected Years (af)

Year	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008	0	0	0	0	0	0
2017	852,769	480,000	789,937	0	800,000	480,000
2026	1,397,415	480,000	1,414,524	0	800,000	480,000
2027	1,397,227	1,437,602	1,394,487	1,599,660	390,915	663,773
2040	1,381,742	1,390,718	1,383,204	1,424,813	1,384,344	1,392,854
2060	1,401,001	1,389,377	1,386,026	1,401,001	1,385,800	1,389,377

While shortage allocations to California and Nevada would affect single entities within each state (MWD in California and SNWA in Nevada) allocations within Arizona are distributed among a number of water users based upon Arizona's system of water rights priorities and recommendations provided by ADWR during the public comment period (Section 3.4 and Appendix G). This shortage distribution does not reflect management decisions that may be taken by Arizona entities to obtain additional water supplies to offset shortages. Tables 4.4-16 through 4.4-20 summarize how shortages of different volumes in Arizona would be distributed among Arizona's priorities and how this distribution changes over time. These tables do not show 5th priority users and the CAP Bank who now rely on unused and surplus water because the assumption is that by 2017, no unused water will be available to the 5th priority users.

The allocation of shortages to individual users within the CAP is affected by the water priority system within the CAP, the AWSA, and the water use buildup schedules for the CAP users. A major change in the allocation of Arizona shortages within the CAP occurs during the period between 2017 and 2040 and can be seen in Table 4.4-16 through Table 4.4-19. Over time, the impact of a given shortage to the CAP increasingly impacts the higher priority Indian and M&I users as their use builds up, and the shortage cannot be absorbed by the lower priorities.

Prior to the enactment of the AWSA, there were differing views as to how smaller shortages would be distributed between the CAP Indian and M&I priority users. As part of the AWSA, a compromise was reached. Also, under the AWSA, the CAP irrigation districts agreed to relinquish their long-term water service subcontracts for Non-Indian Agricultural priority water. Approximately 300 kaf was relinquished, with approximately 200 kaf being made available for Indian water rights settlements and approximately 100 kaf being made available for future M&I use. In return, the irrigation districts obtained CAP distribution system debt relief, relief from the acreage limitation provisions of federal Reclamation law, and a commitment from the CAP to receive an interim water supply at an affordable rate.

Table 4.4-16
Distribution of Shortages Among Arizona Entities[1] (af), Year 2017

Lower Basin Shortage Allocations	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	6,222	14,019	17,921	21,862	30,992	40,787	50,788	79,350	79,350
4th Priority (CAP)	153,778	305,981	382,079	458,138	609,008	759,213	909,212	1,304,575	1,304,575
CAP 5: Arizona Ground Water Bank	0	0	0	0	0	0	0	0	0
CAP 4: Excess Water for Agriculture	146,088	277,891	277,891	277,891	277,891	277,891	277,891	277,891	277,891
CAP 3: Agriculture	0	998	6,637	9,026	9,026	9,026	9,026	9,026	9,026
CAP 3: Tribes	0	2,576	17,134	23,300	23,300	23,300	23,300	23,300	23,300
CAP 3: M&I	0	9,216	61,311	83,375	83,375	83,375	83,375	83,375	83,375
CAP 2: Tribes	0	0	0	40,488	92,623	144,529	196,363	328,486	328,486
CAP 2: M&I	0	0	0	1,150	92,341	183,130	273,795	512,767	512,767
2nd/3rd Priority (includes CAP 1)	0	0	0	0	0	0	0	13,653	149,999
CAP 1: Tribes	0	0	0	0	0	0	0	1,064	11,691
CAP 1: M&I	0	0	0	0	0	0	0	468	5,144
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0

1 CAP users incur five percent conveyance loss through the CAP system due to seepage and therefore the sum of the Arizona shortages in any one column do not add up to the total shortage volume allocated to Arizona at each Lower Basin Shortage increment noted at the top of the table.

Table 4.4-17
Distribution of Shortages Among Arizona Entities[1] (af), Year 2026

Lower Basin Shortage Allocations	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	6,816	14,647	18,565	23,334	33,166	43,041	53,173	81,629	81,629
4th Priority (CAP)	153,184	305,353	381,435	456,666	606,834	756,959	906,827	1,297,791	1,297,791
CAP 5: Arizona Ground Water Bank	0	0	0	0	0	0	0	0	0
CAP 4: Excess Water for Agriculture	72,075	72,075	72,075	72,075	72,075	72,075	72,075	72,075	72,075
CAP 3: Agriculture	2,694	7,998	9,026	9,026	9,026	9,026	9,026	9,026	9,026
CAP 3: Tribes	37,477	111,238	125,540	125,540	125,540	125,540	125,540	125,540	125,540
CAP 3: M&I	33,278	98,774	111,474	111,474	111,474	111,474	111,474	111,474	111,474
CAP 2: Tribes	0	0	26,494	50,582	102,474	154,352	206,141	336,744	336,744
CAP 2: M&I	0	0	17,754	65,136	155,903	246,644	337,229	573,541	573,541
2nd/3rd Priority (includes CAP 1)	0	0	0	0	0	0	0	14,785	151,460
CAP 1: Tribes	0	0	0	0	0	0	0	1,137	11,646
CAP 1: M&I	0	0	0	0	0	0	0	500	5,124
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0

1 *CAP users incur five percent conveyance loss through the CAP system due to seepage and therefore the sum of the Arizona shortages in any one column do not add up to the total shortage volume allocated to Arizona at each Lower Basin Shortage increment noted at the top of the table.*

Table 4.4-18
Distribution of Shortages Among Arizona Entities[1] (af), Year 2027

Lower Basin Shortage Allocations	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	6,819	14,654	18,650	23,477	33,313	43,199	53,339	81,782	81,782
4th Priority (CAP)	153,181	305,346	381,350	456,523	606,687	756,801	906,661	1,297,146	1,297,146
CAP 5: Arizona Ground Water Bank	0	0	0	0	0	0	0	0	0
CAP 4: Excess Water for Agriculture	33,158	33,158	33,158	33,158	33,158	33,158	33,158	33,158	33,158
CAP 3: Agriculture	3,672	8,397	9,026	9,026	9,026	9,026	9,026	9,026	9,026
CAP 3: Tribes	63,334	144,815	155,660	155,660	155,660	155,660	155,660	155,660	155,660
CAP 3: M&I	45,356	103,707	111,474	111,474	111,474	111,474	111,474	111,474	111,474
CAP 2: Tribes	0	0	27,546	51,672	103,564	155,438	207,224	337,661	337,661
CAP 2: M&I	0	0	25,417	72,705	163,470	254,204	344,785	580,808	580,808
2nd/3rd Priority (includes CAP 1)	0	0	0	0	0	0	0	14,909	151,620
CAP 1: Tribes	0	0	0	0	0	0	0	1,144	11,637
CAP 1: M&I	0	0	0	0	0	0	0	503	5,120
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0

1 *CAP users incur five percent conveyance loss through the CAP system due to seepage and therefore the sum of the Arizona shortages in any one column do not add up to the total shortage volume allocated to Arizona at each Lower Basin Shortage increment noted at the top of the table.*

Table 4.4-19
Distribution of Shortages Among Arizona Entities[1] (af), Year 2040

Lower Basin Shortage Allocations	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	6,866	14,920	19,748	24,620	34,508	44,530	55,355	85,403	85,403
4th Priority (CAP)	153,134	305,080	380,252	455,380	605,492	755,470	904,645	1,286,087	1,286,087
CAP 5: Arizona Ground Water Bank	0	0	0	0	0	0	0	0	0
CAP 4: Excess Water for Agriculture	0	0	0	0	0	0	0	0	0
CAP 3: Agriculture	3,600	5,937	5,937	5,937	5,937	5,937	5,937	5,937	5,937
CAP 3: Tribes	86,201	142,140	142,140	142,140	142,140	142,140	142,140	142,140	142,140
CAP 3: M&I	55,675	91,804	91,804	91,804	91,804	91,804	91,804	91,804	91,804
CAP 2: Tribes	0	12,705	30,871	56,016	107,890	159,717	211,266	338,579	338,579
CAP 2: M&I	0	37,240	90,488	136,714	227,447	318,099	408,266	638,823	638,823
2nd/3rd Priority (includes CAP 1)	0	0	0	0	0	0	0	16,791	154,042
CAP 1: Tribes	0	0	0	0	0	0	0	1,270	11,647
CAP 1: M&I	0	0	0	0	0	0	0	559	5,125
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0

1 *CAP users incur five percent conveyance loss through the CAP system due to seepage and therefore the sum of the Arizona shortages in any one column do not add up to the total shortage volume allocated to Arizona at each Lower Basin Shortage increment noted at the top of the table.*

Table 4.4-20
Distribution of Shortages Among Arizona Entities[1] (af), Year 2060

Lower Basin Shortage Allocations	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	7,410	16,857	22,049	27,285	37,903	48,700	59,645	89,740	89,740
4th Priority (CAP)	152,590	303,143	377,951	452,715	602,097	751,300	900,355	1,281,750	1,281,750
CAP 5: Arizona Ground Water Bank	0	0	0	0	0	0	0	0	0
CAP 4: Excess Water for Agriculture	0	0	0	0	0	0	0	0	0
CAP 3: Agriculture	4,123	5,359	5,359	5,359	5,359	5,359	5,359	5,359	5,359
CAP 3: Tribes	98,701	128,312	128,312	128,312	128,312	128,312	128,312	128,312	128,312
CAP 3: M&I	42,162	54,811	54,811	54,811	54,811	54,811	54,811	54,811	54,811
CAP 2: Tribes	0	18,528	31,742	56,594	108,215	159,775	211,283	338,579	338,579
CAP 2: M&I	0	81,000	138,854	185,028	275,320	365,503	455,597	686,126	686,126
2nd/3rd Priority (includes CAP 1)	0	0	0	0	0	0	0	16,791	154,042
CAP 1: Tribes	0	0	0	0	0	0	0	1,270	11,647
CAP 1: M&I	0	0	0	0	0	0	0	559	5,125
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0

1 *CAP users incur five percent conveyance loss through the CAP system due to seepage and therefore the sum of the Arizona shortages in any one column do not add up to the total shortage volume allocated to Arizona at each Lower Basin Shortage increment noted at the top of the table.*

4.4.7.2 Distribution of Shortages within California

This section provides a discussion of how shortages that are allocated to California are distributed to the Colorado River water entitlement holders, based on the shortage sharing assumptions programmed into the Shortage Allocation Model.

The distribution or allocation of California shortages among California's Colorado River water entitlement holders is based on California's system of water entitlement priorities. Of particular note is the frequency and magnitude of the shortages that are allocated to California. Because California's deliveries are not affected by Stage 1 shortages (Section 4.2), the total Lower Basin shortage has to exceed approximately 1.7 maf before deliveries to California are affected. As a result of this, California receives less frequent shortages than Arizona and Nevada, and the magnitude of shortages to California are smaller in proportion to the total Lower Basin shortage, as compared to those of Arizona.

Table 4.4-21 provides an overview of the portion of the total Lower Basin shortage that is allocated to California. As shown on this table, only Stage 2 shortages (Section 4.2) affect California water deliveries. A Stage 2 shortage would occur if the total Lower Basin shortage exceeds 1.83 maf in year 2008. This threshold decreases to 1.72 maf in 2060.

Table 4.4-21
Shortage Allocation to California (af)

Lower Basin Shortage Allocations	200,000	400,000	500,000	600,000	800,000	1,200,000	1,800,000	2,500,000
Shortage allocation to California – 2008	0	0	0	0	0	0	0	409,516
Shortage allocation to California – 2017	0	0	0	0	0	0	39,422	462,876
Shortage allocation to California – 2026	0	0	0	0	0	0	42,795	465,882
Shortage allocation to California – 2027	0	0	0	0	0	0	43,163	466,210
Shortage allocation to California – 2040	0	0	0	0	0	0	48,719	471,162
Shortage allocation to California – 2060	0	0	0	0	0	0	48,719	471,162

The probability of shortage volumes that are less than or equal to those presented in Table 4.4-21 are presented in Tables 4.4-12 and 4.4-13.

Table 4.4-22 provides the maximum observed reductions in water deliveries to California under the No Action Alternative and the five action alternatives for selected years. Because of the large magnitude of Lower Basin shortages assumed to be required to trigger shortages in California, many shortages declared in the Lower Basin would not trigger water delivery reductions to California.

Table 4.4-22
Maximum Observed Reductions in Water Deliveries to California for Selected Years (af)

Year	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008	0	0	0	0	0	0
2017	0	0	0	0	0	0
2026	55,737	0	108,730	0	0	0
2027	56,659	181,672	48,176	683,502	0	0
2040	31,578	59,225	36,082	164,243	39,592	65,806
2060	90,899	55,096	44,773	90,899	44,077	55,096

The maximum observed reductions in water deliveries presented in Table 4.4-22 for California vary with both the maximum level of declared shortage in the Lower Basin and with the timing of the shortage. Under almost all conditions, the California shortage is allocated to the MWD. However, for the maximum shortage analyzed (2.94 maf, which occurs less than one percent of the time under the Water Supply Alternative), the shortage allocated to California would include a very small portion of shortage (15,464 af) that would be allocated to other California users. Due to the observed low probability of occurrence of reductions in water deliveries to California of this magnitude, further analysis was not considered to be warranted.

4.4.7.3 Distribution of Shortages to Nevada

Table 4.4-23 shows different Lower Basin shortage volumes and the portion of the shortage that is allocated to Nevada. The shortage allocation to Nevada represents approximately 3.33 percent of the total Lower Basin shortage amount. This percentage does not vary with time and is distributed among users served by the SNWA.

Table 4.4-23
Shortage Allocation to Nevada (af)

Lower Basin Shortage Allocations	200,000	400,000	500,000	600,000	800,000	1,200,000	1,800,000	2,500,000
Shortage allocation to Nevada	6,667	13,333	16,667	20,000	26,667	40,000	60,000	83,333

The probability of occurrence of shortage volumes that are less than or equal to those presented in Table 4.4-23 are presented in Tables 4.4-12 and 4.4-13.

Table 4.4-24 provides the maximum observed reductions in water deliveries to Nevada under the No Action Alternative and five action alternatives for selected years.

Table 4.4-24
Maximum Observed Reductions in Water Deliveries to Nevada for Selected Years (af)

Year	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008	0	0	0	0	0	0
2017	35,532	127,930	32,914	116,530	33,333	20,000
2026	60,548	131,370	63,469	279,000	33,333	105,470
2027	60,579	67,470	60,111	210,547	16,288	27,657
2040	58,888	60,414	59,137	79,338	59,331	60,777
2060	62,163	60,186	59,617	62,163	59,578	60,186

Table 4.4-24 indicates that Nevada receives water delivery reductions greater than the maximum volumes presented in Table 4.4-23 under the Basin States and Water Supply alternatives, and the Preferred Alternative. The larger reductions in water deliveries presented in Table 4.4-24 include reductions to SNWA associated with the physical constraints of SNWA's Lake Mead intake. For example, under the Basin States Alternative, in year 2017, the shortage related water delivery reduction to Nevada is approximately 20,000 af (3.33 percent of the total 600 kaf Lower Basin shortage). However, in the model, Lake Mead elevation is below 1,000 feet msl (the SNWA lower intake elevation) for four months (April through July). During these four months, the model reduces water deliveries to SNWA to zero. The cumulative water delivery reduction to Nevada for this four month period due to the SNWA intake constraints is 107,930 af. Therefore, the maximum observed reductions in water deliveries to Nevada in 2017 under the Basin States Alternative is 127,930 af (20,000 af + 107,930 af = 127,930 af). Similar conditions are observed in Table 4.4-24 under the Basin States Alternative in year 2026; under the Water Supply Alternative in years 2017, 2026, and 2027; and under the Preferred Alternative in year 2026.

4.4.7.4 Water Reductions to Mexico

For modeling purposes, an assumption was made that Mexico's delivery would be reduced below 1.5 mafy when Lower Basin shortages occur (Section 4.2). The amount of the reduction is assumed to be 16.67 percent of the total Lower Basin shortage volume, resulting in a proportional reduction to Mexico equivalent to the proportional reduction to users in the Lower Division States. The portion of the Lower Basin water delivery reductions that are assumed to be assigned to Mexico, based on the aforementioned assumptions, are summarized in Table 4.4-25. The sensitivity of water reductions to Mexico and other hydrologic variables (e.g., Lake Mead elevation) to this modeling assumption was analyzed and the results of this analysis are presented in Appendix Q.

Table 4.4-25
Water Reductions to Mexico[1] (af)

Lower Basin Shortage Allocations	200,000	400,000	500,000	600,000	800,000	1,200,000	1,800,000	2,500,000
Water reduction to Mexico	33,333	66,667	83,333	100,000	133,333	200,000	300,000	416,667

1. These modeling assumptions do not reflect policy decisions and are not intended to constitute an interpretation or application of the 1944 Treaty.

The probability of water reductions to Mexico are the same as the probability of Lower Basin shortage. The probability of shortage volumes that are less than of equal to those presented in Table 4.4-25 under the No Action Alternative and for each of the action alternatives are presented in Tables 4.4-13 and 4.4-14.

Table 4.4-25 indicates that, while the proportion of the Lower Basin shortage distributed to Mexico is constant, the probability of the occurrence of water reduction increases over time. Table 4.4-26 provides the maximum observed reductions of water deliveries to Mexico under the No Action Alternative and the five action alternatives for selected years.

Table 4.4-26
Maximum Observed Reductions in Water Deliveries to Mexico[1] for Selected Years (af)

Year	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008	0	0	0	0	0	0
2017	177,660	100,000	164,570	0	166,667	100,000
2026	302,740	100,000	317,344	0	166,667	100,000
2027	302,893	337,349	300,555	475,663	81,441	138,286
2040	294,442	302,071	295,685	331,053	296,653	303,887
2060	310,813	300,932	298,083	310,813	297,891	300,932

1. These modeling assumptions do not reflect policy decisions and are not intended to constitute an interpretation or application of the 1944 Treaty.

4.4.8 Summary

The following conclusions may be drawn from the analyses of water deliveries.

4.4.8.1 Normal Conditions

All of the action alternatives increase the probability that normal deliveries will be met over the interim period relative to the No Action Alternative. The differences between the action alternatives and the No Action Alternative, in terms of the probability of occurrence for water supply deliveries under a Normal Condition, begin to diminish after 2027 and are nearly zero by about 2038.

4.4.8.2 Surplus Conditions

The Water Supply Alternative exhibits the same probability of surplus deliveries as the No Action Alternative (between about 30 to 40 percent) between 2008 and 2016 due to identical assumptions regarding surplus during this period. The ISG provisions terminate under the No Action Alternative in 2016. However, these provisions are retained in the Water Supply Alternative through 2026 and therefore this alternative consistently provides the highest probability of surplus deliveries during the interim period. The Reservoir Storage Alternative exhibits the lowest probabilities (between about ten to 20 percent) during the interim period because surplus determinations are limited to Quantified and Flood Control Surplus Conditions beginning in 2008. The surplus provisions under the Basin States and the Conservation Before Shortage Alternatives, and under the Preferred Alternative, are similar and the probability of a Surplus Condition from 2010 through 2016 is slightly less than under the No Action Alternative due to the absence of the Partial Domestic Surplus provision in these three alternatives. After the end of the interim period in 2026, the probability for all alternatives converges to between ten and 20 percent.

The storage and delivery mechanism and related storage and delivery of conserved system and non-system water were modeled under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative. This modeling assumption has the effect of increasing the probability of occurrence of a Surplus Condition. The maximum increase in the probability of occurrence of a Surplus Condition is seven percent, occurring in two years under the Preferred Alternative.

4.4.8.3 Shortage Conditions

During most of the interim period, the probability of involuntary and voluntary shortage is less under all of the action alternatives than under the No Action Alternative. The probability of occurrence of shortages under the Water Supply Alternative is less than under the No Action Alternative and the other action alternatives during the interim period because reductions in water deliveries under the Water Supply Alternative only occur if Lake Mead's elevation is below 1,000 (the minimum elevation for operation of SNWA's lower intake) or if Lake Mead is drawn down to the top of its dead pool elevation (895 feet msl). However, after 2026, the Water Supply Alternative has the highest probability of shortage due to the depleted storage conditions and the assumption that the operations revert back to the criteria used in the modeling of the No Action Alternative after 2026. In terms of magnitude, the average shortages that occur under the Water Supply Alternative (zero and 240 kafy) are significantly less than those observed under the No Action Alternative (500 and 610 kafy) during the interim period. After 2026, higher average and maximum shortage volumes are observed under the Water Supply Alternative relative to the No Action Alternative and the other action alternatives.

The probability of occurrence of shortages under the Reservoir Storage Alternative is slightly higher than under the No Action Alternative between 2008 and 2013. However, after 2013 and through about 2037, shortages under the Reservoir Storage Alternative occur less frequently as compared to the No Action Alternative. In terms of magnitude, the average shortage volumes that are observed during the interim period are highest under the Reservoir Storage Alternative (between 600 and 750 kafy). This occurs because the Reservoir Storage Alternative contains the most aggressive shortage strategy that applies shortages starting at higher elevations in Lake Mead and at higher magnitudes.

Shortages also occur less frequently under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative during the interim period as compared to the No Action Alternative and are similar after 2026. The Preferred Alternative also shows somewhat lower probabilities (up to approximately ten percent) of shortages over the entire interim period when compared to the Basin States and Conservation Before Shortage Alternatives. In terms of magnitude, the average shortages that are observed under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative are similar to each other (between 400 and 530 kafy) and are less than those observed under the No Action Alternative during the interim period.

Multi-year shortages with annual shortage volumes equal to or greater than 400 kaf are likely for all alternatives with the exception of the Water Supply Alternative, with the Conservation Before Shortage Alternative and the Preferred Alternative exhibiting probabilities of between ten and 30 percent over the interim period for durations of two or more years. Multi-year shortages with annual shortage volumes equal to or greater than 500 kafy are most likely for the Reservoir Storage Alternative with probabilities of approximately 35 percent for durations of two or more years and 26 percent for durations of five or more years. Multi-year shortages with annual shortage volumes equal to or greater than 600 kafy are likely only for the Reservoir Storage Alternative. No alternatives exhibited shortages of greater than or equal to 1.0 mafy for any duration.

The mechanism to deliver and store conserved system and non-system water assumed as part of the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and under the Preferred Alternative has the effect of decreasing the occurrence of shortages. Due to the assumptions of increased participation in the storage and delivery mechanism, the greatest differences (up to a ten percent reduction in shortage probability during the interim period) were observed under the Reservoir Storage Alternative and under the Preferred Alternative.

4.5 Water Quality

4.5.1 Introduction

This section describes the methods used to determine the potential effects to water quality associated with each alternative considered in the proposed federal action, and discusses the results of these analyses.

4.5.2 Methodology

The salinity module of the CRSS RiverWare™ model was used to analyze changes in salinity concentration under each of the alternatives for Colorado River reaches from Lake Powell to Imperial Dam.

Using the hydrologic output from CRSS, the CE-QUAL-W2 model was used to simulate temperatures of Lake Powell releases, and the Generalized Environmental Modeling System for Surfacewater (GEMSS) was used to simulate river temperatures between Glen Canyon Dam and Lake Mead for each of the alternatives. Detailed descriptions of these models are provided in Appendix F. Qualitative assessments of other water quality parameters in Lake Powell were based on historical data.

For all parameters other than salinity, the analysis of potential impacts to Lake Mead water quality were based on a combination of detailed water quality modeling and analysis conducted for the SCOP FEIS (Clean Water Coalition 2006), and historical data. Modeling for the SCOP FEIS analyzed the potential effects on water quality as a result of rerouting effluent from Las Vegas Wash to Lake Mead's Boulder Basin via a pipeline. The modeling considered lake elevations down to 1,000 feet msl and two levels of total annual average effluent flows: 462 cfs expected by 2030 and 616 cfs expected by 2050. Under the SCOP FEIS preferred alternative referred to as the Boulder Islands North Alternative, impacts to water quality are considered to be insignificant and negligible with no violation of drinking water regulations for Lake Mead elevations down to 1,000 feet msl with projected effluent inflow levels for 2025. This information was combined with the probabilities of Lake Mead elevations reaching 1,000 feet msl under the No Action Alternative and the action alternatives considered in this Final EIS to assess potential water quality impacts.

Furthermore, an adaptive management plan for Boulder Basin would be implemented as part of the SCOP preferred alternative. The Boulder Basin Adaptive Management Plan (BBAMP) would establish objectives regarding drinking water quality, downstream water quality, nutrient management, and recreational use including sport fisheries. As part of the BBAMP, water quality parameters would be monitored to establish baseline conditions and analyzed for the need of potential future mitigation measures (Clean Water Coalition 2006).

4.5.2.1 Salinity

Reclamation developed a computational model for salinity to aid in the development of salinity reduction targets for the Colorado River Basin Salinity Control Program (SCP) (Prairie and Callejo 2005). The salinity model simulates the effects of water development projects on future salinity concentration levels in the Colorado River. The model includes future salinity control units that have been authorized for construction but have not yet been completed. The salinity control criteria are purposely designed to be long-term and non-degradational goals, rather than exceedence standards such as those used for industry or drinking water. Efforts of the SCP are designed to meet the criteria by implementing, as needed, the most cost effective salinity control projects. This ensures that the salinity control criteria will continue to be met in the future, even with the salinity impacts produced by increasing Upper Basin depletions.

The data used in the CRSS salinity model are based on a monthly regression of natural flow and salinity data from 1971 through 1995 in the Upper Basin (Prairie and Callejo 2005). The Lower Basin monthly regressions are based on the 1971 through 2005 natural flow and salinity data. The monthly regression models allow extension of the CRSS salinity model data from 1906 through 2005, the period for which natural flow data is available. The CRSS salinity model data includes salinity control levels and salt loading due to agricultural return flows as used in the 2005 Triennial Review (Colorado River Basin Salinity Control Forum 2005). The model simulates annual average salinity concentrations for locations downstream of Hoover Dam and Parker Dam, and at Imperial Dam.

The CRSS salinity model is intended for long-term (15 to 20 years) simulation and it is highly sensitive to initial conditions during the first 10 to 12 years. The model assumes salinity is a conservative water quality parameter, and reservoirs are modeled as fully mixed systems.

4.5.2.2 Temperature

Lake Powell undergoes seasonal transformations that can dramatically affect the temperatures of both the reservoir and Glen Canyon Dam releases. During the spring, solar radiation and warmer air temperatures begin to warm the upper surface layers of the reservoirs. This warming is also affected by spring inflow volumes and temperatures. Larger inflows bring greater volumes of warmer water that can cause higher release temperatures. Reservoir drawdowns can bring the warmer surface water closer to the powerplant intake penstocks, also producing warmer releases. As summer progresses, surface warming of reservoirs increases, as does the warming of releases as the water moves downstream. During the winter months, reservoir temperature stratification is usually eliminated by reservoir mixing, and both reservoir and downstream water cooling occurs. The CE-QUAL-W2 model simulates this annual process and can analyze reservoir and dam release temperatures for various reservoir starting elevations and inflows. The CRSS output of dam release and reservoir elevations was used in the CE-QUAL-W2 model to establish a relationship between reservoir elevations and dam release temperatures and to project the impact of reservoir drawdown on dam release temperatures. Calibration of the CE-QUAL-W2 model for Lake Powell used historic temperature profiles from 1990 through 2005 at 13 reservoir stations.

This 15-year data set provided a limited range of historic reservoir elevations, inflows and releases. By using a combination of historic and modeled data for various reservoir elevations, and by analyzing the impact of a repetition of the recent drought years, dam release temperatures for a larger range of reservoir elevations could be analyzed.

The GEMSS used the Glen Canyon Dam release temperatures to model downstream temperatures through Grand Canyon to Lake Mead. The GEMSS model was calibrated for water temperatures at three locations in this river reach: Lees Ferry, 15.9 miles downstream of Glen Canyon Dam; a point one mile downstream of the Little Colorado River confluence; and the Diamond Creek Gaging Station located 240 miles downstream of Glen Canyon Dam. Water temperatures downstream of Diamond Creek approached equilibrium with the ambient air temperature, and the rate of temperature change decreased. Since Lees Ferry temperatures are nearly identical to Glen Canyon Dam release temperatures, only the results for the Little Colorado River confluence and Diamond Creek sites are included in this EIS.

For any specific reservoir starting elevation, there is a range of potential dam release temperatures because the reservoir is affected by the magnitude of spring inflow and summer meteorological conditions. Downstream water temperatures produced by a routing of these releases are also affected by meteorological conditions and the magnitude of dam releases. Thus, for a single reservoir elevation the CE-QUAL-W2 and GEMSS modeling resulted in a range of water temperatures.

The assessment of potential effects of the alternatives on water temperatures in Lake Mead was based on the Lake Mead water quality information provided in the SCOP FEIS.

4.5.2.3 Other Water Quality Parameters

Historic water quality data from Lake Powell and Lake Mead and water quality information from the SCOP FEIS for Lake Mead were used to develop qualitative assessments of potential effects of the alternatives on sediment, nutrients and algae, dissolved oxygen, metals, and perchlorate.

4.5.3 Salinity

Table 4.5-1 presents the SCP salinity control criteria and the CRSS salinity model simulations of salinity concentrations for the years 2008, 2016, 2026, and 2060. The projected salinity concentrations presented are the flow-weighted annual averages for the selected years under the No Action Alternative and the action alternatives. The results assume continuation of existing and implementation of planned salinity control programs and projects. As a result, the flow-weighted annual average salinity concentrations do not increase over time or exceed the SCP salinity control criteria under any of the alternatives for the current plan of implementation, which extends through 2025 (Colorado River Basin Salinity Control Forum 2005). At all times the differences in salinity concentrations among the different alternatives is less than three percent.

Table 4.5-1
Projected Colorado River Salinity (mg/L)[1]
Comparison of Action Alternatives to No Action Alternative

Alternative	Downstream of Hoover Dam SCP Salinity Control Criteria 723 mg/L	Downstream of Parker Dam SCP Salinity Control Criteria 747 mg/L	At Imperial Dam SCP Salinity Control Criteria 879 mg/L
Year 2008			
No Action	639	656	768
Basin States	639	656	773
Conservation Before Shortage	639	656	775
Reservoir Storage	641	658	783
Water Supply	639	656	768
Preferred Alternative	639	657	781
Year 2016			
No Action	596	616	732
Basin States	596	615	732
Conservation Before Shortage	596	616	737
Reservoir Storage	613	623	744
Water Supply	593	612	728
Preferred Alternative	598	618	735
Year 2026			
No Action	602	621	740
Basin States	605	625	747
Conservation Before Shortage	605	625	751
Reservoir Storage	613	633	760
Water Supply	595	615	735
Preferred Alternative	606	625	747
Year 2060			
No Action	625	646	776
Basin States	630	650	782
Conservation Before Shortage	630	650	782
Reservoir Storage	629	650	781
Water Supply	626	646	776
Preferred Alternative	630	650	782

1 CRSS Salinity model simulation of salinity concentration

Salinity of water delivered to Mexico at the NIB pursuant to the 1944 Treaty is limited by Minute 242 (Section 3.5). Accordingly, Minute 242 limits the differential in annual salinity between Imperial Dam and the NIB to 115 ppm (± 30 ppm). Reclamation will continue to take the appropriate actions needed to meet the requirements of Minute 242.

4.5.4 Temperature

4.5.4.1 Lake Powell and Glen Canyon Dam

The release temperature ranges presented in Figure 4.5-1 are comprised of historic and modeled data and represent a yearly range including seasonal fluctuations. This graph shows that as Lake Powell's elevation decreases, the range of annual release temperature fluctuations increases. The minimum release temperatures occur in the winter and are fairly consistent at 7°C to 10°C (44.6ºF to 50ºF). The peak summer release temperature varies significantly with elevation, peaking at about 25°C (77ºF) as the reservoir elevation drops to near the minimum power pool elevation of 3,490 feet msl. The model predicts a wider range of potential temperatures the nearer the reservoir elevation is to the powerplant penstock intakes. Reservoir elevations near the full pool elevation of 3,700 feet msl show much less variation among seasons, with releases consistently cold from 8°C to 12°C (46.4ºF to 53.6ºF). During extreme drought events, the elevation of Lake Powell may drop below the minimum power pool elevation of 3,490 feet msl. If this occurs, releases would be discontinued from the powerplant penstocks and releases would be made through the river outlet tubes, which are located at elevation 3,374 feet msl. Under these conditions, the temperature of water released from Glen Canyon Dam could potentially change from about 25°C to less than 10°C (77ºF to less than 50ºF). If the reservoir elevations were to drop further, closer to the elevation of the river outlet tubes, the releases would again gradually warm.

Figure 4.5 -1
Historic Data and CE-QUAL-W2 Model Results for Lake Powell Release Temperatures by Reservoir Elevation

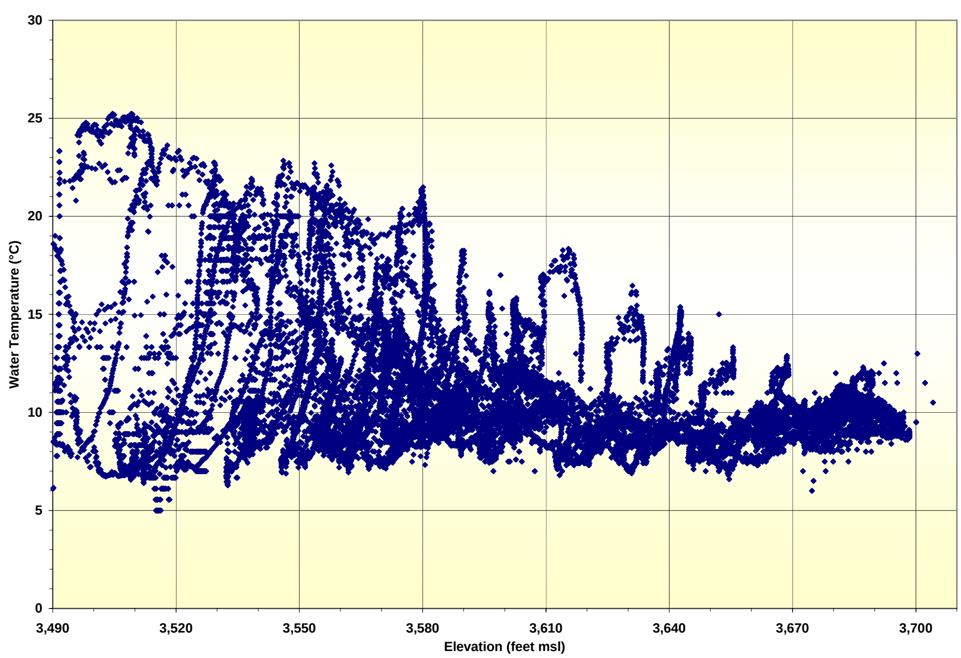


Table 4.5-2 and Table 4.5-3 present projected release temperature ranges associated with the CRSS projected 90th, 50th, and 10th percentile elevations of Lake Powell in 2008, 2016, 2026, and 2060 for the months of July and October, respectively. July and August represent the times of the year when maximum warming occurs in Lake Powell and in Glen Canyon Dam releases. The release temperature ranges in Table 4.5-2 and Table 4.5-3 reflect the variability of hydrologic, meteorological, and hydraulic conditions. The sensitivity of release temperatures to these conditions increases with decreasing reservoir elevations. This sensitivity causes a wide range of possible release temperatures at similar reservoir elevations. In general, for a given month and reservoir elevation, a higher release temperature is associated with an above-average inflow volume and a lower release temperature is associated with a below-average inflow volume. Therefore, the ranges shown in these tables reflect different release temperatures for these specific months and reservoir elevations, ranges which are due primarily to large differences in reservoir inflows.

For reservoir elevations at or above the 90th percentile for all years there are no differences among the alternatives. Overall, the temperature ranges for July and October under the No Action Alternative, Basin States Alternative, Conservation Before Shortage Alternative, and the Preferred Alternative are similar for 2008, 2016, 2026, and 2060 at the 50th and 10th percentiles of reservoir elevations, respectively. The temperature range for the Water Supply Alternative is warmer in 2016 and 2026 due to the corresponding lower Lake Powell reservoir elevations at the 10th and 50th percentiles. The Reservoir Storage Alternative results in cooler water temperatures at the 10th and 50th percentiles of reservoir elevations for some years, due to higher reservoir elevations.

4.5.4.2 Glen Canyon Dam to Lake Mead

Using historic data and output from the CE-QUAL-W2 model as input, the GEMSS model analyzed monthly temperatures for the CRSS at the 90th, 50th, and 10th percentile projected reservoir release flows. Temperatures are presented for each alternative in Table 4.5-4 and Table 4.5-5 for the confluence with the Little Colorado River, and in Table 4.5-6 and Table 4.5-7 for the gage downstream of Diamond Creek for July and October, respectively. The temperature data listed in these tables are averages for each percentile. The projected temperatures vary due to three factors: variable release volume; release temperature ranges; and downstream meteorology. The rate at which the water released from a reservoir approaches ambient air temperature as it travels downstream depends on these factors as well.

Table 4.5-2
Lake Powell End-of-July Elevations and Release Temperatures
Comparison of Action Alternatives to No Action Alternative
90th, 50th, 10th Percentile Values

Alternative	90th Percentile		50th Percentile		10th Percentile	
	Elevation (feet msl)	Temperature (°C)	Elevation (feet msl)	Temperature (°C)	Elevation (feet msl)	Temperature (°C)
Year 2008						
No Action	3,648.3	8.5 to 11.5	3,621.1	8 to 13	3,588.6	9 to 16.5
Basin States	3,645.9	8.5 to 11.5	3,621.1	8 to 13	3,591.7	9 to 16.5
Conservation Before Shortage	3,646.0	8.5 to 11.5	3,621.1	8 to 13	3,591.7	9 to 16.5
Water Supply	3,648.3	8.5 to 11.5	3,621.1	8 to 13	3,592.7	9 to 16.5
Reservoir Storage	3,648.3	8.5 to 11.5	3,621.1	8 to 13	3,590.9	9 to 16.5
Preferred Alternative	3,646.1	8.5 to 11.5	3,621.1	8 to 13	3,591.7	9 to 16.5
Year 2016						
No Action	3,697.9	9 to 11	3,648.1	8.5 to 11.5	3,575.1	10 to 19
Basin States	3,697.9	9 to 11	3,646.0	8.5 to 11.5	3,585.1	9 to 17
Conservation Before Shortage	3,697.9	9 to 11	3,646.0	8.5 to 11.5	3,585.4	9 to 17
Water Supply	3,697.9	9 to 11	3,638.8	8.5 to 11.5	3,560.1	10 to 20
Reservoir Storage	3,698.4	9 to 11	3,650.9	8.5 to 11.5	3,592.7	9 to 16.5
Preferred Alternative	3,697.9	9 to 11	3,646.0	8.5 to 11.5	3,584.3	9 to 17
Year 2026						
No Action	3,698.5	9 to 11	3,659.2	8.5 to 11	3,576.3	10 to 19
Basin States	3,698.3	9 to 11	3,647.6	8.5 to 11.5	3,571.8	10 to 19.5
Conservation Before Shortage	3,698.3	9 to 11	3,647.8	8.5 to 11.5	3,570.9	10 to 19.5
Water Supply	3,698.3	9 to 11	3,629.6	8.5 to 12	3,523.9	17 to 23
Reservoir Storage	3,698.8	9 to 11	3,664.2	8.5 to 11	3,595.9	9 to 16
Preferred Alternative	3,698.3	9 to 11	3,649.3	8.5 to 11.5	3,577.2	10 to 19
Year 2060						
No Action	3,699.2	9 to 11	3,655.9	8.5 to 11	3,565.9	10 to 20
Basin States	3,699.2	9 to 11	3,655.9	8.5 to 11	3,565.9	10 to 20
Conservation Before Shortage	3,699.2	9 to 11	3,655.9	8.5 to 11	3,565.9	10 to 20
Water Supply	3,699.2	9 to 11	3,655.9	8.5 to 11	3,563.7	10 to 20
Reservoir Storage	3,699.2	9 to 11	3,655.9	8.5 to 11	3,565.9	10 to 20
Preferred Alternative	3,699.2	9 to 11	3,655.9	8.5 to 11	3,565.9	10 to 20

Table 4.5-3
Lake Powell End-of-October Elevations and Release Temperatures
Comparison of Action Alternatives to No Action Alternative
90th, 50th, 10th Percentile Values

Alternative	90th Percentile		50th Percentile		10th Percentile	
	Elevation (feet msl)	Temperature (°C)	Elevation (feet msl)	Temperature (°C)	Elevation (feet msl)	Temperature (°C)
Year 2008						
No Action	3,642.0	8.5 to 15	3,613.8	9.5 to 18.5	3,575.3	11 to 21
Basin States	3,641.2	8.5 to 15	3,613.8	9.5 to 18.5	3,577.6	11 to 21
Conservation Before Shortage	3,641.4	8.5 to 15	3,613.8	9.5 to 18.5	3,577.6	11 to 21
Water Supply	3,642.0	8.5 to 15	3,613.8	9.5 to 18.5	3,578.8	11 to 21
Reservoir Storage	3,642.0	8.5 to 15	3,613.8	9.5 to 18.5	3,580.0	11 to 21
Preferred Alternative	3,641.6	8.5 to 15	3,613.8	9.5 to 18.5	3,577.6	11 to 21
Year 2016						
No Action	3,689.6	9 to 11.5	3,642.0	8.5 to 15	3,564.8	12 to 22
Basin States	3,689.6	9 to 11.5	3,637.7	8.5 to 15.5	3,571.4	11 to 21
Conservation Before Shortage	3,689.6	9 to 11.5	3,638.2	8.5 to 15.5	3,571.9	11 to 21
Water Supply	3,689.1	9 to 11.5	3,627.3	8.5 to 17	3,547.6	14 to 22
Reservoir Storage	3,690.0	9 to 11.5	3,647.0	9 to 15	3,585.0	10.5 to 20
Preferred Alternative	3,689.6	9 to 11.5	3,640.5	8.5 to 15	3,572.5	11 to 21
Year 2026						
No Action	3,689.3	9 to 11.5	3,655.7	8.5 to 14	3,567.6	11.5 to 21.5
Basin States	3,689.3	9 to 11.5	3,637.1	8.5 to 15.5	3,562.1	12 to 22
Conservation Before Shortage	3,689.3	9 to 11.5	3,638.4	8.5 to 15.5	3,562.0	12 to 22
Water Supply	3,689.3	9 to 11.5	3,616.9	9.5 to 18	3,501.5	18 to 22.5
Reservoir Storage	3,689.7	9 to 11.5	3,660.3	8.5 to 13	3,590.8	10 to 20
Preferred Alternative	3,689.3	9 to 11.5	3,641.1	8.5 to 15	3,565.0	12 to 22
Year 2060						
No Action	3,689.6	9 to 11.5	3,650.1	8.5 to 14	3,553.0	13 to 22
Basin States	3,689.6	9 to 11.5	3,650.1	8.5 to 14	3,553.0	13 to 22
Conservation Before Shortage	3,689.6	9 to 11.5	3,650.1	8.5 to 14	3,553.0	13 to 22
Water Supply	3,689.6	9 to 11.5	3,650.1	8.5 to 14	3,552.2	13 to 22
Reservoir Storage	3,689.6	9 to 11.5	3,650.1	8.5 to 14	3,553.0	13 to 22
Preferred Alternative	3,689.6	9 to 11.5	3,650.6	8.5 to 14	3,553.0	13 to 22

In general, warmer downstream water temperatures are caused by smaller release volumes, higher release temperatures, and warmer ambient air temperatures. However, the relationship between release temperature and downstream temperature is nonlinear (e.g., a 1°C (1.8ºF) increase in release temperature does not necessarily result in a 1°C (1.8ºF) increase downstream). The temperatures projected for 2008 and 2060 are the same for all alternatives. In 2016 and 2026 the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative, have the same projected average temperatures as the No Action Alternative for both October and July at both modeled locations. In general, the Water Supply and Reservoir Storage Alternatives differ from the No Action Alternative in 2016 and 2026 at the 10th and 50th percentile release volumes. The Water Supply Alternative average temperatures are higher than the No Action Alternative's by 0 to 4°C (0 to 7°F). The projected Reservoir Storage Alternative average temperatures are typically 1°C (1.8°F) less than the No Action Alternative temperatures at the 10th and 50th percentiles of river flows due to higher Lake Powell elevations under this alternative.

Table 4.5-4
Colorado River at Little Colorado River Confluence July Water Temperatures
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Alternative	90th Percentile		50th Percentile		10th Percentile*	
	Release (maf)	Average Temperature (°C)	Release (maf)	Average Temperature (°C)	Release (maf)	Average Temperature (°C)
Year 2008						
No Action	10.98	12	8.23	13	8.23	18
Basin States	11.22	12	8.23	13	8.23	18
Conservation Before Shortage	11.22	12	8.23	13	8.23	18
Water Supply	10.98	12	8.23	13	8.23	18
Reservoir Storage	10.98	12	8.23	13	7.80	18
Preferred Alternative	11.22	12	8.23	13	8.23	18
Year 2016						
No Action	12.91	11.5	8.23	12	8.23	18
Basin States	13	11.5	9.00	12	8.23	18
Conservation Before Shortage	13.05	11.5	9.00	12	8.23	18
Water Supply	12.67	11.5	9.50	12	8.23	18
Reservoir Storage	13.23	11.5	8.23	12	7.80	17
Preferred Alternative	13.13	11.5	9.00	12	8.23	18
Year 2026						
No Action	12.78	11.5	8.23	12	8.23	18
Basin States	12.69	11.5	9.00	12	8.23	18
Conservation Before Shortage	12.78	11.5	9.00	12	8.23	18
Water Supply	12.73	11.5	9.50	13	8.23	22
Reservoir Storage	12.78	11.5	8.23	12	7.89	16
Preferred Alternative	12.96	11.5	9.00	12	8.23	18
Year 2060						
No Action	12.48	11.5	8.23	12	8.23	18
Basin States	12.48	11.5	8.23	12	8.23	18
Conservation Before Shortage	12.48	11.5	8.23	12	8.23	18
Water Supply	12.48	11.5	8.23	12	8.23	18
Reservoir Storage	12.48	11.5	8.23	12	8.23	18
Preferred Alternative	12.48	11.5	8.23	12	8.23	18

* *Although not indicated for the four years displayed on this table, there are minor differences in monthly average temperatures between the No Action Alternative and the Preferred Alternative at this location. At the 10th percentile, the average monthly temperatures are as much as 1°C warmer under the Preferred Alternative than under the No Action Alternative. These small temperature differences are potentially meaningful in the context of fish habitat (Section 4.8 and Appendix R).*

Table 4.5-5
Colorado River at Little Colorado River Confluence October Water Temperatures
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Alternative	90th Percentile		50th Percentile		10th Percentile*	
	Release (maf)	Average Temperature (°C)	Release (maf)	Average Temperature (°C)	Release (maf)	Average Temperature (°C)
Year 2008						
No Action	10.98	13	8.23	13.5	8.23	16
Basin States	11.22	13	8.23	13.5	8.23	16
Conservation Before Shortage	11.22	13	8.23	13.5	8.23	16
Water Supply	10.98	13	8.23	13.5	8.23	16
Reservoir Storage	10.98	13	8.23	13.5	7.80	16
Preferred Alternative	11.22	13	8.23	13.5	8.23	16
Year 2016						
No Action	12.91	10.7	8.23	13	8.23	16
Basin States	13	10.7	9.00	13	8.23	16
Conservation Before Shortage	13.05	10.7	9.00	13	8.23	16
Water Supply	12.67	10.7	9.50	13	8.23	17
Reservoir Storage	13.23	10.7	8.23	12	7.80	16
Preferred Alternative	13.13	10.7	9.00	13	8.23	16
Year 2026						
No Action	12.78	10.7	8.23	13	8.23	16
Basin States	12.69	10.7	9.00	13	8.23	16
Conservation Before Shortage	12.78	10.7	9.00	13	8.23	16
Water Supply	12.73	10.7	9.50	14	8.23	20
Reservoir Storage	12.78	10.7	8.23	12	7.89	16
Preferred Alternative	12.96	10.7	9.00	13	8.23	16
Year 2060						
No Action	12.48	10.7	8.23	13	8.23	16
Basin States	12.48	10.7	8.23	13	8.23	16
Conservation Before Shortage	12.48	10.7	8.23	13	8.23	16
Water Supply	12.48	10.7	8.23	13	8.23	16
Reservoir Storage	12.48	10.7	8.23	13	8.23	16
Preferred Alternative	12.48	10.7	8.23	13	8.23	16

* *Although not indicated for the four years displayed on this table, there are minor differences in monthly average temperatures between the No Action Alternative and the Preferred Alternative at this location. At the 10th percentile, the average monthly temperatures are as much as 1°C warmer under the Preferred Alternative than under the No Action Alternative. These small temperature differences are potentially meaningful in the context of fish habitat (Section 4.8 and Appendix R).*

Table 4.5-6
Colorado River Near Diamond Creek July Water Temperatures
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Alternative	90th Percentile		50th Percentile		10th Percentile*	
	Release (maf)	Average Temperature (°C)	Release (maf)	Average Temperature (°C)	Release (maf)	Average Temperature (°C)
Year 2008						
No Action	10.98	18	8.23	19	8.23	21
Basin States	11.22	18	8.23	19	8.23	21
Conservation Before Shortage	11.22	18	8.23	19	8.23	21
Water Supply	10.98	18	8.23	19	8.23	21
Reservoir Storage	10.98	18	8.23	19	7.80	21
Preferred Alternative	11.22	18	8.23	19	8.23	21
Year 2016						
No Action	12.91	17	8.23	18	8.23	21
Basin States	13	17	9.00	18	8.23	21
Conservation Before Shortage	13.05	17	9.00	18	8.23	21
Water Supply	12.67	17	9.50	18	8.23	21
Reservoir Storage	13.23	17	8.23	18	7.80	20
Preferred Alternative	13.13	17	9.00	18	8.23	21
Year 2026						
No Action	12.78	17	8.23	18	8.23	21
Basin States	12.69	17	9.00	18	8.23	21
Conservation Before Shortage	12.78	17	9.00	18	8.23	21
Water Supply	12.73	17	9.50	19	8.23	23
Reservoir Storage	12.78	17	8.23	18	7.89	20
Preferred Alternative	12.96	17	9.00	18	8.23	21
Year 2060						
No Action	12.48	17	8.23	18	8.23	21
Basin States	12.48	17	8.23	18	8.23	21
Conservation Before Shortage	12.48	17	8.23	18	8.23	21
Water Supply	12.48	17	8.23	18	8.23	21
Reservoir Storage	12.48	17	8.23	18	8.23	21
Preferred Alternative	12.48	17	8.23	18	8.23	21

* *Although not indicated for the four years displayed on this table, there are minor differences in monthly average temperatures between the No Action Alternative and the Preferred Alternative at this location. At the 10th percentile, the average monthly temperatures are as much as 1.4°C warmer under the Preferred Alternative than under the No Action Alternative. These small temperature differences are potentially meaningful in the context of fish habitat (Section 4.8 and Appendix R).*

Table 4.5-7
Colorado River Below Diamond Creek October Water Temperatures
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Alternative	90th Percentile		50th Percentile		10th Percentile*	
	Release (maf)	Average Temperature (°C)	Release (maf)	Average Temperature (°C)	Release (maf)	Average Temperature (°C)
Year 2008						
No Action	10.98	15	8.23	15	8.23	17
Basin States	11.22	15	8.23	15	8.23	17
Conservation Before Shortage	11.22	15	8.23	15	8.23	17
Water Supply	10.98	15	8.23	15	8.23	17
Reservoir Storage	10.98	15	8.23	15	7.80	17
Preferred Alternative	11.22	15	8.23	15	8.23	17
Year 2016						
No Action	12.91	14	8.23	15	8.23	17
Basin States	13	14	9.00	15	8.23	17
Conservation Before Shortage	13.05	14	9.00	15	8.23	17
Water Supply	12.67	14	9.50	15	8.23	17
Reservoir Storage	13.23	14	8.23	15	7.80	17
Preferred Alternative	13.13	14	9.00	15	8.23	17
Year 2026						
No Action	12.78	14	8.23	15	8.23	17
Basin States	12.69	14	9.00	15	8.23	17
Conservation Before Shortage	12.78	14	9.00	15	8.23	17
Water Supply	12.73	14	9.50	16	8.23	21
Reservoir Storage	12.78	14	8.23	14	7.89	17
Preferred Alternative	12.96	14	9.00	15	8.23	17
Year 2060						
No Action	12.48	14	8.23	15	8.23	17.5
Basin States	12.48	14	8.23	15	8.23	17.5
Conservation Before Shortage	12.48	14	8.23	15	8.23	17.5
Water Supply	12.48	14	8.23	15	8.23	17.5
Reservoir Storage	12.48	14	8.23	15	8.23	17.5
Preferred Alternative	12.48	14	8.23	15	8.23	17.5

* *Although not indicated for the four years displayed on this table, there are minor differences in monthly average temperatures between the No Action Alternative and the Preferred Alternative at this location. At the 10th percentile, the average monthly temperatures are as much as 1.4°C warmer under the Preferred Alternative than under the No Action Alternative. These small temperature differences are potentially meaningful in the context of fish habitat (Section 4.8 and Appendix R).*

4.5.4.3 Lake Mead and Hoover Dam

Water quality modeling provided in the SCOP FEIS showed that Lake Mead temperatures would change by no more than 1ºC (1.8°F) when lake elevations are drawn down from 1,178 feet msl to 1,000 feet msl (Clean Water Coalition 2006). The probability of Lake Mead elevations less than 1,000 feet msl is small (zero to two percent) over the interim period for all alternatives, with the exception of the Water Supply Alternative, which has a maximum of 12 percent probability in 2026 (Section 4.3). Based on these results, the potential impact of the alternatives on Lake Mead water temperature is considered negligible.

4.5.5 Sediment and Dissolved Oxygen

The maximum headcutting of sediment deltas occurs when a deeply drawn down reservoir receives very high inflows, similar to that observed in Lake Powell in 2005. This condition is very dependent on the reservoir elevation and spring inflow volume. Compared to the No Action Alternative, the projected additional reservoir drawdown under the Water Supply Alternative could result in additional headcutting of sediment deltas and accompanying water quality impacts. The Reservoir Storage Alternative could result in a decrease in sediment delta headcutting if the projected reservoir elevations remain higher than under the No Action Alternative. Since the projected reservoir drawdown under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative are similar, headcutting of sediment deltas would likely be similar.

Quantified water quality impacts from reservoir sediment delta headcutting are not currently available, nor is it possible to quantitatively distinguish the impact of sediment headcutting among the alternatives. However, recent history shows that high inflows causing sediment delta headcutting likely increases phosphorus release and biological oxygen demand. Large spring inflows then can bring this plume of low dissolved oxygen laden water near the powerplant intakes and result in low dissolved oxygen carrying releases. There may be short term impacts to food base and trout resources between Glen Canyon Dam and Lees Ferry due to these occurrences. Recurrences of low dissolved oxygen such as the one that occurred in 2005 downstream of Glen Canyon Dam may result from reservoir drawdown cycles under any of the alternatives. This condition mostly affects the reach between Glen Canyon Dam and Lee's Ferry since the Colorado River reaerates itself after passing through the rapids downstream of Lees Ferry.

With respect to riverine sediment transport in the Glen Canyon Dam to Lake Mead reach, annual releases lower than 8.23 maf associated with the action alternatives would transport less sediment through Grand Canyon into Lake Mead than under the No Action Alternative. However, some of this effect could be offset by a slightly higher proportion of equalization or balancing releases in these alternatives (Figure 4.3-13).

To estimate the sediment transport impacts of potentially modifying the annual Glen Canyon Dam releases, the USGS prepared an analysis relating normalized sediment transport from Grand Canyon to these annual releases. Table 4.5-8 shows this relationship, with 8.23 maf release volumes as the basis for normalization.

Table 4.5-8
Relationship of Glen Canyon Dam Annual Release Volumes
to Sediment Transport from Grand Canyon

Release (maf)	Normalized Sediment Transport
6.00	0.26
7.00	0.51
8.00	0.89
8.23	1.00
9.00	1.43
10.00	2.15
11.00	3.03
12.00	4.11
13.00	5.43
14.00	7.01
15.00	8.88
16.00	11.02
17.00	13.53
18.00	16.67
19.00	19.72
20.00	23.40

Annual release values obtained from all the traces of RiverWare™ analyses for all the alternatives were applied to this sediment transport relationship for the years 2008, 2016, 2026, and 2060. Relative differences among the alternatives were calculated by comparing the action alternatives to the No Action Alternative at the 10th, 50th, and 90th percentiles of sediment transport. These normalized comparisons are shown in Table 4.5-9 for the years 2008, 2016, 2026, and 2060, respectively.

The data provided in Table 4.5-9 show that in the near term, nearly the same amount of sediment is transported under the alternatives, but that in 2016 and 2026, under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative, potentially more sediment can be transported as water is moved from Lake Powell to Lake Mead under the coordinated operations where balancing results in increased releases from Lake Powell. Under the Water Supply Alternative even more sediment can be transported as a greater amount of water is moved to Lake Mead between 2016 and 2026. Under the Reservoir Storage Alternative, the amount of sediment transport is reduced as releases and water deliveries are reduced to keep Lake Mead, and subsequently Lake Powell, at higher pool elevations.

Table 4.5-9
Sediment Transport (normalized to 8.23 maf annual release volume)
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

	90th Percentile		50th Percentile		10th Percentile	
	Annual Release (maf)	Sediment Transport	Annual Release (maf)	Sediment Transport	Annual Release (maf)	Sediment Transport
Year 2008						
No Action	10.98	3.02	8.23	1	8.23	1
Basin States	11.22	3.26	8.23	1	8.23	1
Conservation Before Shortage	11.22	3.26	8.23	1	8.23	1
Water Supply	10.98	3.02	8.23	1	8.23	1
Reservoir Storage	10.98	3.02	8.23	1	7.80	0.83
Preferred Alternative	11.22	3.26	8.23	1	8.23	1
Year 2016						
No Action	12.91	5.35	8.23	1	8.23	1
Basin States	13.00	5.43	9.00	1.43	8.23	1
Conservation Before Shortage	13.05	5.55	9.00	1.43	8.23	1
Water Supply	12.67	5.01	9.50	1.78	8.23	1
Reservoir Storage	13.23	5.82	8.23	1	7.80	0.83
Preferred Alternative	13.13	5.67	9.00	1.43	8.23	1
Year 2026						
No Action	12.78	5.16	8.23	1	8.23	1
Basin States	12.69	5.03	9.00	1.43	8.23	1
Conservation Before Shortage	12.78	5.16	9.00	1.43	8.23	1
Water Supply	12.73	5.09	9.50	1.78	8.23	1
Reservoir Storage	12.78	5.16	8.23	1	7.89	0.87
Preferred Alternative	12.96	5.42	9.00	1.43	8.23	1
Year 2060						
No Action	12.48	4.75	8.23	1	8.23	1
Basin States	12.48	4.75	8.23	1	8.23	1
Conservation Before Shortage	12.48	4.75	8.23	1	8.23	1
Water Supply	12.48	4.75	8.23	1	8.23	1
Reservoir Storage	12.48	4.75	8.23	1	8.23	1
Preferred Alternative	12.48	4.75	8.23	1	8.23	1

Modeling completed for the SCOP FEIS determined that there would be no adverse effects on dissolved oxygen as a result of the SCOP project or due to drawdown of Lake Mead from elevation 1,178 feet msl to 1,000 feet msl. The probability of Lake Mead elevations less than 1,000 feet msl is small (zero to two percent) over the interim period for all alternatives, with the exception of the Water Supply Alternative, which has a maximum of 12 percent probability in 2026 (Section 4.3). Based on these results, potential effects of the alternatives on dissolved oxygen in Lake Mead are considered negligible. Futhermore, monitoring of dissolved oxygen levels in Lake Mead will be conducted as part of the SCOP BBAMP (Clean Water Coalition 2006).

4.5.6 Nutrients and Algae

Most of the 1.0 mg/L of total phosphorus concentration entering Lake Powell from the major tributaries is bound to the sediment and primarily settles out with the sediment (Section 3.5). Bioavailable phosphorus from the major inflows is generally only 0.007 to 0.009 mg/L and phosphorus concentrations released from Glen Canyon Dam and Hoover Dam generally range from only 0.004 to 0.008 mg/L with occasional spikes to near 0.012 mg/L. Sediment delta headcutting releases phosphorus. This release can significantly boost primary productivity in reservoir inflow areas. A decrease in reservoir elevation could result in additional headcutting in the sediment deltas; however, data is not available to project the amount of headcutting and phosphorous release for different reservoir elevations.

When Lake Powell is full, Glen Canyon Dam release temperatures and inflow temperatures into Lake Mead are cool, and the plume of water entering Lake Mead drops to depths below which algae can grow. Therefore, much of the inflowing phosphorus that is not settled out with the sediment in Lake Mead travels to Hoover Dam. However, when Lake Powell elevations are low enough to produce warm Glen Canyon Dam releases and inflow temperatures into Lake Mead, the inflow plume into Lake Mead will remain nearer the surface where light would increase productivity. The algae thus produced would settle out, trap more phosphorus in the sediment in Lake Mead, and reduce the phosphorus transport down-reservoir into Boulder Basin. Due to the complexity of the system, the direct impact due to the different alternatives can not be projected.

Modeling results provided in the SCOP FEIS showed that there would be no adverse effects on phosphorous concentrations, other nutrients or algae as a result of the SCOP or from Lake Mead being drawn down from elevation 1,178 feet msl to 1,000 feet msl (Clean Water Coalition 2006). The probability of Lake Mead elevations less than 1,000 feet msl is small (zero to two percent) over the interim period for all alternatives, with the exception of the Water Supply Alternative, which has a maximum of 12 percent probability in 2026 (Section 4.3). Based on these results, the concentrations of phosphorus in Boulder Basin and Las Vegas Bay should remain within the Nevada TMDL under all alternatives. Furthermore, the SCOP BBAMP will monitor nutrients and chlorophyll levels in Lake Mead and manage nutrient loadings if water quality objectives are not met (Clean Water Coalition 2006).

4.5.7 Metals

Modeling results provided in the SCOP FEIS for Lake Mead show that the lake's ability to dilute contaminant and nutrient loadings from Las Vegas Valley wastewater treatment plants is not significantly diminished when Lake Mead elevation is 1,000 feet msl in comparison to 1,178 feet msl (Clean Water Coalition 2006). The probability of Lake Mead elevations less than 1,000 feet msl is small (zero to two percent) over the interim period for all alternatives, with the exception of the Water Supply Alternative, which has a maximum of 12 percent probability in 2026 (Section 4.3). Therefore, it is anticipated that drawdown of Lake Mead under any of the alternatives will not increase metals concentrations as a result of reduced dilution.

4.5.8 Perchlorate

Since 1999, perchlorate containment and reduction strategies have resulted in the decline of detectable concentrations in Lake Mead, Willow Beach, Lake Havasu, and other sampling locations in the lower Colorado River, as well as in areas using Colorado River water in Arizona. Perchlorate concentrations are ranging from non-detectable levels to six parts per billion (ppb), indicating a slow and steady decline (Blasius 2006, personal communication). Modeling provided for the SCOP FEIS included a perchlorate analysis and showed that the dilution capacity of Lake Mead did not significantly change when Lake Mead elevations are drawn down from 1,178 feet msl to 1,000 feet msl. The probability of Lake Mead elevations less than 1,000 feet msl is small (zero to two percent) over the interim period for all alternatives, with the exception of the Water Supply Alternative, which has a maximum of 12 percent probability in 2026 (Section 4.3). Therefore, Lake Mead drawdown under any of the action alternatives is not expected to affect perchlorate concentrations.

4.5.9 Summary

The following conclusions were drawn from the analyses of potential effects on water quality constituents of concern.

4.5.9.1 Salinity

The future average annual salinity levels under the action alternatives are not expected to exceed the salinity numeric criteria established by the Colorado River Basin Salinity Control Forum for different locations on the lower Colorado River.

4.5.9.2 Temperature

The temperature range for Glen Canyon Dam releases under the Water Supply Alternative is warmer due to the corresponding lower Lake Powell reservoir elevations at the 10^{th} and 50^{th} percentiles. The Reservoir Storage Alternative results in cooler temperatures for Glen Canyon Dam release at the 10^{th} and 50^{th} percentiles of reservoir elevations for some years. The temperature of Glen Canyon Dam releases under the Basin States Alternative, Conservation Before Shortage Alternative, and the Preferred Alternative are similar to those under the No Action Alternative.

For Lake Mead, modeling performed for the SCOP FEIS showed that lake temperatures would change by no more than 1ºC (1.8º F) when Lake Mead elevations are drawn down from 1,178 feet msl to 1,000 feet msl (Clean Water Coalition 2006). The probability of Lake Mead being drawn down to below elevation 1,000 feet msl is low for all alternatives. Therefore, potential effects of the alternatives on Lake Mead water temperatures are considered to be negligible.

4.5.9.3 Other Water Quality Parameters

The following findings relate to other water quality parameters assessed:

- for Lake Powell, quantified water quality impacts from reservoir sediment delta headcutting are not currently available;
- for Lake Mead, the projected elevations and corresponding changes in dilution capacity are not expected to result in any increase in metals concentrations of concern; and
- for Lake Mead, it is not anticipated that any of the action alternatives would result in a significantly increased concentration of perchlorate.

For Lake Mead, hydrologic and water quality modeling provided in the SCOP FEIS determined that drawing down Lake Mead elevations to 1,000 feet msl would not have a significant effect on water quality in Lake Mead, Hoover Dam releases, and the SNWA water pumped from Lake Mead. The probability of Lake Mead being drawn down below elevation 1,000 feet msl is small for all alternatives with the exception of the Water Supply Alternative. Therefore, potential effects of the alternatives on water quality parameters in Lake Mead are considered negligible.

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4.6 Air Quality

This section describes the methods of analysis and potential effects on air quality at Lake Powell and Lake Mead, focusing on particulate matter. Potential effects on Glen Canyon Dam to Lake Mead reach from particulate emissions at the Lake Mead delta are also considered.

4.6.1 Methodology

Fugitive emissions can result from exposed sediment on the shorelines of Lake Powell and Lake Mead as a result of fluctuations in the elevations of these reservoirs. The mass of particulates generated per acre of exposed shoreline will vary depending upon sediment characteristics and other factors such as saturation, sediment disturbance, wind speeds, and topography. The method for assessing potential fugitive emissions from exposed shoreline sediments at Lake Powell and Lake Mead includes the following assumptions.

- the area of exposed shoreline for Lake Powell was developed using an average shoreline slope of 45 degrees. The area of exposed shoreline for Lake Mead was developed from bathymetry data; and
- incremental changes to Lake Powell and Lake Mead elevations were developed corresponding to the years 2008 through 2060 from the CRSS modeling output. The 10^{th} percentile elevations at the end of March for Lake Powell and at the end of July for Lake Mead were selected as worst-case assumptions that have a reasonable probability of occurring. These elevations were then correlated to the reservoir surface areas (acres) and compared to the maximum elevations for Lake Powell (3,700 feet msl) and Lake Mead (1,221 feet msl) to determine the acres of exposed shoreline.

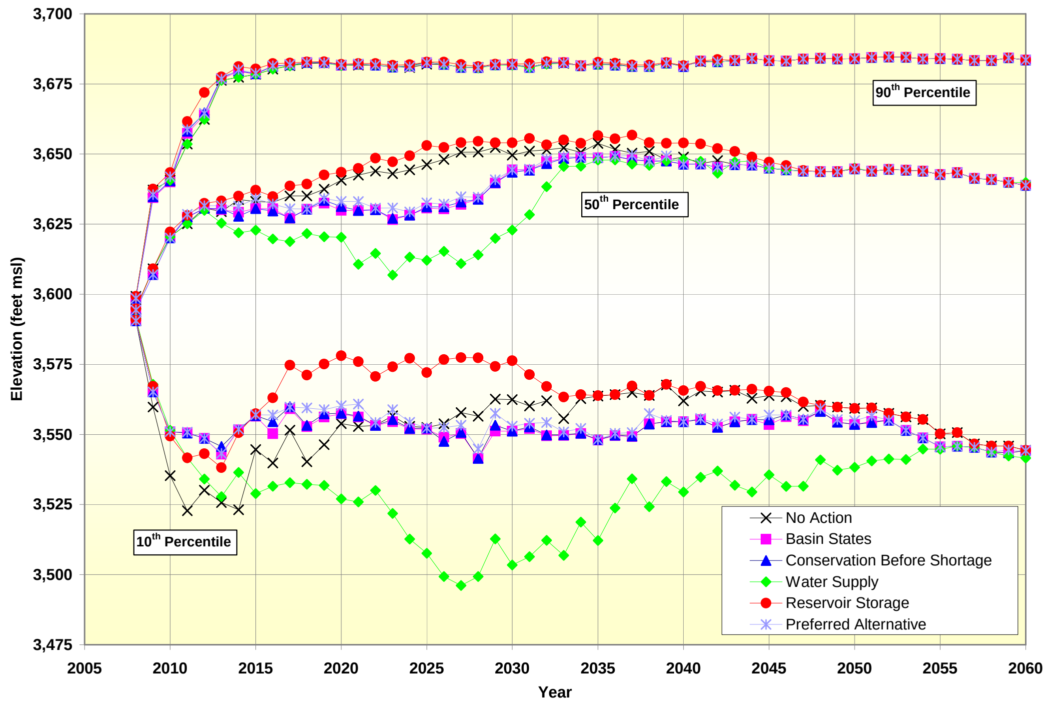
4.6.2 Lake Powell and Glen Canyon Dam

4.6.2.1 No Action Alternative

The lowest Lake Powell elevation occurs in March (Figure 4.6-1). For a comparative evaluation, the years 2008, 2016, 2025, 2040, 2050, and 2060 were examined under the No Action Alternative. The low Lake Powell elevation at the 10^{th} percentile was projected for the year 2025 with about 17,000 acres of exposed shoreline. For a comparative discussion, the action alternatives are compared to the No Action Alternative for the year 2025.

The potential for fugitive emissions is limited by the extent of the area containing fine sediment having the potential to generate dust. Areas of fine sediments at Lake Powell comprise about three percent of the 1,960 miles of shoreline (NPS 2002). The remainder of Lake Powell shoreline consists of Navajo Sandstone and other Glen Canyon Group rock formations. These rock formations are not conducive to creating significant amounts of dust.

Figure 4.6-1
Lake Powell End-of-March Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values



4.6.2.2 Basin States Alternative

At the 10th percentile, Lake Powell elevation is projected to be 3,552 feet msl in the year 2025 under the Basin States Alternative, resulting in approximately 17,000 acres of exposed shoreline. This would result in no change in exposed shoreline compared to the No Action Alternative (Table 4.6-1). With no change in shoreline acreage, there would be no increased potential to exceed the federal PSD Class II threshold or state and national Ambient Air Quality Standards (AAQS) when compared to the No Action Alternative.

Table 4.6-1
Lake Powell End-of-March 10th Percentile Elevation and Exposed Shoreline (rounded to nearest whole number)

Year	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008						
Surface Elevation (feet msl)	3,591	3,591	3,591	3,591	3,591	3,591
Exposed Shoreline Area (acres x 1,000)	12	12	12	12	12	12
Percent Difference Compared to No Action Alternative	0	0	0	(1)	(0)	0
2016						
Surface Elevation (feet msl)	3,540	3,550	3,555	3,532	3,563	3,557
Exposed Shoreline Area (acres x 1,000)	18	17	16	19	15	16
Percent Difference Compared to No Action Alternative[1]	0	(7)	(9)	5	(15)	(11)
2025						
Surface Elevation (feet msl)	3,552	3,552	3,552	3,508	3,572	3,552
Exposed Shoreline Area (acres x 1,000)	17	17	17	22	14	17
Percent Difference Compared to No Action Alternative	0	0	0	30	(13)	0
2040						
Surface Elevation (feet msl)	3,562	3,555	3,555	3,529	3,566	3,555
Exposed Shoreline Area (acres x 1,000)	16	16	16	19	15	16
Percent Difference Compared to No Action Alternative	0	5	5	24	(3)	5
2050						
Surface Elevation (feet msl)	3,559	3,554	3,554	3,538	3,559	3,555
Exposed Shoreline Area (acres x 1,000)	16	17	17	18	16	16
Percent Difference Compared to No Action Alternative	0	4	4	15	0	3
2060						
Surface Elevation (feet msl)	3,544	3,544	3,544	3,542	3,544	3,544
Exposed Shoreline Area (acres x 1,000)	18	18	18	18	18	18
Percent Difference Compared to No Action Alternative	0	0	0	2	0	0

1 Parenthesis indicates a reduction in exposed shoreline as compared to the No Action Alternative.

4.6.2.3 Conservation Before Shortage Alternative

At the 10th percentile, Lake Powell elevation is projected to be 3,552 feet msl in the year 2025 under the Conservation Before Shortage Alternative. Drawdown of Lake Powell to this elevation could result in approximately 17,000 acres of exposed shoreline. This would result in no change in the exposed shoreline compared to the No Action Alternative (Table 4.6-1).

With no change in shoreline acreage, there would be no increased potential to exceed the PSD Class II threshold or the state or national AAQS when compared to the No Action Alternative.

4.6.2.4 Water Supply Alternative

At the 10th percentile, Lake Powell elevation is projected to be 3,508 feet msl in the year 2025 under the Water Supply Alternative, resulting in approximately 30,000 acres of exposed shoreline. This would result in a 30 percent increase in exposed shoreline compared to the No Action Alternative (Table 4.6-1).

This increase would potentially have a negative effect on air quality compared to the No Action Alternative. As sediment comprises about three percent of the 1,960 miles of shoreline, the increase in acreage susceptible to wind erosion would not result in exceedance of the PSD Class II threshold or the state or national AAQS.

4.6.2.5 Reservoir Storage Alternative

At the 10th percentile, Lake Powell elevation is projected to be 3,572 feet msl in the year 2025 under the Reservoir Storage Alternative. Drawdown of Lake Powell to this elevation would result in a decrease of approximately 14,000 acres of exposed shoreline. For the Reservoir Storage Alternative, this would result in a decrease of about 14 percent in exposed shoreline compared to the No Action Alternative (Table 4.6-1).

The Reservoir Storage Alternative would result in having the highest potential to reduce dust emissions and increased beneficial impact to air quality. Due to a decrease in exposed shoreline acreage, the potential to exceed the PSD Class II threshold or the state or national AAQS would also be decreased.

4.6.2.6 Preferred Alternative

At the 10th percentile, Lake Powell elevation is projected to be 3,552 feet msl in the year 2025 under the Preferred Alternative, resulting in approximately 17,000 acres of exposed shoreline. This would result in no change in the exposed shoreline compared to the No Action Alternative (Table 4.6-1).

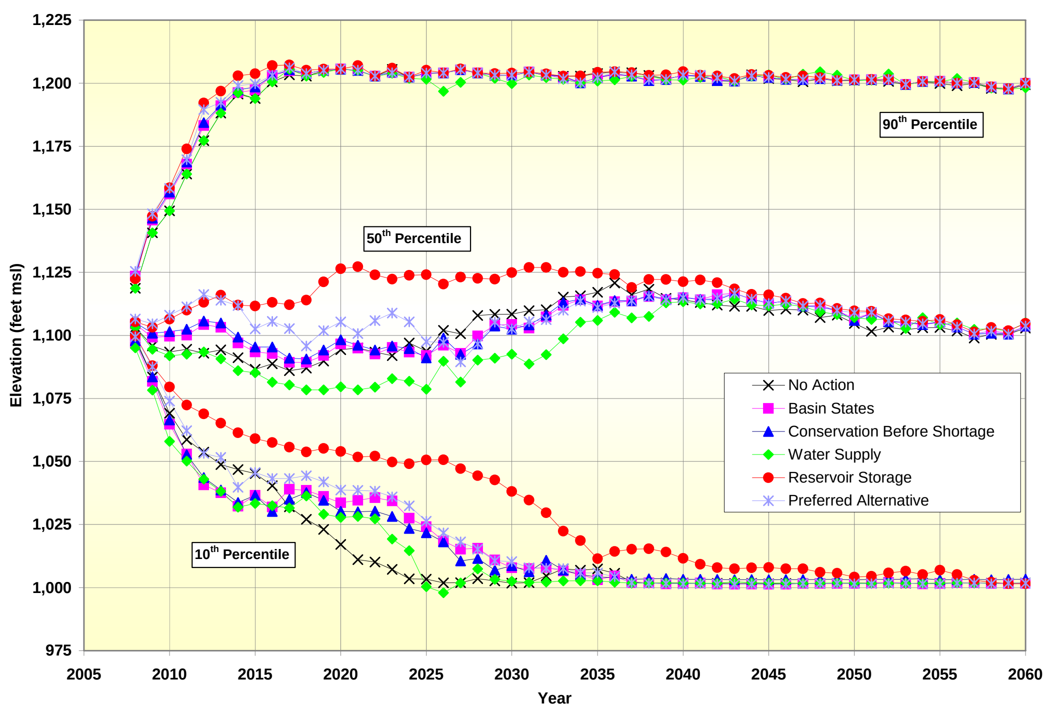
With no change in shoreline acreage, there would be no increased potential to exceed the PSD Class II threshold or the state or national AAQS when compared to the No Action Alternative. The potential to impact air quality would also be similar to that projected for the Basin States and the Conservation Before Shortage alternative.

4.6.3 Glen Canyon Dam to Lake Mead, Lake Mead and Hoover Dam

4.6.3.1 No Action Alternative

The lowest Lake Mead elevation occurs in July (Figure 4.6-2). Under the No Action Alternative, Lake Mead elevation would be drawndown to 1,003 feet msl for the year 2025, resulting in approximately 89,000 acres of exposed shoreline (Table 4.6-2). A comparative discussion of the action alternatives and the No Action Alternative for the year 2025 follows.

Figure 4.6-2
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values



4.6.3.2 Basin States Alternative

At the 10th percentile, Lake Mead elevation is projected to be 1,024 feet msl in the year 2025 under the Basin States Alternative, resulting in approximately 82,000 acres of exposed shoreline. For the Basin States Alternative, this would result in a decrease of about eight percent in exposed shoreline when compared to the No Action Alternative (Table 4.6-2). This decrease in acreage would be directly proportional to the area susceptible to wind erosion and fugitive dust emission. With a decrease in exposed shoreline acreage, the potential to exceed the PSD Class I or II thresholds or the state or national AAQS would also decrease. The eight percent decrease would result in a beneficial effect compared to the No Action Alternative.

Table 4.6-2
Lake Mead End-of-July 10th Percentile Elevation and Exposed Shoreline (Rounded to Nearest Whole Number)

Year	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008						
Surface Elevation (feet msl)	1,099	1,097	1,098	1,095	1,100	1,099
Exposed Shoreline Area (acres x 1,000)	57	58	58	58	57	57
Percent Difference Compared to No Action Alternative[1]	0	1	0	2	(0)	(0)
2016						
Surface Elevation (feet msl)	1,040	1,032	1,030	1,032	1,058	1,043
Exposed Shoreline Area (acres x 1,000)	78	80	81	80	71	77
Percent Difference Compared to No Action Alternative	0	3	3	3	(9)	(2)
2025						
Surface Elevation (feet msl)	1,003	1,024	1,022	1,000	1,051	1,026
Exposed Shoreline Area (acres x 1,000)	89	82	83	90	73	82
Percent Difference Compared to No Action Alternative	0	(8)	(8)	1	(18)	(9)
2040						
Surface Elevation (feet msl)	1,002	1,002	1,003	1,002	1,012	1,001
Exposed Shoreline Area (acres x 1,000)	90	90	90	90	87	90
Percent Difference Compared to No Action Alternative	0	0	(0)	(0)	(3)	0
2050						
Surface Elevation (feet msl)	1,002	1,002	1,003	1,002	1,006	1,002
Exposed Shoreline Area (acres x 1,000)	90	90	90	90	89	90
Percent Difference Compared to No Action Alternative	0	0	(0)	0	(1)	0
2060						
Surface Elevation (feet msl)	1,002	1,002	1,003	1,001	1,002	1,002
Exposed Shoreline Area (acres x 1,000)	90	90	89	90	90	90
Percent Difference Compared to No Action Alternative	0	0	(0)	0	0	0

1 Parenthesis indicates a reduction in exposed shoreline compared to the No Action Alternative.

4.6.3.3 Conservation Before Shortage Alternative

At the 10th percentile, Lake Mead elevation is projected to be 1,022 feet msl in the year 2025 under the Conservation Before Shortage Alternative, resulting in approximately 83,000 acres of exposed shoreline. For the Conservation Before Shortage Alternative, this would result in a decrease of about eight percent in exposed shoreline when compared to the No Action Alternative (Table 4.6-2).

The decrease in acreage would be directly proportional to the area susceptible to wind erosion and fugitive dust emissions. With a decrease in exposed shoreline acreage, the potential to exceed the PSD Class I or II thresholds or the state or national AAQS would also decrease. The potential decrease would result in a beneficial impact to the environment compared to the No Action Alternative.

4.6.3.4 Water Supply Alternative

At the 10th percentile, Lake Mead elevation is projected to be 1,000 feet msl in the year 2025 under the Water Supply Alternative, resulting in approximately 90,000 acres of exposed shoreline. For the Water Supply Alternative, this would result in an increase of about one percent in exposed shoreline when compared to the No Action Alternative (Table 4.6-2). The Water Supply Alternative would have potentially the same impact compared to the No Action Alternative.

Changes in shoreline acreage would be directly proportional to the area susceptible to wind erosion and fugitive dust emissions. With a less than one percent change in exposed shoreline acreage, the potential to exceed the PSD Class I or II thresholds or the state or national AAQS would be minimal compared to the No Action Alternative.

4.6.3.5 Reservoir Storage Alternative

At the 10th percentile, Lake Mead elevation is projected to be 1,051 feet msl in the year 2025 under the Reservoir Storage Alternative, resulting in approximately 73,000 acres of exposed shoreline. For the Reservoir Storage Alternative, this would result in a decrease of about 18 percent in exposed shoreline when compared to the No Action Alternative (Table 4.6-2). Compared to the No Action Alternative, the Reservoir Storage Alternative would have the most potential to reduce fugitive emissions and result in beneficial impact to air quality.

The decrease in acreage would be directly proportional to the area susceptible to wind erosion and fugitive dust emissions. With a decrease in exposed shoreline acreage, the potential to exceed the PSD Class I or II thresholds or the state or national AAQS would also be decreased. The decrease would result in a beneficial impact to the environment compared to the No Action Alternative.

4.6.3.6 Preferred Alternative

At the 10th percentile, Lake Mead elevation is projected to be 1,026 feet msl in the year 2025 under the Preferred Alternative, resulting in approximately 82,000 acres of exposed shoreline. For the Preferred Alternative, this would result in a decrease of about nine percent in exposed shoreline when compared to the No Action Alternative (Table 4.6-2).

The decrease in acreage would be directly proportional to the area susceptible to wind erosion and fugitive dust emissions. With a decrease in exposed shoreline acreage, the potential to exceed the PSD Class I or II thresholds or the state or national AAQS would also decrease. The potential decrease would result in a beneficial impact to the environment compared to the No Action Alternative.

4.6.4 Summary

The projected exposed shoreline acreage under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, are similar (i.e., from zero to five percent for the year 2025) to that projected under the No Action Alternative at Lake Powell. In general, the greatest increase in exposed shoreline acreage (i.e., about 30 percent for the year 2025) compared to the No Action Alternative at Lake Powell is projected under the Water Supply Alternative; the greatest reduction (i.e., about 15 percent for the year 2025) is projected under the Reservoir Storage Alternative. This trend can be observed in Figure 4.6-1.

Except for the Reservoir Storage Alternative, all of the action alternatives are projected to have similar or decreased shoreline exposure (i.e., from a less than one percent increase to a nine percent decrease) compared to the No Action Alternative for Lake Mead, and for Glen Canyon Dam to Lake Mead reach (Lake Mead delta). There is a greater potential for reduction in shoreline acreage exposure (i.e., 18 percent for the year 2025) in the Reservoir Storage Alternative and this potential is generally consistent for all years. This trend can be observed in Figure 4.6-2.

As reservoir elevations decrease and more shoreline is exposed, the potential for increased fugitive dust emission increases. However, an increase in fugitive emissions as a result of increased exposed shoreline would be limited at Lake Powell because the increased exposure of acreage would be comprised largely of sandstone, which is not conducive to generating PM10 standard fugitive emissions.

4.7 Visual Resources

This section describes the methods used in the Final EIS for analyzing the potential effects of changing reservoir elevations on visual resources at Lake Powell and Lake Mead, focusing on selected attraction features, calcium carbonate rings, and sediment deltas.

4.7.1 Methodology

To determine how changes in reservoir elevation might affect attraction features, data provided in Table 4.3-9 (Section 4.3) for end-of-September (the month of highest visitation) Lake Powell elevations were used to compare effects of the alternatives on exposure of Cathedral in the Desert. Table 4.3-9 provides percentage of values less than or equal to Lake Powell reservoir elevation of 3,550 feet msl for multiple years. Elevation 3,550 feet msl is significant because Cathedral in the Desert becomes visible at or below that elevation (Section 3.7).

For calcium carbonate rings, reservoir elevations at the 10^{th} percentile were used. Months representative of lowest reservoir elevations were used to provide a worst case analysis, or maximum extent of calcium carbonate rings; March was selected for Lake Powell and July was selected for Lake Mead, using data provided in Section 4.6 (Tables 4.6-1 and 4.6-2, respectively). The height of the calcium carbonate ring was calculated as the distance in feet from full pool elevations of Lake Powell (3,700 feet msl) and Lake Mead (1,221 feet msl) to the lowest lake elevation within the modeling time period.

The method of analysis used for projecting potential effects on calcium carbonate rings in Section 4.6 was utilized to understand relative differences between the action alternatives and the No Action Alternative for sediment deltas. The 10^{th} percentile of reservoir elevations in the months representative of lowest reservoir elevations, March for Lake Powell and July for Lake Mead, for the year 2026 are used in the Final EIS to provide a relative comparison of effects of the action alternatives on sediment deltas to the No Action Alternative.

4.7.2 Lake Powell and Glen Canyon Dam

4.7.2.1 Attraction Features

No Action Alternative. Using the modeling projections described above, there is a five percent probability of exposing the Cathedral in the Desert under the No Action Alternative. The upstream face of Glen Canyon Dam will be slightly more exposed, but this is not considered a measurable visual impact.

Basin States Alternative and Conservation Before Shortage Alternative. Under these two action alternatives, there is a seven percent chance of exposure of Cathedral in the Desert.

Water Supply Alternative. There is a 17 percent chance of exposure of Cathedral in the Desert.

Reservoir Storage Alternative. There is a three percent chance of exposure of Cathedral in the Desert.

Preferred Alternative. There is a seven percent chance of exposure of Cathedral in the Desert.

4.7.2.2 Calcium Carbonate Rings and Sediment Deltas

No Action Alternative. The 10th percentile values for March 2025 indicate a low Lake Powell reservoir elevation of 3,552 feet msl under the No Action Alternative, thus creating a potential calcium carbonate ring of 148 feet in height. Sediment deltas will continue to build up over time and be visible under the No Action Alternative. Ferrari's (2006) longitudinal profile indicates that the sediment delta is visible for at least 15 miles upstream of Hite. At 10th percentile projections, the delta may be visible from as far away as 25 miles, essentially from Hite to Gypsum Canyon.

Basin States Alternative and Conservation Before Shortage Alternative. The 10th percentile values for March 2025 indicate a low Lake Powell reservoir elevation of 3,552 feet msl under these two action alternatives, thus creating a potential calcium carbonate ring of 148 feet in height, the same as under the No Action Alternative. The sediment deltas would be exposed and visible to the same extent as under the No Action Alternative.

Water Supply Alternative. The 10th percentile values for March 2025 indicate a low Lake Powell reservoir elevation of 3,508 feet msl under the Water Supply Alternative, thus creating a potential calcium carbonate ring of 192 feet in height. Sediment deltas would be more exposed and visible than under the No Action Alternative.

Reservoir Storage Alternative. The 10th percentile values for March 2025 indicate a low Lake Powell reservoir elevation of 3,572 feet msl under the Reservoir Storage Alternative, thus creating a potential calcium carbonate ring of 128 feet in height. Potential exposure of sediment deltas would be less visible than under the No Action Alternative.

Preferred Alternative. The 10th percentile values for March 2025 indicate a low Lake Powell reservoir elevation of 3,552 feet msl under the Preferred Alternative, thus creating a potential calcium carbonate ring of 148 feet in height, the same as under the No Action Alternative. Sediment deltas would be exposed and visible to the same extent as under the No Action Alternative.

4.7.3 Glen Canyon Dam to Lake Mead

The proposed federal action would have no effects on the visual resources in this reach because daily and hourly flows would generally be similar under all alternatives.

4.7.4 Lake Mead and Hoover Dam

4.7.4.1 Attraction Features

Hoover Dam is a major destination and a national landmark. The proposed federal action would not have any visual effects on this resource.

4.7.4.2 Calcium Carbonate Rings and Sediment Deltas

No Action Alternative. The 10th percentile values for July 2025 indicate a low Lake Mead reservoir elevation of 1,003 feet msl under the No Action Alternative, thus creating a potential calcium carbonate ring of 218 feet in height. Sediment deltas are visible primarily to water-based recreationists, though they can also be viewed by visitors of the Lake Mead NRA (Section 3.7).

Basin States Alternative and Conservation Before Shortage Alternative. The 10th percentile values for July 2025 indicate a low Lake Mead reservoir elevations of 1,024 feet msl for the Basin States Alternative and 1,022 for the Conservation Before Shortage Alternative, thus creating a potential calcium carbonate ring of 197 feet and 199 feet in height, respectively. Sediment deltas would be somewhat less visible than under the No Action Alternative.

Water Supply Alternative. The 10th percentile values for July 2025 indicate a low Lake Mead reservoir elevation of 1,000 feet msl under the Water Supply Alternative, thus creating a potential calcium carbonate ring of 221 feet in height. Sediment deltas would be only slightly more exposed and therefore slightly more visible than under the No Action Alternative.

Reservoir Storage Alternative. The 10th percentile values for July 2025 indicate a low Lake Mead reservoir elevation of 1,051 feet msl under the Reservoir Storage Alternative, thus creating a potential calcium carbonate ring of 170 feet in height. Sediment deltas would be less exposed and therefore less visible than under the No Action Alternative.

Preferred Alternative. The 10th percentile values for July 2025 indicate a low Lake Mead reservoir elevation of 1,026 feet msl under the Preferred Alternative, thus creating a potential calcium carbonate ring of 195 feet in height. Sediment deltas would be somewhat less exposed and therefore less visible than under the No Action Alternative.

4.7.5 Summary

The probability of exposing Cathedral in the Desert ranged from three to 17 percent under the alternatives. The Water Supply Alternative would offer the greatest chance that visitors could see Cathedral in the Desert, while the Reservoir Storage Alternative offers the least chance. Most would agree that Cathedral in the Desert was one of the most spectacular geological features in Glen Canyon before inundation; seeing this feature would be considered a positive visual impact. There would be no visual effects on attraction features at Lake Mead.

At Lake Powell, the maximum height of calcium carbonate rings ranged from 192 feet under the Water Supply Alternative to 148 feet under the Basin States and Conservation Before Shortage alternatives, the Preferred Alternative, and the No Action Alternative, and to 128 feet under the Reservoir Storage Alternative. At Lake Mead, the maximum height of calcium carbonate rings ranged from 170 feet under the Reservoir Storage Alternative to 221 feet under the Water Supply Alternative, which is somewhat similar to the 218 foot height under the No Action Alternative. The calcium carbonate ring height under the Basin States and Conservation Before Storage alternatives, and the Preferred Alternative was around 197 feet. For both reservoirs, the presence of the calcium carbonate ring produces an effect regardless of its height. Therefore, while there are numeric differences in the projected height of the rings, the overall difference in visual impact among the alternatives is not considered significant.

At the inflow areas to both Lake Powell and Lake Mead, sediment deltas will continue to build up over time and be visible under all alternatives. Their relative exposure and visibility are directly related to reservoir elevations. The differences among all alternatives are negligible for both Lake Powell and Lake Mead.

4.8 Biological Resources

This section describes the environmental consequences related to biological resources associated with implementation of the proposed federal action, and describes the methods used to determine these effects. This section also provides descriptions of two ongoing environmental protection programs within the study area.

4.8.1 Related Environmental Programs

Reclamation is committed to compliance with environmental statutes such as the ESA and the Grand Canyon Protection Act. The following are ongoing collaborative programs intended to meet environmental compliance requirements.

4.8.1.1 Glen Canyon Dam Adaptive Management Program

Impacts to biological resources downstream of Glen Canyon Dam are considered in the Glen Canyon Dam Adaptive Management Program, which was established to monitor the effects of Glen Canyon Dam operations and other management actions on the downstream environment. This program makes recommendations to the Secretary regarding ways to fulfill the resource protection requirements of the Grand Canyon Protection Act while complying with all applicable federal laws. This program will continue to analyze the effects of varied conditions on biological resources downstream of Lake Powell.

4.8.1.2 Lower Colorado River Multi-Species Conservation Program

For a portion of the study area, Reclamation is the implementing agency for the LCR MSCP. This program mitigates potential flow-related and non-flow related impacts to biological resources along the lower Colorado River. These impacts could result from various federal and non-federal actions over the next 50 years along the lower Colorado River from Lake Mead to the SIB. This habitat-based program is being implemented to mitigate impacts to special status species, although benefits of the LCR MSCP will accrue to all species that utilize those habitats. This program covers potential impacts to the same types of habitats that may be affected by flow-related impacts of the action alternatives. For NEPA purposes, the No Action Alternative is used to represent baseline conditions. Reclamation has reviewed the effects of the Preferred Alternative in this Final EIS and has determined that all potential effects on listed species and their habitats along the Colorado River from the full pool elevation of Lake Mead to the SIB are covered by the LCR MSCP. The LCR MSCP BO addresses the effects of covered actions on reduction of Lake Mead reservoir elevations to 950 feet msl, and on flow reductions of up to 0.845 maf from Hoover Dam to Davis Dam, 0.860 maf from Davis Dam to Parker Dam, and 1.574 maf from Parker Dam to Imperial Dam. The LCR MSCP identified and it is mitigating impacts on LCR MSCP covered species and their habitats. Based on the flow reductions described above, these impacts include the potential loss of up to:

- 2,008 acres of cottonwood-willow habitats;
- 133 acres of marsh habitat; and

- 399 acres of backwater habitat.

To address these impacts, the LCR MSCP would:

- restore 5,940 acres of cottonwood-willow habitat;
- restore 512 acres of marsh habitat;
- restore 360 acres of backwater habitat;
- stock 660,000 razorback sucker over the term of the LCR MSCP; and
- stock 620,000 bonytail over the term of the LCR MSCP.

In addition, these habitats would be actively managed to provide habitat values greater than those of the impacted habitats. The quality and in most cases the quantity of restored habitat will be greater than the impacted habitats. Restoration and management of these habitats for LCR MSCP covered species would provide benefit to all flora and fauna that utilize cottonwood-willow, marsh, and backwater habitats along the lower Colorado River.

LCR MSCP flow-related covered activities include flow reductions due to potential implementation of future shortages in the Lower Basin. Reclamation is committed to enacting the conservation measures of the LCR MSCP and these measures will effectively offset any potential minor impacts identified in this Final EIS to cottonwood-willow, marsh, and backwater habitats from Lake Mead to the SIB.

4.8.2 Methodology

Two types of modeling results were used to perform the biological analysis, as follows:

- hydrologic modeling (CRSS) – reservoir elevations, dam releases, river flows; and
- water quality modeling (CE-QUAL-W2 and GEMSS) – water temperatures.

This biological analysis evaluates the relative difference between the action alternatives and the No Action Alternative. The level of available information varies with the study reaches; therefore, the methodology is adjusted according to the availability of information for a particular reach or group of reaches.

4.8.2.1 Assumptions

Desert scrub plant communities would not be affected by lowered reservoir elevations, river stage, or groundwater levels. Cottonwood-willow and marsh vegetation types could be adversely affected by lowered reservoir elevations, river stage, or groundwater levels and may be lost. Saltcedar and mesquite communities would not be adversely affected by lowered groundwater levels. For example, it has been reported that declines in groundwater levels of approximately 3.6 feet caused 92 to 100 percent of cottonwoods and willows to die, while only zero to 13 percent of saltcedar died at the sampling sites along the Bill Williams River (Shafroth et al. 2000).

Davis Dam and Parker Dam will continue to be operated to meet target reservoir elevations and these operations will not vary between alternatives, thus the proposed federal action will not impact riparian and marsh vegetation or wildlife habitats supported by these reservoirs.

The biological analyses are dependent upon the data inputs, modeling assumptions and validity of the CE-QUAL-W2 and GEMSS models for water quality. The historic data and water temperature models represent limited combinations of weather patterns, hydrology, discharge patterns, and reservoir elevations. The upper and lower temperature bounds from this analysis are the best estimates of probable discharge temperature ranges at the indicated reservoir elevations. Additional discussion and data on water temperature is provided in Section 4.5 and in Appendix P.

Inflow temperatures to Lake Mead often do not warm to equilibrium temperatures during much of the year. This is due to upstream cold releases from Lake Powell. The cool inflows restrict the depth of surface water warming and contribute to cooler discharge temperatures from Hoover Dam. If Lake Powell releases were significantly warmer, then inflow temperatures to Lake Mead could reach equilibrium and discharge temperatures would be warmer.

4.8.2.2 Vegetation Assessment Methodology

Lake Powell and Lake Mead. Reservoir elevations under the action alternatives were compared to the No Action Alternative to determine whether shoreline vegetation is more or less likely to establish and/or be inundated.

Glen Canyon Dam to NIB. Projections of average monthly releases from Glen Canyon Dam, Hoover Dam, Davis Dam, and Parker Dam under each action alternative were compared to the No Action Alternative (Figures P-BCR-6 through P-BCR-54; Figures and Tables identified with the letter P throughout this section are located in Appendix P of this Final EIS). The differences between the alternatives, primarily at the 10^{th} percentile, which has the most potential to adversely affect vegetation, were used as an indicator of potential low-flow conditions. To estimate the significance of potential impacts, the modeled releases were analyzed to determine if they would fall inside or outside the annual ranges that have historically occurred in the Colorado River (Section 3.3). Both Scott et al. (1999) and Shafroth et al. (2000) indicated that phreatophytes may develop root systems according to the hydrologic regime under which these plants have developed. Flow variations of several thousand cfs within one month and between months are considered within the range of normal conditions.

In addition to average monthly flows, annual median releases were evaluated to identify potential changes in groundwater along the Colorado River floodplain (Section 4.3, Figures 4.3-32 and 4.3-37). Changes to groundwater levels along the Colorado River may influence riparian and marsh vegetation.

Vegetation impacts from changes in river flow and groundwater levels were assumed to be restricted to those plant communities that consist of obligate phreatophytes (reliant on alluvial groundwater) and/or marsh communities. Based on the relationships used in Appendix K of the LCR MSCP BA (Reclamation 2004c), declines in groundwater levels under the action alternatives could be between 0.25 and 0.5 foot. These reductions would not impact saltcedar and mesquite land cover types because these species are facultative phreatophytes (not solely reliant on alluvial groundwater) and are more tolerant to reductions in surface water and groundwater levels than cottonwood-willow or marsh land cover types.

NIB to SIB. Potential flow changes downstream of the NIB as a result of implementation of the proposed federal action would primarily be the result of potential changes in excess flows (flood flows) arriving at the NIB. The differences in probability of these excess flows under each of the alternatives could potentially affect vegetation between the NIB and the SIB. Probabilities of these excess flows passing downstream of Morelos Diversion Dam under the action alternatives were compared to the No Action Alternative to analyze potential vegetation impacts.

4.8.2.3 Wildlife Assessment Methodology

Terrestrial wildlife was assumed to be affected only where vegetation showed substantial changes from the No Action Alternative.

Analyses of river sport fishery and aquatic food base impacts were based on release temperature modeling, surface water temperature data for Lake Powell, and review of the temperature conclusions in the SCOP FEIS (Clean Water Coalition 2006) for Lake Mead. Since sport fishery is primarily of interest to anglers, effects on this resource are discussed in Section 4.12.

4.8.2.4 Special Status Species Assessment Methodology

Lake Powell and Lake Mead. Analysis of impacts to terrestrial special status species at these two reservoirs were based primarily on the vegetation impact assessment. Potential impacts to special status fish were assessed by comparing reservoir elevations under each action alternative to those under the No Action Alternative. The potential monthly average release temperatures from Lake Powell were also used to analyze potential impacts to special status fish between Glen Canyon Dam and Lake Mead. Previous impact analysis for Lake Mead had used elevation 1,160 feet msl as a threshold for potential impact to razorback sucker spawning areas in Lake Mead. However, recent monitoring has shown that the two subpopulations of razorback sucker in Lake Mead would change their spawning locations in response to lower reservoir elevations (Albrecht and Holden 2006). Lake Mead elevation is currently below 1,160 feet msl. The elevation range of 1,120 feet msl to 1,150 feet msl was used for comparison purposes in this analysis.

Glen Canyon Dam to NIB. Analysis of impacts to terrestrial special status species along the Colorado River were based primarily on the vegetation impact assessment. Impacts to special status fish were based on comparing the modeled average monthly temperatures at Lees Ferry, Little Colorado River, and Diamond Creek to the life history temperature tolerances. There is a wide range of possible downstream temperatures when releases from Lake Powell coincide with lower Lake Powell elevation (Section 1.5; Figures P-BCR-56 through P-BCR-67). In order to provide a more meaningful comparison, the average monthly temperatures were used as the basis for evaluating impacts to special status fish (Tables P-BCR-1 through P-BCR-3). Special status fish impacts were also based on comparing the monthly Lake Mead elevations and monthly releases from Davis Dam and Parker Dam, for which water temperature data were not available. Changes in dam releases that would fall outside the range of flows that typically occur were deemed to cause impacts. Changes in release temperatures from Glen Canyon Dam under the No Action Alternative were used to determine whether impacts to the aquatic food base could in turn impact the special status fish in the Grand Canyon. This analysis used larval chironomids, larval simuliids, *Gammarus lacustris*, and *Cladophora glomerata* as indicator organisms. If a particular alternative would substantially affect non-native sport fish (Section 4.12), this was included in the special status fish assessment.

NIB to SIB. Special status fish species do not exist in this river reach so the analysis was limited to terrestrial special status species. Flows in this reach of the Colorado River are sporadic, with the river channel in the downstream portion of the reach being frequently dry.

4.8.3 Effects on Vegetation and Wildlife

This section discusses the potential impacts to vegetation and wildlife that may result from implementation of the proposed federal action.

4.8.3.1 Lake Powell and Lake Mead

No Action Alternative. Under the No Action Alternative, fluctuation of these reservoirs will continue to inhibit plant growth around the reservoirs over the long term. Lake Powell elevations trend upward at the 50th and 90th percentiles throughout the modeling period. At the 10th percentile, Lake Powell elevations trend temporarily downward (2010 through 2019 and 2041 through 2060), and temporarily upward (2027 through 2041). At the end of the interim period in 2026, Lake Powell elevation is virtually unchanged from current elevations. Figures P-WQA-6, P-BCR-1, and P-BCR-2 provide Lake Powell end-of-March, July, and September elevations, respectively.

Lake Mead elevations exhibit a pronounced downward trend at the 10th percentile. At the 50th percentile, the trend is generally unchanged at the end of the modeling period, though periodic upward and downward trends occur in both the interim and long term. Figures P-BCR-4, P-BCR-6, and P-BCR-7 provide Lake Mead end-of-month elevations for March, July, and September, respectively. To the extent that Lake Mead elevations may be lowered, these lower lake elevations may have effects on biological resources, as described in the following paragraphs.

The sediment deltas in both reservoirs are expected to continue to be colonized by weeds and saltcedar. Lake Mead sediment deltas and the downstream portion of the Grand Canyon have had riparian vegetation become established and persist over long periods of time, until inundated by rising reservoir elevations. The type of vegetation that becomes established in these delta areas is dependent on two factors. The first factor is timing. If the sediment becomes exposed during seed-fall season for cottonwood or willow, then those species are likely to become established. If the sediment becomes exposed during the fall months, then saltcedar is likely to be established and become the dominant vegetation.

A second factor that may influence the type of plant community that may become established in the delta areas is the depth to groundwater or river stage relative to these exposed sediments. As the reservoir elevation declines and the sediment becomes exposed, the level of the river as it downcuts through the newly exposed sediment delta helps determine whether cottonwoods or willows can survive, even if they become established. If the river level drops too far below the root zone of cottonwoods and willows, plant mortality would begin to occur, thus, opening gaps for saltcedar and other species to become established.

Wildlife that utilizes these reservoirs and their shorelines are affected by the fluctuating nature of these habitats to some extent. Reservoir elevation fluctuation would continue into the future, which would continue to alter habitat along the shoreline and below full pool elevation as has occurred in the past.

Quagga mussels have been detected in Lake Mead and in downstream reservoirs, and a small number of zebra and/or quagga mussel larvae were detected in Lake Powell in July 2007 (Section 3.8). Under the No Action Alternative, the potential remains for these mussels to establish in Lake Powell and continue to be present in Lake Mead and in downstream reservoirs. The adoption of guidelines for shortage and coordinated reservoir operations does not affect the potential for colonization in Lake Powell and continued presence in Lake Mead, Lake Mohave and Lake Havasu, or connected waterways. Precautionary measures of cleaning boats entering and leaving these reservoirs will continue under the No Action Alternative and the action alternatives, and the geographic locations of water delivery from the Colorado River system will not change because of this action. Since the nature of the proposed federal action will not impact the potential for spreading and/or continued presence of these invasive mussels, and since conditions related to this issue will be the same under the No Action Alternative and the action alternatives, this issue is not discussed further in this Final EIS.

Action Alternatives. While the action alternatives differ from the No Action Alternative to some degree, all action alternatives exhibit similar reservoir elevation fluctuations as compared to the No Action Alternative. Temporary establishment and loss of vegetation and wildlife habitat below the full pool elevation would occur similarly under all alternatives. In general, higher reservoir elevations such as those associated with the Reservoir Storage Alternative would decrease exposed shoreline available for plant colonization by decreasing the distance between permanent shoreline vegetation and the lake edge, and would thus provide less opportunity for temporary desirable and undesirable plant communities to develop. Lower elevations such as those associated with the Water Supply Alternative would increase the distance between permanent shoreline vegetation and aquatic habitats, which would increase shoreline available for plant colonization, but would also increase the distance wildlife would need to travel between permanent cover habitat and the lake edge. The descriptions below are limited to the 10th and 50th percentiles, as elevations at the 90th percentile under the action alternatives are virtually unchanged from those under the No Action Alternative for both Lake Powell and Lake Mead.

Preferred Alternative, Lake Powell. Compared to the No Action Alternative, the Preferred Alternative results in somewhat higher elevations during the interim period and somewhat lower elevations in the long term at the 10th percentile; and somewhat lower elevations in the interim period at the 50th percentile.

Preferred Alternative, Lake Mead. At the 10th percentile, the Preferred Alternative is generally unchanged from the No Action Alternative, with the exception of somewhat higher elevations from 2018 through 2032. At the 50th percentile, 2009 through 2025 have somewhat higher elevations. The Preferred Alternative is bracketed by the high and low reservoir elevations of the other action alternatives for all percentile scenarios, through both the interim period and the –post-interim period.

Basin States Alternative, Lake Powell. With only a few minor exceptions, the Basin States Alternative has reservoir elevations similar to the Preferred Alternative at the 10th and 50th percentiles.

Basin States Alternative, Lake Mead. From 2010 through 2017, the Basin States Alternative has somewhat lower elevations than the No Action Alternative at both the 10th and 50th percentiles. In other years, the Basin States Alternative mimics the Preferred Alternative.

Conservation Before Shortage Alternative, Lake Powell. With a few minor exceptions, the Conservation Before Shortage Alternative has reservoir elevations similar to the Preferred Alternative at the 10th and 50th percentiles.

Conservation Before Shortage Alternative, Lake Mead. The Conservation Before Shortage Alternative has reservoir elevations similar to the Basin States Alternative at the 10th and 50th percentiles.

Water Supply Alternative, Lake Powell. Through 2014, the Water Supply Alternative elevations are somewhat higher than the No Action Alternative at the 10th percentile, and significantly lower throughout the remainder of the interim period and through the modeling period. At the 50th percentile, elevations are similar through 2010, somewhat to significantly lower through approximately 2032, and similar through the remainder of the modeling period.

Water Supply Alternative, Lake Mead. At the 10th percentile, the Water Supply Alternative results in somewhat lower reservoir elevations than the No Action Alternative from 2010 through 2017, somewhat higher elevations from 2018 through 2023, and generally mimics the No Action Alternative for the remainder of the modeling period. At the 50th percentile, this alternative results in somewhat lower elevations through 2035, and unchanged elevations for the remainder of the modeling period.

The lower reservoir elevations that may occur under the Water Supply Alternative fall outside the potential range of the No Action Alternative. At these low reservoir elevations, there would be a greater potential for sediment delta headcutting at the inflow areas causing movement of sediment further into the reservoirs. The Water Supply Alternative would have the greatest potential effect on these deltas due to increased reservoir drawdown, which could potentially impact vegetation and wildlife habitat. These impacts may occur in the interim period and the post-interim period. The lower lake elevations under the Water Supply Alternative may remain lower than under the No Action Alternative until approximately 2036 for Lake Powell and until 2040 for Lake Mead at the 50th percentile, and until 2055 for Lake Powell at the 10th percentile.

Reservoir Storage Alternative, Lake Powell. Reservoir elevations under the Reservoir Storage Alternative are somewhat higher than under the No Action Alternative throughout the interim period at the 10th percentile. Beginning in 2034, there is little variation between the Reservoir Storage Alternative and the No Action Alternative throughout the remainder of the modeling period. At the 50th percentile, lake elevations under the Reservoir Storage Alternative are slightly higher than under the No Action Alternative from 2017 through 2042, and unchanged in other years.

Reservoir Storage Alternative, Lake Mead. Reservoir elevations are somewhat higher through 2045 at the 10th percentile, and through 2035 at the 50th percentile.

4.8.3.2 Glen Canyon Dam to Lake Mead

No Action Alternative. Data on modeled Glen Canyon Dam releases are provided in Figures P-BCR-8 through P-BCR-19 in Appendix P. The range of releases is similar to the range of historic annual flows observed from 2000 to the present (Section 3.3, Figure 3.3-2), though lower than the high water years between 1995 and 2000. Therefore, the release conditions which the vegetation and wildlife downstream of Glen Canyon Dam have experienced since 2000 would continue into the future at these percentiles. Vegetation and wildlife are likely adjusting or have adjusted to these lower flows. Stabilized lower flows have been observed to favor riparian vegetation development at numerous locations in the Western United States (Reclamation 1995; Gloss et al. 2005). This trend benefits species that utilize shrubby riparian vegetation. The modeled release trends indicate that the magnitude of average monthly releases under the No Action Alternative would likely be unchanged to somewhat lower in the future through the modeling period at the 10th, 50th, and 90th percentiles. The only noticeable exception to these trends occurs at the 90th percentile in June.

Action Alternatives. From the end of the interim period through the modeling period, the differences in modeled releases for the action alternatives at the 10th, 50th, and 90th percentiles are well within both daily and monthly release variations (modeled and historical), and generally mimic the modeled releases under the No Action Alternative. It is therefore anticipated that none of the action alternatives will have significant positive or negative impacts on riparian vegetation or wildlife in the Glen Canyon Dam to Lake Mead river reach in the post-interim period when compared to the No Action Alternative.

During the interim period, releases under the action alternatives at the 10th percentile are generally unchanged or lower than under the No Action Alternative, with the Reservoir Storage Alternative being the closest to the No Action Alternative. Maximum 10th percentile release reductions are typically between 700 and 2,000 cfs, though the Water Supply Alternative may be lower than the No Action Alternative by up to 3,800 cfs in July and September. Releases under the Preferred Alternative are lower by as much as 2,000 cfs between July and December at the 10th percentile. Low flows have the greatest likelihood of negatively impacting riparian and marsh vegetation and wildlife that utilize such habitats. The impacts would be minor because for the most part, these reduced releases remain within the range of annual fluctuation and would be temporary. The impacts may cause stress to phreatophytes, but would not be expected to cause significant plant die-off. These impacts would affect obligate phreatophytes such as willow more than facultative phreatophytes such as saltcedar. Thus, these minor impacts may favor continued saltcedar expansion, though saltcedar is expanding along the Colorado River under existing conditions.

Because Glen Canyon Dam releases under the action alternatives generally return to the releases under the No Action Alternative near the end of the interim period, these impacts would end after the interim period. However, the effects on phreatophytes and continued saltcedar expansion may be observable even after the releases return to those under the No Action Alternative. Minor negative impacts to riparian vegetation at the lower 10th percentile of releases under all alternatives, including the No Action Alternative, would in turn impact the habitats for herptofauna, small mammals, waterfowl, and songbirds that utilize those habitats. Snakes found downstream of Glen Canyon Dam are typically found in drier portions of the reach and should not be impacted by these alternatives. Lake Powell releases at the 50th percentile of lake elevations would have temperatures under the action alternatives similar to those under the No Action Alternative and thus would cause no temperature related impacts to amphibians along the river. Only the Water Supply Alternative may result in substantially higher temperatures in some years and may provide some thermal benefit to amphibian reproduction along the river (Tables P-BCR-1 through P-BCR-3). It would be difficult to quantitatively measure these potential impacts as the impacts to river temperatures and vegetation may be temporary and minor and thus indirect impacts to species using those habitats would be small. These potential small habitat impacts are unlikely to in turn impact large mammals in the canyon. Due to the potential for minor impacts to riparian vegetation, all the alternatives would have similar minor impacts to wildlife in the Glen Canyon Dam to Lake Mead river ranch.

At the 50th percentile, releases under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, are generally greater than under the No Action Alternative. Differences of as much as 3,800 cfs occur during May through September under the Water Supply Alternative, with slightly smaller increases under the other action alternatives. The Reservoir Storage Alternative releases are virtually unchanged from the No Action Alternative releases at the 50th percentile. Since the 50th percentile releases are well within the range of historical annual releases, negative impacts to permanent riparian vegetation and wildlife habitat are expected to be minimal, though higher summer releases may inhibit the reestablishment of some herbaceous vegetation in riparian areas that have been exposed during recent low release years. Modestly higher seasonal flows may expand marshy areas, and benefit existing saltcedar, willow, and shrub habitat both by inundation and contributions to groundwater.

At the 90th percentile, the magnitude of flows exceeding those under the No Action Alternative that may occur under the action alternatives is relatively small, with the exception of the Reservoir Storage Alternative. Releases under the Reservoir Storage Alternative in June may be up to 6,800 cfs above releases under the No Action Alternative and approach 30,000 cfs. Unusually high flows may cause scouring of vegetation that may have developed at the lower levels on the river banks under previously lower flow conditions. These flows, however, are below the levels of historical high flows which have exceeded 40,000 cfs. Despite the potential scouring effects from these higher flows, they provide an overall benefit to vegetation and wildlife in the long term.

Releases under the Preferred Alternative at the 90th percentile are somewhat lower than under the No Action Alternative at the 90th percentile in July and September through December, and generally somewhat higher during January through May.

4.8.3.3 Hoover Dam to Davis Dam

No Action Alternative. The Hoover Dam to Davis Dam reach consists primarily of the reservoir pool of Lake Mohave, the elevation of which is controlled by operation of Davis Dam. Lake Mohave and Lake Havasu are operated on a monthly rule curve and end-of-month target elevations and therefore significant fluctuations in reservoir elevations do not occur. No change in vegetation or wildlife is expected over the interim period or the modeling period. Information on monthly Hoover Dam releases is provided in Figures P-BCR-20 through P-BCR-31.

Action Alternatives. Elevations of these two reservoirs under the action alternatives would not deviate from elevations under the No Action Alternative. Accordingly, there would be no impacts to vegetation or wildlife at these reservoirs. Because vegetation is limited in the Hoover Dam to Lake Mohave river reach, potential flow differences among alternatives in this reach of the Colorado River would not substantially impact vegetation or wildlife.

4.8.3.4 Davis Dam to Parker Dam

No Action Alternative. Fluctuations of monthly flows downstream of Davis Dam of several thousand cfs have occurred in the recent past and will continue into the future. Vegetation and wildlife habitat along the Colorado River continuously make minor adjustments as these flows fluctuate. Annual median releases from Davis Dam under the No Action Alternative show a slight downward trend through 2040 (Section 4.3, Figure 4.3-32). Accordingly, the lower releases could potentially cause a corresponding decline in groundwater levels along the 39 mile section of the Colorado River that extends from Davis Dam to Lake Havasu.

Action Alternatives. In general, both lower and higher monthly releases under the action alternatives would have similar impacts to vegetation and wildlife as discussed for the Glen Canyon Dam to Lake Mead reach. At the 10th and 50th percentiles, release rates for Davis Dam fall within a relatively narrow band for all months. Average monthly Davis Dam releases under all alternatives are provided in Figures P-BCR-32 through P-BCR-43. The differences in monthly releases under the Preferred Alternative and under the No Action Alternative are generally small, and are not expected to impact vegetation or wildlife at these percentiles in either the interim period or the post-interim period. The Reservoir Storage Alternative results in lower releases during the interim period, while the Water Supply Alternative results in higher releases. The higher releases would benefit vegetation and wildlife, but release differences are small, and these benefits would be minor. Slightly lower releases under the Reservoir Storage Alternative may have minor negative impacts on vegetation and wildlife as compared to releases under the No Action Alternative. Similarly to the Preferred Alternative, the Basin States and Conservation Before Shortage alternatives essentially follow the No Action Alternative, and where there are differences they are infrequent, small differences. Therefore, the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, should have no measurable impacts on vegetation in the Davis Dam to Parker Dam river reach.

At the 90th percentile, the Reservoir Storage Alternative may result in higher releases due to increased flood control releases not projected under the other alternatives. These releases typically occur in winter months, outside the growing season. These flows may be up to 6,000 cfs greater than under the No Action Alternative at the 90th percentile, but would not be large enough to cause significant scouring or over-bank flooding. Thus, no substantial riparian impacts are expected. The Preferred Alternative may result in somewhat higher releases in January and February in the interim period, and somewhat lower or unchanged releases in the modeling period at the 90th percentile. The differences would be isolated and temporary, and are not expected to significantly impact vegetation or wildlife along this reach. With the exception of January, modeled releases for the No Action Alternative and the action alternatives converge relatively quickly after the end of the interim period. Releases and their effects under the action alternatives generally return to those under the No Action Alternative relatively soon after the interim period, though minor effects on vegetation may be observed beyond the interim period.

A comparison of annual median release under each action alternative to the annual median release under the No Action Alternative showed minor reductions in river stage and corresponding groundwater levels (Section 4.3). The Reservoir Storage Alternative results in the greatest reduction in annual median release from Davis Dam (Section 4.3, Figure 4.3-32) that may lower groundwater levels during the interim period by as much as 0.25 to 0.50 foot for gaining and losing reaches, respectively. Sustained decreases in groundwater levels of this magnitude might have minor negative effects on cottonwood-willow and marsh communities as compared to the No Action Alternative. The Water Supply Alternative results in annual median releases that are somewhat higher than under the No Action Alternative through the interim period, and may have minor positive impacts on cottonwood-willow and marsh vegetation during this period due to higher groundwater levels. The Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, result in annual median releases somewhat lower than but close to those under the No Action Alternative through 2012, and otherwise generally mimic the No Action Alternative in the interim and post-interim periods. These alternatives are therefore not expected to impact cottonwood-willow or marsh vegetation.

4.8.3.5 Parker Dam to Imperial Dam

No Action Alternative. Fluctuations of monthly flows downstream of Parker Dam of several thousand cfs have occurred in the recent past, and will continue into the future. Vegetation and wildlife habitat along the Colorado River continuously make minor adjustments as these flows fluctuate. Annual median releases from Parker Dam under the No Action Alternative show a slight downward trend through 2040 (Section 4.3, Figure 4.3-37), which may effect groundwater levels.

Action Alternatives. In general, both lower and higher monthly releases under the action alternatives would have similar impacts to vegetation and wildlife as discussed for the river reach between Glen Canyon Dam and Lake Mead. Release rates at the 10^{th} and 50^{th} percentiles for Parker Dam fall within a relatively narrow band for all months. Average monthly Parker Dam releases are provided in Figures P-BCR-44 through P-BCR-55. The differences in releases under the Preferred Alternative and under the No Action Alternative are generally small, and are not expected to impact vegetation or wildlife at these percentiles in either the interim or the modeling period. The Reservoir Storage Alternative results in lower releases during the interim period, while the Water Supply Alternative results in higher releases. The higher releases would benefit vegetation and wildlife, but release differences are small, and these benefits would be minor. Slightly lower releases under the Reservoir Storage Alternative may have minor negative impacts on vegetation and wildlife compared to releases under the No Action Alternative. Similarly to the Preferred Alternative, releases under the Basin States and Conservation Before Shortage alternatives essentially follow the releases under the No Action Alternative, and where there are differences they are infrequent, small differences. Therefore, changes in monthly releases from Parker Dam under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, should have no substantial impacts on vegetation in the river reach between Parker Dam and Imperial Dam.

At the 90th percentile, the Reservoir Storage Alternative may create higher releases due to increased flood control releases not modeled under other alternatives. These releases typically occur in winter months, outside the growing season. These flows may be up to 4,000 cfs higher than those under the No Action Alternative at the 90th percentile, but would not be large enough to cause significant scouring or over-bank flooding. Thus, no substantial riparian impacts are expected. The Preferred Alternative may result in somewhat higher releases in January and February in the interim period, and somewhat lower or unchanged releases in the modeling period at the 90th percentile. The differences would be isolated and temporary, and are not expected to significantly impact vegetation or wildlife along this river reach. With the exception of January, modeled releases under the No Action Alternative and the action alternatives converge relatively quickly after the end of the interim period. Releases and other effects under the action alternatives generally return to the those the No Action Alternative relatively soon after the interim period, though minor effects on vegetation of interim period conditions may be observed beyond the interim period.

The Reservoir Storage Alternative results in annual median releases from Parker Dam that are lower than under the No Action Alternative (Section 4.3, Figure 4.3-37), which may lower groundwater levels throughout the interim period by as much as 0.15 to 0.30 foot for gaining and losing reaches, respectively. Sustained decreases in groundwater levels of this magnitude might have minor negative effects on cottonwood-willow and marsh communities as compared to those under the No Action Alternative. The Water Supply Alternative results in annual median releases that mimic or are slightly higher than under the No Action Alternative through the interim and modeling periods, which may have minor positive impacts on cottonwood-willow and marsh vegetation from 2016 through 2026 due to higher groundwater levels. Annual median releases under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, are generally bracketed between the Reservoir Storage Alternative and the No Action Alternative, are all somewhat lower than under the No Action Alternative through the interim and post-interim periods. These slightly lower groundwater levels may result in minor negative impacts on marsh and riparian communities.

4.8.3.6 Imperial Dam to NIB

Most of the water delivered to Mexico is diverted at Imperial Dam, conveyed via the AAC, and then returned to the Colorado River through the Pilot Knob and Siphon Drop Powerplants and their respective wasteway channels, which discharge to the Colorado River mainstream 2.1 and 7.6 miles upstream of the NIB, respectively (Section 3.3). The proposed federal action will not alter the operation of these diversions and wasteways and therefore will not have an effect on the river reach between Imperial Dam and the NIB.

4.8.3.7 NIB to SIB

No Action Alternative. The frequency and magnitude of flows are important factors in maintaining riparian habitat and wildlife in the river reach between Morelos Diversion Dam and the SIB; however, the potential biological effects downstream of the NIB cannot be specifically determined because of the uncertainty of water use once it flows to the NIB and becomes available to Mexico.

The hydrologic models for this Final EIS (Section 4.2) have assumed that any water in excess of Mexico's scheduled normal or surplus deliveries would not be diverted by Mexico but would continue down the Colorado River channel from Morelos Diversion Dam to the SIB. This assumption results in the probability of flows passing Morelos Diversion Dam that might be somewhat higher than may actually occur. The potential impacts discussed in the following section are based on this assumption.

Under the No Action Alternative, flows downstream of Morelos Diversion Dam will continue to be primarily the result of dam leakage and agricultural return flows. Flows past Morelos Diversion Dam will continue to be relatively rare events (Figure P-BCR-56). It is expected that riparian and marsh vegetation and wildlife will continue to experience some year-round flow in the upstream part of this reach and sporadic flow in the downstream part of this reach under the No Action Alternative. Thus, historical conditions will generally continue under the No Action Alternative.

Action Alternatives. During the interim period and beyond, the Basin States and Water Supply alternatives, and the Preferred Alternative, are just as likely to result in excess flows downstream of Morelos Diversion Dam as the No Action Alternative, and would therefore have no impact on this reach as compared to the No Action Alternative. Further, the probabilities of occurrence for these excess flows are low and range between ten percent and 15 percent (Figure P-BCR-56). The magnitude of excess flows past Morelos Diversion Dam is zero for approximately 80 to 90 percent of the model traces between 2008 and 2060 (Section 4.3, Figure 4.3-39). The magnitude of these excess flows under the Reservoir Storage Alternative may be higher by as much as one mafy than under the No Action Alternative. The magnitude of these excess flows under the Conservation Before Shortage Alternative may be higher by as much as 0.35 mafy than under the No Action Alternative (Section 4.3, Figure 4.3-43).

Due to modeling assumptions under the Conservation Before Shortage and Reservoir Storage alternatives, water is also delivered to Mexico through this river reach via periodic flows of about 40 kafy to 200 kafy (Appendix M). These pulse flows[1] would

[1] These flows were modeled as part of the storage and delivery mechanism under the Conservation Before Shortage and Reservoir Storage alternatives. The modeling assumptions were utilized in this Final EIS in order to analyze the potential impacts to environmental resources of the storage and delivery mechanism, particularly with regard to reservoir elevations and river flow impacts. The use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, these releases could be made under current management of the Colorado River.

occur approximately every fifth year during the interim period only and other flows that could be used for environmental, domestic, or agricultural purposes would also be released every five years. The probability of flows past Morelos Diversion Dam under these two alternatives returns to that under the No Action Alternative after the interim period. These flows would benefit vegetation and wildlife downstream of Morelos Diversion Dam because they would increase river flow, scour and redistribute sediment, and provide opportunities for establishment of cottonwood-willow and marsh vegetation. These fluvial processes are valuable to aquatic and riparian systems in the long term, though temporary losses of riparian or marsh vegetation may occur from scouring, which could temporarily disrupt wildlife.

Table 4.8-1 summarizes impacts to vegetation and wildlife under the action alternatives relative to the No Action Alternative.

Table 4.8-1
Vegetation and Wildlife Impact Summary
Comparison of Action Alternatives to No Action Alternative

Location	Alternative	Impact	Rationale
Lake Powell and Lake Mead	Preferred Alternative	Minor - positive	Potential for higher reservoir elevations, especially at the 10th percentile in Lake Powell during the interim period.
	Conservation Before Shortage, Basin States	No impact to Minor - Positive	Elevations and fluctuation similar to those under the No Action Alternative and the Preferred Alternative.
	Water Supply	Minor – negative	Reservoir elevations tend to be lower than under the No Action Alternative, with increased opportunities for undesirable plants to colonize shoreline and for sediment delta headcutting. Lower elevations would increase distance between shoreline vegetation and the lakes.
	Reservoir Storage	Minor-positive	Elevations tend to be higher than under the No Action Alternative, with decreased opportunities for undesirable plants to colonize shoreline and for sediment delta headcutting. Elevation fluctuations inundate all vegetation below full pool elevation. Higher elevations would decrease distance between shoreline vegetation and lakes.
Glen Canyon Dam to Lake Mead	All action alternatives	Minor – negative	Decreased releases at the 10th percentile (for all alternatives there are similar reductions overall). Release differences are within the range of recent history and annual fluctuation.
Hoover Dam to Davis Dam and Lake Havasu to Parker Dam	All action alternatives	No impact	Relatively small Hoover Dam release differences and very limited vegetation upstream of Lake Mohave. Monthly rule curves at Lake Mohave and Lake Havasu prevent elevation deviations from the No Action Alternative.

Table 4.8-1
Vegetation and Wildlife Impact Summary
Comparison of Action Alternatives to No Action Alternative

Location	Alternative	Impact	Rationale
Davis Dam to Parker Dam	Conservation Before Shortage, Basin States, Preferred Alternative	No impact	Monthly releases closely follow the No Action Alternative. Annual median Davis Dam release is similar to the No Action Alternative.
	Water Supply	Minor-positive	Monthly releases higher than under the No Action Alternative at the 10th and 50th percentiles. Higher annual median release from Davis Dam.
	Reservoir Storage	Minor – Negative	Monthly releases lower than under the No Action Alternative at the 10th and 50th percentiles. Lower annual median release from Davis Dam.
Parker Dam to Imperial Dam	Water Supply	Minor - Positive	Monthly releases closely follow the No Action Alternative. Annual median Parker Dam release is similar to or higher than under the No Action Alternative.
	Basin States, Conservation Before Shortage, Reservoir Storage, Preferred Alternative	Minor – Negative	Monthly releases lower than under the No Action Alternative at the 10th and 50th percentiles (the Reservoir Storage Alternative has the greatest reduction; the Basin States Alternative has the least reduction). The Reservoir Storage Alternative higher flows in the winter are unlikely to have substantial benefits due to channel capacity. Annual median Parker Dam releases are lower than under the No Action Alternative.
	All action alternatives	No impact	Flow changes are routed through AAC and Pilot Knob/Siphon Drop Powerplants rather than the Colorado River downstream of Imperial Dam.
Imperial Dam to NIB	Basin States, Water Supply, Preferred Alternative	No impact	Probability of excess flows past Morelos Diversion Dam is very close to that of the No Action Alternative.
NIB to SIB	Reservoir Storage, Conservation Before Shortage	Moderate – positive	Relatively likely high flows expected past Morelos Diversion Dam, which would benefit the riparian corridor.

4.8.4 Special Status Species

4.8.4.1 Lake Powell

No Action Alternative. Fluctuations of Lake Powell elevations would continue into the future, precluding the development of stable vegetated terrestrial habitats below elevation 3,700 feet msl because vegetation that develops would be periodically dewatered or inundated.

Fish. The Colorado pikeminnow, bonytail chub, razorback sucker and flannelmouth sucker all occur in Lake Powell, primarily at the inflow areas of the Colorado River and the San Juan River. The flannelmouth sucker population has been decreasing since the reservoir was formed (Reclamation 2000). Low reservoir elevations increase the amount of riverine habitat available for these species in the river inflow areas, which may be a temporary benefit to these fish. In addition, when the lake elevation is below 3,660 feet msl, a waterfall becomes exposed in the San Juan River where it enters Lake Powell. This waterfall forms a barrier to upstream movement of non-native fish that can prey upon or compete with special status fish in the San Juan River (i.e., Colorado pike minnow and razorback sucker). The waterfall, however, also would prevent native fish that enter the reservoir from the river from moving back into the river. Thus, reservoir elevations below 3,660 feet msl could provide a minor benefit to special status fish in the San Juan River. The probability that Lake Powell will be at or below elevation 3,660 feet msl generally increases during the interim period but levels off at approximately 50 percent near the end of the modeling period (Figure P-BCR-57).

Birds. Special status birds that currently may be affected by elevation fluctuations of Lake Powell include California condor, bald eagle, osprey, belted kingfisher, Clark's grebe, and American peregrine falcon. California condors are scavengers, primarily on large mammals and sometimes on fish. The lower reservoir elevations projected for the future may expose additional shoreline for scavenging.

Bald eagles in this area are primarily winter residents that feed on fish, waterfowl and carrion. Though there may be effects on fisheries as reservoir elevations decline, no effects on the population of fish are anticipated. Therefore, this food source is expected to remain available for bald eagles under the No Action Alternative.

Ospreys are a rare transient in summer along the Colorado River. However, they could potentially utilize Lake Powell during migration. Fluctuating reservoir elevations would have no direct impacts to ospreys, and no substantial indirect effects on food sources (fish) are expected.

Peregrine falcons may utilize Lake Powell for hunting songbirds, bats and small mammals. Reservoir elevation fluctuations would not directly impact peregrine falcons. Nearby populations in the Grand Canyon are considered stable and the species was delisted from federal listing in 1999 (Gloss et al. 2005).

Belted kingfishers inhabit riparian areas in Arizona and mainly consume fish. Kingfishers could be affected as fish availability fluctuates over time. Given the gradual downward trend for Lake Powell elevations in the future, it is anticipated that fish populations would be able to adjust to the changing conditions. Increased inflow areas as the elevations decline may provide improved shallow-water hunting area.

Clark's grebe inhabit marshes and may be found in marsh habitat at Lake Powell inflow areas. They are common breeders in Utah and utilize lakes and shoreline vegetation for breeding habitat. The decline of reservoir elevations projected in the future under the No Action Alternative may dewater marshes at the inflow areas, causing temporary loss of marsh habitat until the marsh re-establishes at a lower elevation, or the reservoir elevations recover.

Mammals. Special status mammals that may utilize Lake Powell include spotted bat, Townsend's big-eared bat, pale Townsend's big-eared bat, Yuma myotis, Allen's big-eared bat, western red bat, and occult little brown bat. All of these species may utilize riparian habitats around the shoreline of Lake Powell. As lake elevations fluctuate, these habitats may be dewatered or inundated and localized effects on food source populations may occur. Given their wide-ranging nature, these species would not be expected to be substantially impacted under the No Action Alternative or the action alternatives. Accordingly, these species are not discussed further for this reach.

Amphibians. Northern leopard frog populations are found in side canyons of Lake Powell above the fluctuating reservoir elevations (Gloss et al. 2005). These populations in habitat areas located above elevation 3,700 feet msl and would not be impacted by declining elevations of Lake Powell. However, continued fluctuations of Lake Powell elevations would likely limit marsh and riparian vegetation at the shoreline, or only allow it to establish temporarily, thus continuing to limit the potential for leopard frogs and other amphibians to utilize areas below the full pool elevation of Lake Powell.

Action Alternatives.

Fish. Flannelmouth suckers, razorback sucker, Colorado pikeminnow and bonytail chub occur in the inflow areas of the Colorado River and the San Juan River but do not spawn in Lake Powell, and fluctuating reservoir elevations under the action alternatives would be unlikely to affect habitats within the reservoir for any individuals remaining in the reservoir. For fish in the inflow areas, however, lower reservoir elevations would increase the amount of riverine habitat while higher elevations would decrease that habitat. A waterfall would be exposed in the San Juan River when Lake Powell elevation declines to 3,660 feet msl; this waterfall would be a barrier to upstream fish movement and limit the benefits to native fish below that elevation. The changes in the extent of habitat under the action alternatives were estimated using modeling results for March, July and September at the 90th, 50th and 10th percentiles of reservoir elevations (Figures P-WQA-6, P-BCR-1 and P-BCR-2). The 90th percentile elevations are essentially the same under all alternatives and are not analyzed here. The waterfall in the San Juan River would be exposed at the 10th percentile of reservoir elevations under all alternatives, and under all but the Reservoir Storage Alternative at the 50th percentile of reservoir elevations. Thus, benefits of increased riverine habitat to native fish would be limited to the Colorado River and any other smaller tributaries that discharge to Lake Powell.

Preferred Alternative. Lake Powell elevations under the Preferred Alternative could be up to 32 feet higher than under the No Action Alternative until about 2025, and then up to 17 feet lower until about 2060 at the 10th percentile. Reservoir elevations at the 50th percentile would be up to 17 feet lower than under the No Action Alternative until about 2045 at which time reservoir elevations under the Preferred Alternative and the No Action Alternative would become equal. Thus, the Preferred Alternative could provide minor benefits to native fish during those times when Lake Powell elevations are lower than under the No Action Alternative. The probability that the San Juan River waterfall will be exposed under the Preferred Alternative is similar or higher than the probability that the waterfall will be exposed under the No Action Alternative (Figure P-BCR-57).

Basin States Alternative. Under this alternative Lake Powell elevations would be similar to those described for the Preferred Alternative, but the elevations could be slightly (up to two feet) lower. Benefits to native fish would be essentially the same as under the Preferred Alternative. The probability that the San Juan River waterfall will be exposed under the Basin States Alternative is similar or higher than the probability that the waterfall will be exposed under the No Action Alternative (Figure P-BCR-57).

Conservation Before Shortage Alternative. Lake Powell elevations would generally be within one foot of those under the Basin States Alternative, and benefits to native fish would be the same as under the Basin States Alternative. The probability that the San Juan River waterfall will be exposed under the Conservation Before Shortage Alternative is similar to or higher than the probability that the waterfall will be exposed under the No Action Alternative (Figure P-BCR-57).

Water Supply Alternative. Lake Powell elevations would remain higher than those under the No Action Alternative until about 2015 by up to about 21 feet at the 10^{th} percentile. After 2015, the elevations would be up to 65 feet lower than under the No Action Alternative to the end of the modeling period (2060). At the 50^{th} percentile, reservoir elevations would be up to 40 feet lower than under the No Action Alternative from about 2010 until 2042. This alternative would provide the most riverine habitat of all the alternatives considered. The probability that the San Juan River waterfall will be exposed under the Water Supply Alternative is similar to or higher than the probability that the waterfall will be exposed under the No Action Alternative (Figure P-BCR-57).

Reservoir Storage Alternative. Under this alternative, Lake Powell elevations would remain higher than those under the No Action Alternative at the 10^{th} and 50^{th} percentiles until about 2040 or later. Reservoir elevations would be up to 31 feet higher at the 10^{th} percentile and 10 feet higher at the 50^{th} percentile. Thus, the Reservoir Storage Alternative would provide less riverine habitat for native fish than any of the other alternatives, including the No Action Alternative, and result in a minor negative impact. The probability that the San Juan River waterfall will be exposed under the Reservoir Storage Alternative is lower than the probability that the waterfall will be exposed under the No Action Alternative (Figure P-BCR-57).

Birds. Since bald eagles, peregrine falcons, California condor and osprey are all wide-ranging species that utilize many different habitat types in the area, none of the action alternatives differ substantially enough to impact these species at Lake Powell.

Clark's grebe would be impacted predominantly by impacts to marsh habitats. The Water Supply Alternative would have a minor negative impact on vegetation, including marshes at the inflow areas, and the Reservoir Storage Alternative would have a minor-positive impact on vegetation. These impacts may occur during the interim period and the post-interim period. Clark's grebe would not be impacted under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative.

Belted kingfishers would be most impacted by potential changes in fish food supplies. Substantial impacts to fish food supplies at Lake Powell are not anticipated under the action alternatives, thus no impacts to belted kingfishers are anticipated.

Amphibians. Northern leopard frog populations are found in side canyon areas located above elevation 3,700 feet msl, therefore, the special status amphibians at Lake Powell would not be impacted under the action alternatives.

Table 4.8-2 summarizes the impacts to special status species under the action alternatives relative to the No Action Alternative.

Table 4.8-2
Lake Powell Special Status Species Impact Summary
Comparison of Action Alternatives to No Action Alternative

Species	Alternative	Impact	Rationale
Razorback sucker, bonytail, Colorado pikeminnow, flannelmouth sucker	Water Supply, Conservation Before Shortage, Basin States, Preferred Alternative	Minor - positive	Reservoir elevations tend to be lower than under the No Action Alternative, increasing riverine conditions at the inflows. Alternatives are more likely to result in exposure of waterfall at San Juan River inflow.
	Reservoir Storage	Minor-negative	Reservoir elevations tend to be higher than under the No Action Alternative, decreasing riverine conditions at the inflows. Lower likelihood of exposure of waterfall at San Juan River inflow.
Bald eagle, peregrine falcon, osprey, California condor, belted kingfisher	All action alternatives	No impact	Wide ranging species and action alternatives do not differ substantially enough to cause indirect impacts.
Clark's grebe	Conservation Before Shortage, Basin States, Preferred Alternative	No impact	Reservoir elevations trend close to those under the No Action Alternative. Impacts to marsh not anticipated.
	Water Supply	Minor - negative	Lower reservoir elevations would have minor negative impact on marshes at the inflows, by increased likelihood of sediment delta headcutting.
	Reservoir Storage	Minor – positive	Higher reservoir elevations would have minor positive impact on marshes at the inflows, by decreased likelihood of sediment delta headcutting.
Mammals	All action alternatives	No impact	Wide-ranging species under the action alternatives do not differ substantially enough to cause indirect impacts.
Northern leopard frog	All action alternatives	No Impact	Known populations above Lake Powell elevation fluctuations.

4.8.4.2 Glen Canyon Dam to Lake Mead

No Action Alternative. Under the No Action Alternative, the magnitude of annual releases from Glen Canyon Dam would remain relatively stable during the interim period, but would be reduced over the later years of the modeling period (90th percentile) as Upper Basin depletions increase (Section 4.3, Figure 4.3-12). The magnitude of monthly releases from Glen Canyon Dam at the 90th percentile also trend downward over the later modeling period in some months (Figures P-BCR-8 through P-BCR-19). Reduced river flows have the potential to affect phreatophytes, marshes, and associated special status species.

Plants. Grand Canyon evening primrose grows on beaches along or near the mainstream Colorado River in the vicinity of Separation Canyon and downstream of Diamond Creek (Reclamation 2000). Lower releases could allow this species to colonize lower beaches exposed during reduced releases. Reduced high flows would favor encroachment of riparian vegetation towards the Colorado River, which would compete with the species. High flows and sediment, which are needed to maintain beach habitats and discourage riparian vegetation encroachment, would continue to be limited in the future. Beach habitat occupied by this species is also utilized by recreationists, which limits Grand Canyon evening primrose establishment.

Invertebrates. The Kanab ambersnail occurs in semi-aquatic habitat associated with springs and seeps. In the Grand Canyon, Kanab ambersnail were originally known to occur only at Vasey's Paradise, a large perennial spring. As part of an effort to recover the species, Kanab ambersnails were translocated from Vasey's Paradise to three other locations. One of the criteria used to select these sites was that it be above the elevation of any potential future flood flows past Glen Canyon Dam. These translocated populations would not be affected by the proposed federal action. The Vasey's Paradise population and vegetation are not flooded until flows exceed 17,000 cfs (Reclamation 2002b). Monthly releases under the No Action Alternative may exceed 17,000 cfs for more than a single year in January, February, May, June, July, August, September, and December at the 90th percentile of releases (Figures P-BCR-8 through P-BCR-19).

Niobrara ambersnail occur in wetland habitats at several locations downstream of Glen Canyon Dam. The population near Lees Ferry is subject to inundation from even moderate flows of the Colorado River (greater than 25,000 cfs), and more than 90 percent of the entire habitat is inundated at 45,000 cfs or more. The Indian Gardens population persisted through the 1996 experimental flow. The population has not been monitored since May 1998 and March 1999 at which time it was abundant. However, flows exceeded 22,000 cfs for extended periods in the summer of 1998 and in May 1999, and no snails were found during habitat searches in those periods. Flows over 20,000 cfs inundate the Indian Gardens habitat (Arizona Game and Fish 2004). Monthly releases under the No Action Alternative may exceed 20,000 cfs at the 90th percentile releases in June, July, August, September, and December, which could cause a loss of wetland vegetation and individual snails.

MacNeill's sootywing skipper is a butterfly found along the Colorado River from southern Utah and Nevada to Arizona and southeastern California (Reclamation 1996b). Communication with Mr. Larry Stevens, the Curator of Ecology at the Museum of Northern Arizona indicated that potential sootywing skipper habitat does not occur upstream of Lake Mead (Stevens 2007, personal communication). Mr. Stevens has performed surveys for various butterflies in northern Arizona. Therefore, no impacts to this species are anticipated in the Grand Canyon.

Fish. Glen Canyon Dam releases would continue to follow the guidelines provided in the 1996 Glen Canyon Dam ROD and under the No Action Alternative; the annual releases have a low probability of declining below 8.23 mafy in the future (Section 4.3, Table 4.3-11). Thus, the extent and physical characteristics of habitat available to native special status fish species (humpback chub, bluehead sucker, flannelmouth sucker) would remain about the same under the No Action Alternative. Little information is available to quantitatively assess the potential effects of monthly release trends on the habitat of these fish. In general, the daily operations and Glen Canyon Dam releases will continue to be consistent with the 1996 Glen Canyon Dam ROD; therefore, the proposed federal action is not expected to result in substantial change in the historically observed daily releases. The potential range in hourly flows of 6,000 to 8,000 cfs would continue to occur with the larger fluctuations in December, January, July, and August (Section 4.3, Tables 4.3-13 and 4.3-14). For example, a study of backwaters in the Grand Canyon (Goeking et al. 2003) found that the number and area of backwaters present varied with river discharge between years at any given site and varied among sites within one year. Given that there is little information to quantitatively correlate differences in annual or monthly releases to impacts on the physical characteristics of special status fish habitat availability, water temperature was selected as a better metric to analyze the impacts to special status fish species. Cold river temperatures and the presence of non-native fish species appear to be the key reasons for declines in populations of some native fish species (e.g., humpback chub) in this river reach.

Glen Canyon Dam release temperatures vary depending on the reservoir elevation and other factors. These release temperatures have been modeled (Section 4.5) and comparisons of the action alternatives to the No Action Alternative are shown on Figures P-BCR-58 through P-BCR-60 in Appendix P. A comparison of modeled river temperatures at selected locations downstream of Glen Canyon Dam is shown on Figures P-BCR-61 through P-BCR-69 and Tables P-BCR-1 through P-BCR-3. Native fish, such as the humpback chub, flannelmouth sucker and bluehead sucker could benefit from warmer water temperatures during their spawning season, because releases of cold water from Lake Powell generally keep water temperatures downstream of Lake Mead below that needed for mainstream spawning to occur except in the vicinity of the Diamond Creek confluence (near Lake Mead). Thus, spawning could only occur in warmer tributaries or backwaters. When Lake Powell elevations fall below about 3,600 feet msl (approximately 10th percentile of elevations), water above 15ºC (59ºF) could be released (Table P-BCR-1). This water may warm by approximately 2ºC (3.6ºF) by the time it reaches the Little Colorado

River confluence and by up to 5ºC (9ºF) near the Diamond Creek confluence (Tables P-BCR-2 and P-BCR-3). At the 10th percentile reservoir elevations, the associated release water temperatures could be warm enough for humpback chub spawning and egg incubation from approximately late May through July near Diamond Creek and in July near the Little Colorado River confluence. Growth could occur from late May through October near Diamond Creek and from July to early October near the Little Colorado River confluence.

Flannelmouth and bluehead suckers are also present in this reach of the Colorado River although they use the warmer tributaries for spawning. Only under low Lake Powell elevations (10th percentile), could suitable temperatures for spawning occur in the river for the bluehead sucker over a portion (about June through October) of their spawning season near the Little Colorado River confluence, and from about May through October near Diamond Creek. Egg incubation requires temperatures about 2ºC (3.6ºF) warmer than for spawning and thus would not occur for up to a month later in the spring, and then primarily near Diamond Creek. At the 50th percentile of reservoir elevations, water temperatures near Diamond Creek could be warm enough for their spawning from about June through October, while elevations at the 90th percentile could result in suitable spawning temperatures from about late May through September. However, temperatures may only be suitable for egg incubation in September at the 50th percentile and periodically in July and August at the 90th percentile. For flannelmouth suckers, water temperatures could be warm enough for spawning in May and June near the Little Colorado River and at Diamond Creek, and in June at Lees Ferry at the 10th percentile of reservoir elevations, while egg incubation could not occur at Lees Ferry, could occur only in June near the Little Colorado River confluence, and in May and June near Diamond Creek. Average water temperatures may be adequate to support growth of these three fish species as summarized in Table 4.8-3. Please refer to Tables P-BCR 1 through P-BCR-3 in Appendix P for further specifics on temperature.

Table 4.8-3
Months When Average Water Temperatures may be Adequate to Support Growth of Fish Under the No Action Alternative

Location	Species		
	Humpback Chub	Flannelmouth Sucker	Bluehead Sucker
Lees Ferry	August and September at the 10th percentile	August and September at the 10th percentile	July through October at the 10th percentile
Downstream of the Little Colorado River	July to early October at the 10th percentile	July to early October at the 10th percentile	Late June through October at the 10th percentile
Diamond Creek	June through October at the 10th percentile July through September at the 50th percentile July to mid September at the 90th percentile	June through October at the 10th percentile July through September at the 50th percentile July to mid September at the 90th percentile	May through October at the 10th percentile June through October at the 50th percentile Late May through September at the 90th percentile

Lake Powell elevations at the 10th percentile level pose a low potential for non-native fish to be released from Lake Powell into the Glen Canyon Dam to Lake Mead river reach. Warmer temperatures in the future under the No Action Alternative at the Diamond Creek confluence could also create conditions that would favor the upstream movement of non-native fish into the Grand Canyon from Lake Mead (e.g. striped and largemouth bass). Warmer river temperatures may also promote the movement of non-native warmwater fish from tributaries that provide inflow to this river reach. The conditions that would favor non-native warmwater species would occur infrequently and would be of short duration. Since many non-native fish prey on native fish, the potentially increased number and or higher feeding rate of non-native warmwater fish could adversely affect native species in this reach through competition or predation. However, many warmwater species of non-native fish are already present in this reach (Section 3.8, Table 3.8-4), and infrequent warmer water temperatures are unlikely to increase their numbers or change the species composition present in the long term. For cold water non-native species, such as brown trout and rainbow trout, the slight increase in water temperature at the 10th percentile would not be expected to affect their populations.

Glen Canyon Dam release temperatures have exhibited a relatively narrow seasonal variability and typically ranged from approximately 7°C to 12°C (44.6ºF to 53.6ºF) between 1990 and 2002 (Appendix F, Figure F-5). After 2002, the temperatures began to increase and the seasonal variability widened and ranged from approximately 8°C to 16°C (46.4ºF to 60.8ºF). Modeled future release temperatures under the No Action Alternative for Lake Powell elevations at the 50th percentile indicate similar potential conditions to those that began in 2002. Modeled release temperatures for Lake Powell elevations at the 10th percentile indicate the possibility of warmer release temperatures in the future (Table P-BCR-1). Warmer average river temperatures could increase the potential for expansion of the Asian tapeworm (*Bothriocephalus acheilognathi*) and anchorworm (*Lernaea cyprinacea*) in the mainstream Colorado River in some years, and could adversely affect native fish, including the humpback chub. Currently, these non-native fish parasites are found primarily in fish in the Little Colorado River and other tributaries and mostly affect native fish. Currently, and under the No Action Alternative, these parasites are less likely to infect fish in the Colorado River because water temperatures are less than optimal for these parasites.

These warmer release temperatures under the No Action Alternative also could affect the aquatic foodbase downstream of Glen Canyon Dam. However, larval chironomids, larval simuliids, *Cladophora* and *Gammarus* are key components of the aquatic foodbase downstream of Glen Canyon Dam and they are tolerant of a wide range in temperature.

The favorable temperature ranges are:

- 8°C to 25°C (46.4°F to 77°F) for larval chironomids (LeSage and Harrison 1980; Laville and Vincon 1991; Sublette et al. 1998; Stevens et al. 1998; Danks 1978; Maier et al. 1990);
- 10°C to 26°C (50°F to78.8°F) for larval simuliids (Becker 1973; Ross and Merritt 1978; Colbo and Porter 1981; Hauer and Benke 1987);
- 13°C to 17°C (55.4°F to 62.6°F) for *Cladophora* (Graham et al. 1982; Wong et al. 1978); and
- 7°C to 29°C (44.6°F to 84.2°F) for *Gammarus* (Smith 1973; Pennak and Rosine 1976; Macneil et al. 1997).

The potential future release temperatures under the No Action Alternative should be similar to or higher than historic release temperatures. The warmer releases that may occur at Lake Powell elevations at the 10th percentile may be warmer than the preference of *Cladophora* in some years, but in general, these potential warmer releases may provide some overall benefit to the aquatic foodbase. This change is anticipated to benefit special status fish that rely on these organisms as their food source. The aquatic foodbase and special status fish populations are expected to remain similar to present conditions.

Mammals. Small-footed myotis, pale Townsend's big-eared bat, Townsend's big-eared bat, spotted bat, Allen's big-eared bat, western red bat, Yuma myotis, occult little brown bat, and greater western mastiff bat all may utilize this river reach. Colorado River flows do not directly impact these species as they generally roost in caves and trees well above potential flow-related impacts. They are not obligate riparian species but may utilize such habitats for hunting. Impacts to these bat species from changes in vegetation, insect populations, from flow and water temperature changes are not likely under the No Action Alternative or the action alternatives. Accordingly, these species are not discussed further for this river reach.

Amphibians. Reduced flows in the future would not affect the spring-fed site of the leopard frog population upstream of Lees Ferry. Inundation of this site occurs at flows of approximately 21,000 cfs. Inundation of this site would potentially occur under the No Action Alternative from June through September, as releases at the 90th percentile in these months could exceed 21,000 cfs (Figures P-BCR-13 through P-BCR-16). Leopard frog reproduction has only been observed in warm (20°C or 68°F) pool and marsh areas, away from the direct influence of the Colorado River (Drost 2005). Colder pools (10°C to 15°C [50°F to 59°F]) that receive water from the Colorado River appear to be avoided. Water temperature at the spring site remains above 15°C (59°F) throughout the year and above 20°C (68°F) for several months (Spence 1996). Most of the warmer pools are located above the 21,000 cfs flow level; larvae and any remaining eggs still present during spring release peak flows would only infrequently be exposed to Colorado River flows. Average temperatures at Lees

Ferry under the No Action Alternative may be at or above 15°C (59°F) for the reservoir elevation at the 10th percentile in July, August, September and October (Table P-BCR-1). At the 50th and 90th percentiles, the average Lees Ferry temperatures are expected to remain predominantly below 15°C (59°F) under the No Action Alternative (Table P-BCR-1). Thus, temperatures would continue to remain below ideal temperatures for leopard frog under the No Action Alternative for most of the time.

Birds. Special status birds in this reach include bald eagle, California condor, southwestern willow flycatcher, Clark's grebe, osprey, belted kingfisher, snowy egret, and American peregrine falcon. For the same reasons that California condor, osprey, belted kingfisher, and American peregrine falcon would be unaffected at Lake Powell, the proposed federal action would not impact these species in the river reach between Glen Canyon Dam and Lake Mead. Steep shorelines limit the establishment of significant marshes in this river reach. It is unlikely that Clark's grebe or snowy egret would be impacted in this reach. Accordingly, only bald eagle and southwestern willow flycatcher are discussed further for this reach.

Bald eagles in this area are primarily winter residents and they feed largely on fish, waterfowl and carrion. Bald eagles feed on trout in the Lees Ferry area, and historically often congregate at Nankoweap Creek. Less than ideal river temperatures for trout may occur in the future in some years; however, despite such potential adverse effects on trout in some years, it is anticipated that trout will remain a food source for bald eagles under the No Action Alternative. Potential increases in river temperatures under the No Action Alternative or action alternatives may result in an increase in the warmwater fish population which could serve as a supplemental food source for bald eagles. The roost or nest sites are not anticipated to be effected in the future under the No Action Alternative.

Southwestern willow flycatchers nest in riparian shrub habitats of saltcedar and willow downstream of Glen Canyon Dam. Reduced flows in the future under the No Action Alternative would tend to continue favoring the establishment of riparian shrub vegetation in this reach. These conditions would benefit southwestern willow flycatchers since they inhabit willow and saltcedar plant communities and have generally benefited from post-Glen Canyon Dam conditions. This trend would continue into the future.

Action Alternatives. Releases under the action alternatives will only deviate from those under the No Action Alternative during the interim period for this river reach. Though conditions causing potential impacts would cease after the interim period, effects on vegetation communities during the interim period may be observed beyond the interim period.

Plants. At the 90th percentile for June Glen Canyon Dam releases, the Reservoir Storage Alternative may have spill avoidance releases that would exceed those under the No Action Alternative. June releases are the highest for the year at the

90th percentile and were used to gage potential impacts to Grand Canyon primrose habitat (Figure P-BCR-11 in Appendix P). These higher releases have a greater potential to adversely impact beach habitat and thus Grand Canyon evening primrose. These high flows may approach 28,000 cfs during the interim period, which is still less than recent experimental releases that have exceeded 40,000 cfs, so the impacts should be negligible. Releases under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, sometimes exceed those under the No Action Alternative at the 90th percentile, but typically in months that are not the annual high release months, and the releases remain relatively close to those under the No Action Alternative. Therefore, these four action alternatives are not expected to result in impacts to Grand Canyon evening primrose. There could potentially be a minor negative impact on Grand Canyon primrose under the Reservoir Storage Alternative due to occasional spill avoidance releases discussed above.

Invertebrates. Kanab ambersnail habitat is impacted when flows exceed 17,000 cfs. During the interim period, flows under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, may exceed the flows observed under the No Action Alternative and 17,000 cfs in April and May at the 90th percentile (Figures P-BCR-11 and P-BCR-12). There are only a few isolated years under the other two action alternatives when flows are above those under the No Action Alternative and 17,000 cfs in these months. July releases at the 90th percentile under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, would be above 17,000 cfs, but lower than under the No Action Alternative, therefore possibly inundating less Kanab ambersnail habitat in this month. Flows under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, could also be above those under the No Action Alternative and 17,000 cfs at the 50th percentile in August, thus inundating more Kanab ambersnail habitat (Figure P-BCR-15). There could be flows under the Water Supply Alternative at the 50th percentile that are higher than those under the No Action Alternative and above 17,000 cfs in August, though this is the only month where this may occur under the Water Supply Alternative, and most of the time flows would be similar to those under the No Action Alternative when above 17,000 cfs (Figure P-BCR-15). In June, occasional spill avoidance releases under the Reservoir Shortage Alternative up to 4,000 cfs above those under the No Action Alternative (approaching 27,000 cfs) would flood additional Kanab ambersnail habitat (Figure P-BCR-13). The Kanab ambersnail population at Vasey's Paradise survived and recovered from innumerable similar and higher flows during the pre-Glen Canyon Dam era, and has survived six flows in excess of 45,000 cfs during the post-Glen Canyon Dam era (1965, 1980, and 1983 through 1986). Flows above 17,000 cfs could be produced under the Reservoir Storage Alternative, exceeding the flows observed under the No Action Alternative in December.

At the 10th percentile, all action alternatives may have lower releases from Glen Canyon Dam in some months. Though it is not possible to accurately project under which months those releases would occur or how many months in a row this would occur, these lower releases would allow spring vegetation at Vasey's Paradise to develop lower down on the canyon. Ambersnails could move into this lower habitat if releases are lower for long enough for such habitat to develop. When releases rise again, this habitat would be inundated and could impact ambersnails. However, this type of impact also occurs under the No Action Alternative. Accordingly, these potential impacts are expected to be minor, and the population that occurs above the zone of fluctuating releases should not be impacted under the action alternatives. Reclamation has consulted with FWS (FWS 1995; FWS 2002; Department 2004) on the effects of Glen Canyon Dam operations on the Vasey's Paradise population.

When releases under the Reservoir Storage Alternative exceed those under the No Action Alternative and 20,000 cfs in June and December at the 90th percentile, the Reservoir Storage Alternative would have a greater potential for a negative impact on Niobrara ambersnail habitat. In the months of June through September, and December, when Glen Canyon Dam releases under the No Action Alternative and the action alternatives are above 20,000 cfs at the 90th percentile, the magnitude of releases under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, are equal to or less than those under the No Action Alternative. Thus, there is the potential for a positive impact on Niobrara ambersnail habitat during those months.

Fish. Lake Powell releases would be altered under the action alternatives, thus affecting sediment transport, water temperatures, and the potential range of hourly flows. Sediment transport is directly related to river flow, and annual releases below 8.23 mafy (as under the No Action Alternative) would transport less sediment out of the Colorado River and into Lake Mead while higher releases would transport more sediment (Section 4.5, Table 4.5-9). Temperature of the water released from Lake Powell depends on the reservoir elevation and various other conditions, with potentially warmer water being released when reservoir elevations are lower. As described for the No Action Alternative, daily fluctuations in river flows occur throughout the year. The potential range of hourly flows would be reduced, but not eliminated, in some months when annual releases are lower than 8.23 maf, and the potential range would increase in some months when annual releases are higher than 8.23 maf. Water temperatures corresponding to reservoir elevations at the 90th percentile are the same or nearly the same under the action alternatives as under the No Action Alternative; thus, no impacts would occur relative to the No Action Alternative at higher Lake Powell elevations. Temperature impacts of Lake Powell releases when lake elevations are at the 10th and 50th percentiles are described below for the action alternatives.

Preferred Alternative. Annual Glen Canyon Dam releases under the Preferred Alternative could be less than 8.23 mafy, with an approximately 9.7 percent higher probability than those under the No Action Alternative (Section 4.3, Table 4.3-11), which would reduce the transport of sediment out of the river and into Lake Mead (Section 4.5). Releases above the minimum objective release of 8.23 mafy would occur with a nearly 17 percent higher probability under the Preferred Alternative than under the No Action Alternative. These higher releases would transport more sediment out of the river. The probability of releases above nine mafy (9.01 mafy to above 16 mafy) is very similar (differ by approximately 0.5 percent) to the No Action Alternative and thus the effect on sediment transport would also be very similar to the No Action Alternative (Table 4.3-11). The impacts of these changes in sediment transport on instream habitat suitability and quantity for native fish are unknown, though higher rates of sediment transport could reduce the amount of fine sediment within the channel over time.

Average water temperatures at Lees Ferry under the Preferred Alternative would be the same as under the No Action Alternative at the 10th and 50th percentiles, resulting in no impact (Table P-BCR-1). Near the Little Colorado River confluence, average water temperatures would be up to 1ºC (1.8°F) warmer at the 10th percentile and range from 1ºC (1.8ºF) warmer to 2ºC (3.6ºF) colder than the 50th percentile of reservoir elevations (Table P-BCR-2). At Diamond Creek, the average temperatures would be less than 1.5ºC (2.7ºF) warmer at the 10th percentile and range from 1ºC (1.8ºF) warmer to 1ºC (1.8ºF) colder than the 50th percentile of reservoir elevations (Table P-BCR-3). These small changes in water temperature would have little effect on native fish spawning, egg incubation, and growth. The warmer temperatures at the 10th percentile would increase the length of time that suitable temperatures are present for spawning of native fish (humpback chub, flannelmouth sucker, and bluehead sucker) from near the Little Colorado River to Lake Mead river reach while the slightly lower temperatures from September through March at the 50th percentile would decrease the spawning season and growth in October for the bluehead sucker near Diamond Creek. The cooler water temperatures would not affect spawning or growth of the humpback chub or flannelmouth sucker.

The warmer temperatures at the 10th percentile could also increase growth of the native species and their food base organisms, which could provide a minor positive impact to special status fish. The preferred temperature for invertebrates described above would not be exceeded by the warmer temperatures at the 10th percentile of reservoir elevations, although the preferred temperature for *Cladophora* could be exceeded for a longer time relative to those under the No Action Alternative. These extensions of warm temperatures could occur in early July and late September near the Little Colorado River confluence and in early June and early October near Diamond Creek. However, *Cladophora* should remain present despite the potential for temperatures above its preferred thermal range, and invertebrates may benefit from warmer temperatures overall. The predominance of *Cladophora* downstream of Glen Canyon Dam appears to be linked to water clarity; substantial effects on river clarity trends in the reach between Glen Canyon Dam and Lake Mead are not expected under the Preferred Alternative.

The small increase in water temperatures at the 10th percentile under the Preferred Alternative relative to those under the No Action Alternative also could benefit the non-native fish species present in the Colorado River by allowing earlier reproduction and increased growth in those years when such temperature increases occur. Furthermore, the small increase in temperature in some years has a low potential to increase movement of nonnative species into the river from Lake Mead (e.g., striped and largemouth bass) and from tributaries that provide inflow to the river in the years that such temperature increases occur, as discussed for the No Action Alternative. Since many non-native fish prey on native fish, the potentially increased number or feeding activity of non-native fish could adversely impact the native fish in this reach. However, many species of non-native fish are already present in this reach and the infrequent, slightly warmer temperatures are unlikely to significantly increase their abundance or species composition in the long term. Passage of non-native fish from Lake Powell to the Colorado River in releases under low reservoir elevations would have a slightly higher probability of occurring at the 10^{th} percentile under the Preferred Alternative as compared to the No Action Alternative because lake elevations would generally be up to 13 feet lower under the Preferred Alternative from about 2025 to 2060 (Figures P-WQA-6, P-BCR-1, and P-BCR-2). Only some of these fish would survive this passage, resulting in few additional fish in the river to interact with native fish, which could result in a minor negative impact to special status fish.

Warmer river temperatures could increase the potential for expansion of the Asian tapeworm and anchorworm in the mainstream Colorado River in years when Lake Powell elevations are at the 10^{th} percentile level (Table P-BCR-3). Water temperatures could be above 20ºC (53.8°F) for the same three months as under the No Action Alternative near Diamond Creek in those years. The level of effect is unknown but expected to be negligible considering the low frequency of warmer water occurrences and the small increase in temperature that could occur under the Preferred Alternative. Glen Canyon Dam releases made when Lake Powell elevations are at the 50^{th} percentile of elevations result in approximately the same to cooler downstream temperatures that are always below 20°C (53.8°F) (Table P-BCR-3).

Releases from Glen Canyon Dam of less than 8.23 mafy could also result in a reduction in the potential range of hourly flows in the Colorado River (Section 4.3, Tables 4.3-13 and 4.3-14). The reduction in this potential range at a release rate of 7.48 mafy could be as much as 1,000 to 2,000 cfs in April, and October through December. This level of reduction would be unlikely to occur under the No Action Alternative and would have about an eight percent chance of occurring under the Preferred Alternative (Section 4.3, Table 4.3-11). For release rates of nine mafy, the potential range of hourly flows could be 2,000 cfs greater in June and September, and this annual release volume would have a higher probability of occurring under the Preferred Alternative than under the No Action Alternative (Section 4.3, Tables 4.3-11, 4.3-13 and 4.3-14). Because the range of hourly flows would change and the probability of this level of annual release is higher than under the No Action Alternative, an increased range of flows could impact habitat conditions for native fish.

Basin States Alternative. The probability of annual Glen Canyon Dam releases above nine maf and below 8.23 maf would be essentially the same as described for the Preferred Alternative (Section 4.3, Table 4.3-11), and the alteration of sediment transport would be the same. Average water temperatures in the Colorado River at Lees Ferry under the Basin States Alternative would be up to 1.9ºC (3.4ºF) warmer from March through August and up to 1.1ºC (2ºF) colder from October through February than under the No Action Alternative at the 10th percentile (Table P-BCR-1). At the 50th percentile, the average water temperatures would be up to 0.8ºC (1.4ºF) warmer from March through October and up to 1.4ºC (2.7ºF) colder in January and February than under the No Action Alternative. Average water temperatures at the 90th percentile would be within 0.5ºC (0.9ºF) of those under the No Action Alternative. These small changes in water temperature would not affect bluehead sucker and flannelmouth sucker spawning, egg incubation, and growth (humpback chubs are not in this reach). Average water temperatures would be the same at the Little Colorado River confluence and Diamond Creek as under the Preferred Alternative, and the impacts would also be the same (Tables P-BCR-2 and P-BCR-3). The probability of annual releases less than 8.23 maf would be approximately the same under the Basin States Alternative as under the Preferred Alternative with negligible impacts on native fish habitat (Section 4.3, Table 4.3-11).

Conservation Before Shortage Alternative. The probability of annual Glen Canyon Dam releases above nine maf and below 8.23 maf would be essentially the same as described for the Preferred Alternative (Section 4.3, Table 4.3-11), and the alteration of sediment transport would be the same. Average water temperatures would be the same as under the Basin States Alternative, and thus, impacts would also be the same. The probability of annual releases less than 8.23 maf would be approximately the same under the Conservation Before Shortage Alternative as under the Preferred Alternative and the Basin States Alternative, with negligible impacts on native fish habitat.

Water Supply Alternative. Annual Glen Canyon Dam releases of less than 8.23 mafy could result approximately 9.5 percent more frequently under the Water Supply Alternative than under the No Action Alternative (Section 4.3, Table 4.3-11), similar to the Preferred Alternative. During those times, sediment transport out of the Colorado River and into Lake Mead would be reduced. Higher annual release rates (between 9.01 and greater than 16 mafy) could occur with a frequency of about 24 percent higher under the Water Supply Alternative than under the No Action Alternative. These higher releases would transport more sediment into Lake Mead. The effects of these changes in release rates on habitat suitability and quantity for native fish are unknown.

Under the Water Supply Alternative, the Colorado River could be up to 2ºC (3.6ºF) warmer than under the No Action Alternative at the 10th percentile of elevations in the river reach extending to Lake Mead (Tables P-BCR-1 through P-BCR-3). Temperature changes throughout the river at the 50th percentile would range from about 1ºC (1.8ºF) warmer to 2ºC (3.6ºF) colder as described for the Preferred

Alternative. These changes in temperature at the 50th percentile are about the same for those under the Preferred Alternative, and impacts to native fish would be the same as described for the Preferred Alternative. At Lees Ferry, suitable spawning and egg incubation temperatures at the 10th percentile could be present in July for humpback chub and in June for flannelmouth sucker. The bluehead sucker could spawn in August and September compared to no spawning under the No Action Alternative. Near the Little Colorado River confluence, all three species could spawn a month earlier plus a month later for the bluehead sucker. Near Diamond Creek, humpback chubs could spawn a month earlier (May) than under the No Action Alternative while the other two species could spawn a few weeks earlier.

Under the Water Supply Alternative, water temperatures may support growth of all three species for one to two months longer in the Glen Canyon Dam to Lake Mead river reach than under the No Action Alternative at the 10th percentile of reservoir elevations. The cooler water temperatures in the fall and winter at the 50th percentile of elevation releases would not impact growth of the humpback chub or flannelmouth sucker but would not support growth of bluehead sucker in October near Diamond Creek.

The warmer water temperatures under the Water Supply Alternative would also benefit existing populations of non-native, non-game warmwater species such as carp, fathead minnows, catfish, and red shiner. This could increase competition for resources or predation on the native species which would have a negative impact on the native species, thereby at least partially offsetting the benefits of the warmer temperatures on the native species. Increasing water temperatures by up to about 2ºC (3.6°F), primarily during the spring and summer, could benefit non-native species as described for the Preferred Alternative, but a long-term increase in their population size and species composition is unlikely to occur due to the small, infrequent temperature increases. There is also a greater probability of providing favorable conditions for the migration of the Asian tapeworm and anchorworm into the mainstream of the Colorado River under the Water Supply Alternative than under the No Action Alternative because the Water Supply Alternative results in the lowest Lake Powell elevations, and thereby potentially warmer Glen Canyon Dam release temperatures. Based on the temperature modeling, however, average monthly water temperatures above 20ºC (68°F) could occur only near Diamond Creek from late June through September. These temperatures would be less than 2ºC (3.6°F) warmer than under the No Action Alternative and the duration would be about one month longer. Thus, increased parasitism of native fish in the Colorado River would have a low probability of occurring.

The passage of non-native fish through Glen Canyon Dam may occur as the lake elevations drop, and the greatest potential for this to occur is under the Water Supply Alternative, which tends to have lake elevations that are considerably lower than under the No Action Alternative after 2015 (Section 4.6, Figure 4.6-1; Figures P-BCR-1 and P-BCR-2).

Reservoir Storage Alternative. Annual Glen Canyon Dam releases of less than 8.23 mafy could result approximately 17 percent more frequently under the Reservoir Storage Alternative than under the No Action Alternative (Section 4.3, Table 4.3-11). When releases are below 8.23 mafy, sediment transport out of the Colorado River and into Lake Mead would be reduced. The probability of releases higher than nine mafy is similar to the No Action Alternative but about 1.5 percent more likely (Section 4.3, Table 4.3-11). The lower release rates would remove less sediment from the river system in those years when they occur. The effects of reduced sediment transport on habitat suitability and quantity of native fish habitat is unknown.

Under the Reservoir Storage Alternative, average monthly water temperatures in the Colorado River would be up to 0.8 ºC (1.4 ºF) warmer in some months and up to 2.8 ºC (5.0 ºF) colder in some months at the 10^{th} and 50^{th} percentiles relative to the No Action Alternative. At the 10^{th} percentile, the water could be too cold for growth of the humpback chub and flannelmouth sucker at Lees Ferry (Table P-BCR-1), and the number of months with adequate growth temperatures for the bluehead sucker would be reduced by one month (July) compared to the No Action Alternative. Near the Little Colorado River confluence, water temperatures would be too cold for humpback chub spawning during July, the only month when water would be warm enough for spawning under the No Action Alternative (Table P-BCR-2). The flannelmouth sucker growing season would be about one month shorter as would the bluehead sucker spawning season. Changes in water temperature near Diamond Creek at the 10^{th} percentile would not affect spawning or growth of the humpback chub, flannelmouth sucker, or bluehead sucker (Table P-BCR-3). At the 50^{th} percentile, the changes in water temperature compared to the No Action Alternative would not affect spawning or the growing season of these three species at Lees Ferry or near the Little Colorado River confluence. Near Diamond Creek, however, bluehead sucker growing season would be reduced by about one month due to the colder temperatures in October.

Average monthly water temperatures would be colder beginning in June or July at the 10^{th} percentile and would generally be less than 0.5ºC (0.9 ºF) warmer in the spring and fall (except at Lees Ferry where temperatures would be colder) compared to the No Action Alternative. At the 50^{th} percentile, average monthly water temperatures would be up to 0.5 ºC (0.9ºF) warmer in the spring to early summer (three to four months) and colder in the other months under the Reservoir Storage Alternative relative to the No Action Alternative. Because consistently warmer temperatures would not occur under the Reservoir Storage Alternative, changes in warmwater non-native fish populations would not be expected to occur. The cooler summer temperatures would provide less favorable conditions for migration of Asian tapeworm and anchorworm the into mainstream Colorado River than under the No Action Alternative. Based on the temperature modeling, average monthly water temperatures above 20 ºC (68 ºF) could occur only near Diamond Creek in July under the Reservoir Storage Alternative.

There is also a low potential for non-native fish passage from Lake Powell under the Reservoir Storage Alternative because the lake elevations are generally higher than those under the No Action Alternative (Section 4.6, Figure 4.6-1; Figures P-BCR-1 and P-BCR-2). Reductions in the potential range of hourly flows would also occur as described for the Preferred Alternative, and these reductions could occur a little more frequently because reduced releases could occur more frequently under the Reservoir Storage Alternative.

Amphibians. Because leopard frogs preferentially select warmer water for breeding, as such, the occasional introduction of warmer water would presumably benefit them. Lake Powell releases and average temperatures at Lees Ferry at the 50th percentile of reservoir elevations would always be colder than 15°C (59°F) under the alternatives, so there would be no temperature impact to leopard frogs at the 50th percentile of Lake Powell elevation releases (Table P-BCR-1). Average Lees Ferry temperatures of 15°C (59°F) or above may result under the No Action Alternative and the action alternatives, except under the Reservoir Storage Alternative, starting in July at the 10th percentile of Lake Powell elevations and continuing through October, which would provide a thermal benefit from less thermal shock to eggs and larvae (Table P-BCR-1). Under the Reservoir Storage Alternative average water temperatures would not reach 15ºC (59°F) until July, a minor negative impact compared to the No Action Alternative. Following Atkinson (1996), it is possible that the warmer water would increase the rate of metamorphosis but result in a smaller size class of metamorphs.

Flows under the action alternatives may inundate the Lees Ferry leopard frog habitat from June through September at the 90th percentile of Glen Canyon Dam releases (Figures P-BCR-11 through P-BCR-15). During the interim period, these high releases may differ from those under the No Action Alternative. There are no differences relative to the No Action Alternative beyond the interim period at these higher-end releases. Occasional June spill avoidance releases under the Reservoir Storage Alternative, when above 21,000 cfs, may exceed the releases that occur under the No Action Alternative by up to 4,000 cfs (Figure P-BCR-11). Though these higher flows would presumably have a greater impact on the Lees Ferry leopard frog habitat, they would occur in years when flows under the No Action Alternative may also exceed 21,000 cfs, so the inundation impacts would be similar, though the habitat may be under deeper water than under the No Action Alternative. The Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, may have lower flows at the 90th percentile in July and September, but still above 21,000 cfs, so the inundation impacts would be similar to those under the No Action Alternative, though the habitat may be under shallower water (Figures P-BCR-13 and P-BCR-15).

Birds. Bald eagles may be indirectly impacted by alterations to the trout fishery. At the 10th percentile, the greatest potential temperature related impact to the trout fishery would occur under the Water Supply Alternative (Table P-BCR-1). However, these potential temperature effects are mitigated by the trout’s ability to move to thermal refugia at different Colorado River stages and because warmer temperatures will only occur in some years. Accordingly, despite these potential occasional changes in temperature, population-level impacts to the Lees Ferry trout fishery are not anticipated as a result of the proposed federal action. Warmer river flow temperatures may affect trout in some years and may benefit warmwater fish which could provide an alternative food source for bald eagles. The levels of potential flow impacts to vegetation communities anticipated under some alternatives are not likely to cause a significant impact to bald eagles. Given their mobility, varied diet, and lack of impacts to roost or nest sites, none of the action alternatives would substantially impact bald eagles that inhabit areas downstream of Glen Canyon Dam.

Though higher flows, particularly under the Reservoir Storage Alternative in June (Figure P-BCR-11), may flood riparian habitats, these flows would not be expected to impact southwestern willow flycatcher populations. Nests are typically above the 45,000 cfs stage. Reclamation concluded that long term effects of the 42,000 to 45,000 cfs test flow in 2002 on southwestern willow flycatcher habitat are expected to be beneficial (Reclamation 2002b). Saltcedar are expected to withstand potential increased flows that may occur under the Reservoir Storage Alternative peaks in June. Flows under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, are higher than flows under the No Action Alternative by up to a few thousand cfs in some months, though these higher flows would not inundate southwestern willow flycatcher nests. When flows under the action alternatives (all at least in some months) are lower than those under the No Action Alternative (typically at the 10^{th} percentile), these flows would not be expected to kill saltcedar, which is what southwestern willow flycatcher typically nest in downstream of Glen Canyon Dam.

Under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, releases at the 10^{th} percentile would be lower from April through September (Figures P-BCR-9 through P-BCR-15), and under the Reservoir Storage Alternative, releases at the 10^{th} percentile would be lower from June through September (Figures P-BCR-11 through P-BCR-15). These lower releases may reduce moist soil conditions below nesting sites, which is a preference of southwestern willow flycatcher. Lack of moist soil below nest sites may degrade the habitat for this species, at least temporarily. A lack of moist soil conditions is more likely under the action alternatives than under the No Action Alternative at the 10^{th} percentile of monthly releases, because there could be an annual release less than 8.23 maf under the action alternatives under certain conditions. Releases at the 50^{th} percentile under the action alternatives would be at or above those under the No Action Alternative during the southwestern willow flycatcher nesting season. Therefore, potential impacts to southwestern willow flycatcher are only expected to occur coincident with lower releases which may occur in a few years.

Table 4.8-4 displays impacts to special status species in the Glen Canyon Dam to Lake Mead reach under the action alternatives relative to the No Action Alternative.

Table 4.8-4
Glen Canyon Dam to Lake Mead Reach Special Status Species Impact Summary
Comparison of Action Alternatives to No Action Alternative

Species	Alternative	Impact	Rationale
Mammals	All action alternatives	No impact	Flow differences not expected to rise to the level of indirectly impacting special status mammals.
Grand Canyon evening primrose	Conservation Before Shortage, Basin States, Water Supply, Preferred Alternative	No impact	Similar to 90th percentile releases under the No Action Alternative.
	Reservoir Storage	Minor-negative	Higher 90th percentile releases than under the No Action Alternative may affect beach habitat more than the No Action Alternative. Interim period only. High flows still less than experimental releases.
Kanab ambersnail	All action alternatives	Minor-negative	90th percentile releases exceed the No Action Alternative and 17,000 cfs. Interim period only. High flows still less than past high flows from which Kanab ambersnail has recovered.
Niobrara ambersnail	Reservoir Storage	Minor-negative	90th percentile releases exceed the No Action Alternative and 20,000 cfs. Interim period only. High flows still less than past high flows.
	Conservation Before Shortage, Basin States, Water Supply, Preferred Alternative	Minor-positive	When above 20,000 cfs at the 90th percentile of releases, impacts under the action alternatives are equal or less than those under the No Action Alternative.
Humpback chub, bluehead sucker, flannelmouth sucker	Conservation Before Shortage, Basin States, Preferred Alternative	Minor-positive to negative No impact No impact	Release temperatures similar to or slightly higher than those under the No Action Alternative with warming a little earlier in the year, resulting in small benefit to native fish, non-native fish, and fish parasites. Slightly less sediment loss due to reduced annual releases in some years and greater loss in some years due to higher annual releases. Reduction in range of hourly flows in some months during reduced releases and increased range during higher releases.
	Reservoir Storage	Minor-negative No impact No impact	Release temperatures slightly higher to or lower than those under the No Action Alternative with warmer temperatures primarily in the spring to early summer and cooler temperatures the remainder of the year, resulting in a shorter growing season for native fish and no benefit to non-native fish and fish parasites. Slightly less sediment loss due to reduced annual releases in some years and greater loss in some years due to higher annual releases. Reduction in range of hourly flows in some months during reduced releases and increased range during higher releases.

Table 4.8-4
Glen Canyon Dam to Lake Mead Reach Special Status Species Impact Summary
Comparison of Action Alternatives to No Action Alternative

Species	Alternative	Impact	Rationale
	Water Supply	Minor-positive to negative No impact No impact	Release temperatures similar to or slightly higher than those under the No Action Alternative with warming a little earlier in the year, resulting in small benefit to native fish, non-native fish, and fish parasites. Slightly less sediment loss due to reduced annual releases in some years and greater loss in some years due to higher annual releases. Reduction in range of hourly flows in some months during reduced releases and increased range during higher releases.
Northern leopard frog	Conservation Before Shortage, Basin States, Water Supply, Preferred Alternative	No Impact	Average river temperatures higher than 15°C (59°F) at the 10th percentile of releases would occur in the same months as under the No Action Alternative. High flows would inundate Lees Ferry frog habitat, but the habitat is inundated also under the No Action Alternative.
	Reservoir Storage	Minor-negative	Average river temperatures higher than 15°C (59°F) at the 10th percentile of releases would occur one month later than under the No Action Alternative. High flows inundate Lees Ferry frog habitat; the habitat is inundated also under the No Action Alternative.
Bald eagle	All action alternatives	No impact	Substantial indirect impacts through impacts to food sources not anticipated. Wide ranging species with the varied diet. Impacts to roost or nest sites are not anticipated.
Southwestern willow flycatcher	All action alternatives	Minor-negative	Lower flows at the 10th percentile may impact southwestern willow flycatcher but not saltcedar. Lower flows at the 10th percentile may reduce moist soil conditions below nest sites and degrade habitat value. Occurs under all action alternatives at the 10th percentile of releases.

4.8.4.3 Lake Mead

No Action Alternative.

Birds. Lake Mead elevations may exhibit a slight downward trend into the future under the No Action Alternative (Figures P-BCR-3 and P-BCR-4). This trend would have effects on the riparian and marsh habitats at the inflow areas and on the special status bird species that utilize such habitats for breeding, roosting or foraging. The downward trend of Lake Mead elevations would increase the potential for dewatering and sediment delta headcutting, which would adversely affect riparian and marsh vegetation that has developed on the sediment deltas. This adverse effect on the sediment delta in turn has the greatest potential to adversely affect special status birds that utilize cottonwood-willow and marsh habitats such as bald eagle, southwestern willow flycatcher, yellow-billed cuckoo, long-eared owl, American kestrel, osprey, Cooper's hawk, American peregrine falcon, northern harrier, Clark's grebe, snowy egret, Yuma clapper rail, California black rail, American bittern, western least bittern, great egret, white-faced ibis, belted kingfisher, and American white pelican.

Mammals. Townsend's big-eared bat, pale Townsend's big-eared bat, occult little brown bat, spotted bat, Allen's big-eared bat, western red bat, Yuma myotis, western yellow bat, cave myotis, greater western mastiff bat, and small-footed myotis may utilize the riparian and marsh habitats at Lake Mead for foraging and roosting. These bat species utilize a variety of habitats for roosting, including dead trees, so potential vegetation effects should not substantially impact roosting opportunities for these bats. Substantial effects to insect food sources for special status bats are not expected because Lake Mead elevations will continue to experience annual fluctuations and the downward trend will be gradual over time. The Yuma hispid cotton rat or Colorado River cotton rat would not be impacted under the No Action Alternative as these species are found further south along the lower Colorado River.

Amphibians. Relict leopard frog populations at Lake Mead would not be affected under the No Action Alternative because the known populations are at springs located above the influence of Lake Mead's elevation fluctuations. Colorado River toads are not known to exist at Lake Mead. Special status amphibians at Lake Mead are not expected to be affected under the No Action Alternative.

Plants. Sticky buckwheat, Geyer's milkvetch and Las Vegas bear poppy all occur at the shorelines of Lake Mead. These species typically benefit from lower reservoir elevations that expose additional shoreline habitat. Lake Mead would continue to experience elevation fluctuations under the No Action Alternative, which would result in varied levels of exposed shoreline through the year. The general downward trend of Lake Mead elevations that may occur under the No Action Alternative would generally result in increased shoreline exposure which would benefit these species while this trend continues.

Invertebrates. MacNeill's sooty-winged skipper is not known to exist at Lake Mead and would thus not be affected under the No Action Alternative. Potential vegetated habitats below the full pool elevation of Lake Mead are ephemeral and change over time as the lake elevation fluctuates.

Fish. Under the No Action Alternative, special status fish would experience Lake Mead elevations less than 1,120 feet msl all year at the 50^{th} and 10^{th} percentiles. The 90^{th} percentile of reservoir elevations is generally projected to be near or above 1,200 feet msl all year. Modeled Lake Mead elevations for end of February, March, April, July, and September are provided in Figures P-BCR-3 through P-BCR-7. Razorback sucker spawning is known to occur between elevations 1,120 feet msl and 1,150 feet msl from January through June, and as elevations have dropped within this range and exposed areas used for spawning in earlier years, the fish have moved their spawning to nearby suitable areas (Albrecht and Holden 2006). Based on the modeled reservoir elevations under the No Action Alternative, the preferred spawning sites would be out of the water over 50 percent of the time during the spawning season. Razorback sucker would have to move to suitable spawning habitat at lower reservoir elevations, where such habitat is available.

Action Alternatives. Lake Mead elevations will deviate from those under the No Action Alternative during the interim period and the post-interim period.

Birds. No impacts to riparian or marsh habitats are anticipated at Lake Mead under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, because Lake Mead elevations under these action alternatives trend close to those under the No Action Alternative. Therefore, special status bird species at Lake Mead would not be impacted under these action alternatives.

Minor negative impact to cottonwood-willow, saltcedar and marsh vegetation at Lake Mead inflow areas and sediment deltas would result under the Water Supply Alternative. These negative impacts would be caused by lower reservoir elevations, increased dewatering of sediment deltas, and delta erosion. However, depending on duration of the lower elevations, the impact may be offset by new vegetation growing on the newly exposed sediments. These impacts to vegetation would cause minor negative impact to those special status bird species that forage, breed or roost in cottonwood-willow, saltcedar and marsh habitats. Potentially impacted species include: southwestern willow flycatcher, Clark's grebe, snowy egret, Yuma clapper rail, yellow-billed cuckoo, California black rail, American bittern, western least bittern, great egret, white faced ibis, long-eared owl, American kestrel, osprey, northern harrier, Cooper's hawk, bald eagle, belted kingfisher, American peregrine falcon, and American white pelican.

Minor positive impact to vegetation at Lake Mead would result under the Reservoir Storage Alternative, primarily at the inflow areas and sediment deltas. These positive impacts would be caused by higher reservoir elevations than under the No Action Alternative, and thus result in less potential for dewatering or sediment delta headcutting than under the No Action Alternative. Positive impacts are anticipated for the southwestern willow flycatcher, Clark's grebe, snowy egret, Yuma clapper rail, yellow-billed cuckoo, California black rail, American bittern, western least bittern, great egret, white faced ibis, long-eared owl, American kestrel, osprey, northern harrier, Cooper's hawk, bald eagle, belted kingfisher, American peregrine falcon, and American white pelican.

Mammals. Impacts to special status mammals at Lake Mead are not expected to occur for the same reasons provided for the No Action Alternative discussion.

Amphibians. Impacts to special status amphibians at Lake Mead are not expected for the reasons described for the No Action Alternative.

Plants. Sticky buckwheat, Geyer's milkvetch and Las Vegas bear poppy all occur at the shorelines of Lake Mead. These species typically benefit from lower reservoir elevations that expose additional shoreline habitat. These species would not be impacted under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, since reservoir elevations trend close to the elevations under the No Action Alternative. A minor beneficial impact would be provided to these species under the Water Supply Alternative through lowered elevations.

A minor negative impact to these species would be caused under the Reservoir Storage Alternative through raised elevations and inundation of shoreline habitats.

Invertebrates. MacNeill's sooty winged skipper is not known at Lake Mead, and would thus not be impacted under any action alternative. Habitats below the full pool elevation of Lake Mead are ephemeral and are periodically inundated and desiccated as the reservoir elevation changes.

Fish. Effects on razorback sucker spawning is the primary issue to be addressed for the alternatives. Since their spawning season is from January through June, modeling results for February, March, and April were used in the analysis. Lowered reservoir elevations are known to allow vegetation to grow on the exposed lake bed, and these areas are then inundated at higher reservoir elevations. These submerged vegetated areas can provide cover for juvenile razorback suckers and enhance their survival. Thus, periodic lower reservoir elevations may have some benefits (minor positive impact) to razorback sucker spawning success and recruitment after the reservoir elevations rise and inundate the vegetation growing on the edge under all alternatives. In addition, reservoir elevations would be nearly the same under all alternatives at the 90^{th} percentile, resulting in no impacts relative to the No Action Alternative.

Preferred Alternative. Lake Mead elevations at the 50^{th} percentile would be above those under the No Action Alternative through 2026 and then below until 2038 when the elevations become the same as those under the No Action Alternative (Figures P-BCR-3, P-BCR-4 and P-BCR-5). The maximum elevation would be 1,122 feet msl in February and the minimum would be 1,090 feet msl in April. Reservoir elevations may vary from 25 feet above to 13 feet below those under the No Action Alternative. The Preferred Alternative would have minor positive impacts when elevations are above those under the No Action Alternative (to 2026) to minor negative impacts when elevations are below those under the No Action Alternative. Reservoir elevations at the 10^{th} percentile would vary from a little above to a little below those under the No Action Alternative until 2017 when the elevations would be above those under the No Action Alternative until after 2035. Because the elevations would be below the current elevations used by razorback suckers for spawning, no impacts would likely occur.

Reservoir elevations below those under the No Action Alternative would extend the riverine habitat where the Colorado River enters Lake Mead, which in turn would increase habitat for the humpback chub, razorback sucker, flannelmouth sucker, and bluehead sucker that could move downstream from Grand Canyon. At the 50^{th} percentile of reservoir elevations, this minor benefit would occur from about 2026 through 2037, and at the 10^{th} percentile this minor benefit would occur only in one to two years and thus would provide no benefit to those species.

Basin States Alternative. Under the Basin States Alternative, reservoir elevations may vary from ten feet above to ten feet below at the 50^{th} percentile of reservoir elevations as compared to the No Action Alternative in February (Figure P-BCR-3), the month with the highest reservoir elevations. The maximum elevation may be 1,122 feet msl and the minimum 1,093 feet msl. In April, the maximum elevation may be 1,118 feet msl and the minimum 1,093 feet msl (Figure P-BCR-5). Minor positive impacts could occur under the Basin States Alternative when elevations are above those under the No Action Alternative (before 2020), to minor negative impacts when elevations are below those under the No Action Alternative (after about 2020). These impacts would trend to no impact. Reservoir elevations at the 10th percentile would be less than under the No Action Alternative until 2018 and then higher until 2033. Because the projected elevations would be below the current elevations used by razorback suckers for spawning, no impacts would likely occur.

There would be elevations at the 50th percentile under the Basin States Alternative above or only slightly below those under the No Action Alternative which would provide essentially no benefit to species in the Colorado River inflow. At the 10th percentile of reservoir elevations, there could be a minor positive impact prior to 2018 under this alternative.

Conservation Before Shortage Alternative. This alternative would be essentially the same as the Basin States Alternative at the 50th percentile of reservoir elevations with maximum and minimum elevations differing by one foot (Figures P-BCR-3, P-BCR-4, and P-BCR-5). At the 10th percentile of reservoir elevations, the Conservation Before Shortage Alternative would be similar to the Basin States Alternative in most years but not as high as, or above the No Action Alternative in 2021 through 2025.

Water Supply Alternative. Reservoir elevations at the 50th percentile under the Water Supply Alternative would be near or below those under the No Action Alternative until 2045 when they would become slightly higher, resulting in a minor negative impact compared to the No Action Alternative (Figures P-BCR-3, P-BCR-4, and P-BCR-5). At the 10th percentile, elevations under the Water Supply Alternative would be below and then above those under the No Action Alternative elevations, with no impact.

At the 50th percentile of reservoir elevations, the Water Supply Alternative would provide the greatest benefit, relative to the No Action Alternative, of any of the action alternatives to those species using riverine habitat at the Colorado River inflow to the reservoir, resulting in a minor positive impact.

Reservoir Storage Alternative. Under the Reservoir Storage Alternative, reservoir elevations at the 50th percentile would be above those under the No Action Alternative by up to 35 feet with occurrences of elevations above 1,125 feet msl from 2020 through 2037 with the maximum elevation at 1,135 feet msl (Figures P-BCR-3, P-BCR-4, and P-BCR-5). Thus, the Reservoir Storage Alternative would maintain reservoir elevations within the range currently used by razorback suckers for spawning more than 50 percent of the time in about half of the years modeled, a moderate positive impact. Reservoir elevations at the 10th percentile under the

Reservoir Storage Alternative would be above those under the No Action Alternative but none would be near the current elevations used for razorback spawning. Impacts could range from no effect to a minor positive impact but would likely result in no impact.

The Reservoir Storage Alternative would provide no riverine habitat increase relative to the No Action Alternative, a minor negative impact.

Table 4.8-5 compares potential special status species impacts under the action alternatives at Lake Mead relative to the No Action Alternative.

4.8.4.4 Hoover Dam to Davis Dam and Lake Havasu to Parker Dam

Due to lack of differences among the alternatives in these reaches, and the lack of change in vegetation or habitat, there would be no impacts to special status species at these locations.

4.8.4.5 Davis Dam to Lake Havasu

No Action Alternative. Monthly releases from Davis Dam exhibit a downward trend in the future at the 90th percentile (Figures P-BCR-32 through P-BCR-43). While special status species along the Colorado River are constantly making minor adjustments as flows fluctuate, downward trending releases could result in special status species habitat impacts.

Birds. Downward trending Davis Dam releases in the future under the No Action Alternative may have gradual adverse effects on cottonwood-willow and marsh habitats, which are utilized by many special status bird species. These species include: bald eagle, osprey, belted kingfisher, peregrine falcon, southwestern willow flycatcher, vermillion flycatcher, Clark's grebe, snowy egret, Yuma clapper rail, western yellow-billed cuckoo, California black rail, elf owl, gilded flicker, Gila woodpecker, Arizona Bell's vireo, Sonoran yellow warbler, summer tanager, American white pelican, double crested cormorant, American least bittern, Western bittern, great egret, black-crowned night heron, white faced ibis, black tern, long-eared owl, brown crested flycatcher, Lucy's warbler, yellow-breasted chat, northern cardinal, northern harrier, Cooper's hawk, and American kestrel. Since lower flows are more likely to affect cottonwood-willow than saltcedar, continued saltcedar expansion along the lower Colorado River is expected to be favored under the No Action Alternative.

Table 4.8-5
Lake Mead Special Status Species Impact Summary
Comparison of Action Alternatives to No Action Alternative

Species	Alternative	Impact	Rationale
Birds	Conservation Before Shortage, Basin States, Preferred Alternative	No impact	Reservoir elevations trend close to the No Action Alternative.
	Reservoir Storage	Minor-positive	Reservoir elevations trend higher than the No Action Alternative.
	Water Supply	Minor-negative	Reservoir elevations trend lower than the No Action Alternative.
Mammals	All action alternatives	No Impact	Substantial impacts to insect food sources for bats not anticipated.
Relict leopard frog	All action alternatives	No impact	Overton Arm population is located at a spring above Lake Mead's influence.
MacNeill's sooty-winged skipper	All action alternatives	No impact	Species not known at Lake Mead. LCR MSCP indicates zero acres of *atriplex* habitat at Lake Mead. Habitats below the full pool elevation are ephemeral under all alternatives.
Sticky buckwheat, Geyer's milkvetch, and Las Vegas bearpoppy	Conservation Before Shortage, Basin States, Preferred Alternative	No impact	Reservoir elevations trend close to the No Action Alternative.
	Reservoir Storage	Minor-negative	Reservoir elevations trend higher than the No Action Alternative, inundating shoreline habitat. Habitats below full pool elevation considered temporary due to reservoir, elevation fluctuation.
	Water Supply	Minor-positive	Reservoir elevations trend lower than the No Action Alternative, exposing additional shoreline habitat. Habitats below full pool elevation considered temporary due to reservoir elevation fluctuation.
Fish	Preferred Alternative	Minor-positive No impact Minor-positive	Elevations would be higher than the No Action Alternative in some years but seldom above the current razorback spawning areas at the 50th percentile of reservoir elevations. Elevations at the 10th percentile would be well below current razorback spawning areas. Lower elevations would extend riverine habitat at the inflow areas for species status fish at the 50th percentile of reservoir elevations.
	Conservation Before Shortage, Basin States	No impact Minor-positive	Elevations above 1,120 feet msl could have a slight benefit to razorback sucker spawning while lower elevations could be less valuable; at the 10th percentile, elevations under these alternatives would be above and below those under the No Action Alternative and below the current razorback spawning level. Increased amount of riverine habitat at the 10th percentile of reservoir elevations prior to 2018.
	Water Supply	Minor negative Minor positive	Reservoir elevations would be near to or less than those under the No Action Alternative at the 50th percentile of reservoir elevations. Lower reservoir elevations would provide more riverine habitat for fish from Separation Canyon at the 50th percentile of reservoir elevations.
	Reservoir Storage	Moderate positive Minor negative	Reservoir elevations would be above 1,120 feet msl over 50 percent of the time in about half the modeled years; at the 10th percentile of elevations, no impact. Higher reservoir elevations would provide less riverine habitat for fish from Separation Canyon than under the No Action Alternative at the 10th and 50th percentiles of reservoir elevations.

Mammals. Townsend's big-eared bat, Pale Townsend's big-eared bat, spotted bat, Allen's big-eared bat, Western red bat, occult little brown bat, Yuma myotis, Western Yellow bat, cave myotis, greater western mastiff bat, and small-footed myotis utilize riparian and marsh habitats in this reach for foraging and roosting. Downward trending Davis Dam releases under the No Action Alternative are expected to be gradual, though they may affect the composition of riparian habitats. Such gradual changes are not expected to substantially affect insect food sources for special status bats. Since these bats typically utilize a variety of roost sites, including live and dead trees, substantial impacts to these species' roost sites are not anticipated under the No Action Alternative.

The Yuma hispid cotton rat is only known to exist from Yuma south. This species will not be affected under the No Action Alternative in this reach. The Colorado River cotton rat inhabits this reach, and particularly grassy riparian areas along the Colorado River. Downward trending Davis Dam releases under the No Action Alternative are expected to be gradual, though they may impact the habitat for the Colorado River cotton rat in this reach. The lower monthly releases and lower annual median releases from Davis Dam under the Reservoir Storage Alternative could have a minor negative impact on the Colorado River cotton rat. The higher monthly and annual median releases from Davis Dam under the Water Supply Alternative could have minor positive impact on the Colorado River cotton rat. Monthly and annual median releases from Davis Dam under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, are similar to those under the No Action Alternative and therefore should not impact the Colorado River cotton rat.

Amphibians. Relict leopard frogs are known downstream of Hoover Dam at several springs to the north of this reach and are above the influence of the Colorado River. The Lowland leopard frog is known along the Bill Williams River, but not in this reach. The Colorado River toad is not known to occur in this reach. The special status amphibians in this reach would not be affected under the No Action Alternative.

Invertebrates. MacNeill's sooty-winged skipper is known at scattered sites along the lower Colorado River and is associated with quailbrush (*Atriplex*) and mesquite communities. The *Atriplex* land cover type is present in this reach (Section 3.8, Table 3.8-2). However, quailbrush typically grows on alluvial floodplains and flow-related impacts under the No Action Alternative are not anticipated to affect alluvial floodplains. Downward trending releases may affect groundwater levels. However, because the declines will likely be gradual and that mesquite and quailbrush are not obligate phreatophytes, groundwater-related effects under No Action Alternative are not anticipated. MacNeill's sooty-winged skipper in this reach is not expected to be affected under the No Action Alternative.

Fish. In the Colorado River reach between Davis Dam and Lake Havasu, some backwaters are present that could be used by razorback suckers, bonytail, and flannelmouth suckers, the only special status fish species present. Reduced flows in the future in this reach may result in more frequent dewatering of backwaters, resulting in a reduction of habitat for these special status fish species. Backwaters may become vegetated with marsh plants under reduced flow conditions. Non-native fish would continue to be present in this reach and compete with native fish.

Action Alternatives. Special status species in this reach would not be impacted under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, because Davis Dam monthly and annual median releases trend close to those under the No Action Alternative (Section 4.3, Figure 4.3-32; Figures P-BCR-32 through P-BCR-43), therefore, these three action alternatives are not discussed further for this reach. Flow deviations under the Water Supply and Reservoir Storage alternatives from those under the No Action Alternative generally return to those under the No Action Alternative at the end of the interim period, though the vegetation and associated special status species effects of interim period conditions may be observed beyond the interim period.

Birds. The Reservoir Storage and Water Supply alternatives may result in lower and higher monthly and annual median releases, respectively. Lower and higher annual median releases would have corresponding effects on groundwater levels and could impact riparian and marsh vegetation (Section 4.8). Respective impacts to special status birds would be similar to impacts at Lake Mead. However, a higher number of species may be impacted in this river reach since this reach includes California special status birds not considered at Lake Mead. There would be a minor negative impact on the following special status birds under the Reservoir Storage Alternative through flow-related and groundwater-related negative impacts to their habitats: bald eagle, osprey, belted kingfisher, peregrine falcon, southwestern willow flycatcher, vermillion flycatcher, Clark’s grebe, snowy egret, Yuma clapper rail, western yellow-billed cuckoo, California black rail, elf owl, gilded flicker, Gila woodpecker, Arizona Bell’s vireo, Sonoran yellow warbler, summer tanager, American white pelican, double crested cormorant, American least bittern, Western bittern, great egret, black-crowned night heron, white faced ibis, black tern, long-eared owl, brown crested flycatcher, Lucy’s yellow warbler, yellow-breasted chat, northern cardinal, northern harrier, Cooper’s hawk, and American kestrel. The Water Supply Alternative is expected to have a minor positive impact on these same species since monthly and annual median flows will be higher than under the No Action Alternative. Fluctuations of groundwater levels anticipated for this reach may be on the order of 0.5 foot or less (Section 4.3), which contributes to these impacts being minor.

Mammals. Though there may be higher and lower Davis Dam releases under the Water Supply and Reservoir Storage alternatives, respectively, these differences are not expected to substantially impact foraging or roosting conditions for special status bats. Impacts under the action alternatives on special status mammals are expected to be similar to those expected under the No Action Alternative.

The Yuma hispid cotton rat is only known to exist along the Colorado River from Yuma south. Therefore, the proposed federal action would not impact this species in this reach. The Colorado River cotton rat is present in this reach and its habitat could be adversely impacted by the lower monthly and annual median releases from Davis Dam and potentially lower groundwater levels associated with the Reservoir Storage Alternative. The Water Supply Alternative could have a small positive impact on this species' habitat because the higher monthly and annual median releases from Davis Dam under this alternative would benefit riparian and marsh vegetation in this reach.

Amphibians. There would be no impacts under the Water Supply and Reservoir Storage alternatives to the Colorado River toad, relict leopard frog or lowland leopard frog in this reach for the same reasons as described for the No Action Alternative.

Invertebrates. There would be no impacts under the Water Supply and Reservoir Storage alternatives to MacNeill's sooty-winged skipper in this reach for the same reasons as described for the No Action Alternative.

Fish.

Water Supply Alternative. There may be slightly more flows under the Water Supply Alternative than under the No Action Alternative in most months of the year at the 10^{th} and 50^{th} percentiles of reservoir elevations. The slightly higher flows could have a minor positive impact on the razorback sucker, bonytail, and flannelmouth sucker.

Reservoir Storage Alternative. There may be slightly lower flows under the Reservoir Storage Alternative than under the No action Alternative in most months of the year at the 10^{th} and 50^{th} percentiles of reservoir elevations. Reductions in Colorado River flows downstream of Davis Dam could affect the flannelmouth sucker through loss of spawning habitat in the riverine sections and rearing habitat in backwaters. This would be a minor negative impact for this species. Reduced flows could also have a minor negative impact on razorback sucker and bonytail through loss of rearing habitat. At the 90^{th} percentile, higher releases in the winter under the Reservoir Storage Alternative could have potential benefits or detriments to backwater habitats depending on the amount of sediment scour or deposition. Overall, however, no impact would be expected from higher winter releases.

Table 4.8-6 provides a summary of potential impacts that may occur under the action alternatives to special status species in the Davis Dam to Lake Havasu reach as compared to the No Action Alternative.

Table 4.8-6
Davis Dam to Lake Havasu Reach Special Status Species Impact Summary
Comparison of Action Alternatives to No Action Alternative

Species	Alternative	Impact	Rationale
Birds	Conservation Before Shortage, Basin States, Preferred Alternative	No Impact	Monthly and annual median releases are similar to the No Action Alternative.
	Water Supply	Minor-positive	Monthly and annual median releases higher than under the No Action Alternative at the 10th and 50th percentiles.
	Reservoir Storage	Minor-negative	Monthly and annual median releases lower than under the No Action Alternative at the 10th and 50th percentiles.
Mammals	Conservation Before Shortage, Basin States, Preferred Alternative	No impact	Conservation Before Shortage and Basin States alternatives monthly and annual median releases are similar to those under the No Action Alternative.
	Reservoir Storage	Minor-negative	Lower monthly and annual median releases from Davis Dam could degrade riparian habitats of the Colorado cotton rat. Flow differences not expected to impact special status bats.
	Water Supply	Minor – positive	Higher monthly and annual median releases from Davis Dam could benefit riparian habitats of the Colorado River cotton rat. Flow differences not expected to impact special status bats.
Amphibians	All action alternatives	No Impact	Species not known in this reach.
Invertebrates	All action alternatives	No impact	Action alternatives not expected to adversely impact quailbrush or mesquite communities on alluvial floodplains.
Fish	Conservation Before Shortage, Basin States, Preferred Alternative	No impact	Davis Dam releases trend close to those under the No Action Alternative.
	Water Supply	Minor- positive	Increased releases at the 10th and 50th percentiles of reservoir elevations could benefit razorback sucker, bonytail, and flannelmouth sucker.
	Reservoir Storage	Minor- negative	Decreased releases at the 10th and 50th percentiles of reservoir elevations could result in habitat reduction for razorback sucker, bonytail, and flannelmouth sucker.

4.8.4.6 Parker Dam to NIB

No Action Alternative. Monthly flows from Parker Dam to Imperial Dam may be sightly lower in future years because of a reduction in the 90th percentile releases in some months (Figures P-BCR-44 through P-BCR-55). Annual median releases from Parker Dam also indicate a slight downward trend into the future (Section 4.3, Figure 4.3-37). While special status species along the Colorado River are constantly adjusting as flows fluctuate, the slight downward trend in the future could adversely affect cottonwood and marsh communities and the special status species that rely on such habitats. Under the No Action Alternative, shortage conditions would occur without specific operating criteria.

The gradual nature of this slight downward trend is such that terrestrial special status species and habitat conditions would not change abruptly or substantially. The Colorado River downstream of Imperial Dam would not be affected under the No Action Alternative because flows between Imperial Dam and the NIB consist primarily of leakage from Imperial Dam and return flows from water diverted at Imperial Dam. Accordingly, there will be no effects under the proposed federal action on special status species downstream of Imperial Dam. The following discussion applies only to the Colorado River reach between Parker Dam and Imperial Dam.

Birds. The gradual and slight downward trend of monthly and annual median flows in this reach in the future may adversely affect cottonwood-willow and marsh habitats and thus the special status birds that utilize such habitats. These species include: bald eagle, osprey, belted kingfisher, peregrine falcon, southwestern willow flycatcher, vermillion flycatcher, Clark's grebe, snowy egret, Yuma clapper rail, western yellow-billed cuckoo, California black rail, elf owl, gilded flicker, Gila woodpecker, Arizona Bell's vireo, Sonoran yellow warbler, summer tanager, American white pelican, double crested cormorant, American bittern, Western least bittern, great egret, black-crowned night heron, white faced ibis, black tern, long-eared owl, brown crested flycatcher, Lucy's warbler, yellow-breasted chat, northern cardinal, northern harrier, Cooper's hawk, and American kestrel. Lower flows would continue to favor expansion of saltcedar along this reach, which tends to reduce the value of the habitats the species invades.

Mammals. The gradual and slight downward trend of monthly and annual median flows in this reach in the future under the No Action Alternative would have similar effects on special status bats as described for the No Action Alternative for the Davis Dam to Lake Havasu reach.

The Yuma hispid cotton rat and Colorado River cotton rat do occur in this reach and they inhabit moist grassy areas along the lower Colorado River, including wetlands. The downward trend of monthly and annual median releases from Parker Dam under the No Action Alternative may have minor effects on the moist riparian habitats these two species prefer. However, since these species also utilize agricultural fields and the downward release trend is gradual and small, effects under the No Action Alternative on these two rat species is expected to be small.

Amphibians. Special status amphibians do not occur in this reach, thus, effects under the No Action Alternative are not anticipated.

Invertebrates. MacNeill's sooty-winged skipper may occur in the quailbrush and mesquite communities that are present in this reach. However, the alluvial floodplains or *Atriplex* communities are not expected to be affected or impacted under the No Action Alternative through groundwater effects. MacNeill's sooty-winged skipper in this reach would not be affected under the No Action Alternative.

Fish. The only listed fish species present in the Colorado River or in-stream reservoirs from Parker Dam to the NIB are the razorback sucker and bonytail chub. Reduced flows under the No Action Alternative would alter habitat for these fish downstream of Parker Dam as described for downstream of Davis Dam.

Action Alternatives. Flow deviations under the action alternatives from those under the No Action Alternative generally return close to those under the No Action Alternative at the end of the interim period, though the vegetation and associated special status species effects of the interim period may be observed beyond the interim period.

Birds. In the river reach between Parker Dam and Imperial Dam, monthly and annual median flows under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, would be lower than under the No Action Alternative at the 10th and 50th percentiles. The Reservoir Storage Alternative results in the greatest reduction of flows as compared to the No Action Alternative, while the Basin States Alternative results in the least reduction (Section 4.3, Figure 4.3-37; Figures P-BCR-44 through P-BCR-55). Departures under the action alternatives from the No Action Alternative may cause a decline in groundwater levels adjacent to the Colorado River of 0.15 to 0.30 foot. These lower releases and groundwater levels would have a minor negative impact on cottonwood-willow and marsh habitats and thus a correspondingly minor negative impact to special status birds that rely on those habitats. Potentially impacted species include the following: bald eagle, osprey, belted kingfisher, peregrine falcon, southwestern willow flycatcher, vermillion flycatcher, Clark's grebe, snowy egret, Yuma clapper rail, western yellow-billed cuckoo, California black rail, elf owl, gilded flicker, Gila woodpecker, Arizona Bell's vireo, Sonoran yellow warbler, summer tanager, American white pelican, double crested cormorant, American bittern, Western least bittern, great egret, black-crowned night heron, white faced ibis, black tern, long-eared owl, brown crested flycatcher, Lucy's yellow warbler, yellow-breasted chat, northern cardinal, northern harrier, Cooper's hawk, and American kestrel. The annual median flows under the Water Supply Alternative are somewhat higher than under No Action Alternative and therefore would have a minor positive impact on cottonwood-willow and marsh habitats, and on these same special status species.

Mammals. The special status bat species would not be impacted in this reach for the same reasons as described for the Davis Dam to Lake Havasu reach.

The lower flows, declines in groundwater levels adjacent to the river of 0.15 to 0.30 foot, and resultant impacts to riparian vegetation associated with the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, could have a minor negative impact on the Colorado River cotton rat upstream of Imperial Dam. The higher flows, groundwater levels, and small positive impacts to riparian vegetation under the Water Supply Alternative could have a minor positive impact on the Colorado River cotton rat upstream of Imperial Dam. The action alternatives would not alter the historic operational methodology or range of flow volumes in the river channel downstream of Imperial Dam. Therefore, none of the action alternatives would impact the Yuma hispid cotton rat or Colorado River cotton rat downstream of Imperial Dam.

Amphibians. Special status amphibians do not occur in this reach.

Invertebrates. MacNeill's sooty-winged skipper would not be impacted in this reach because alluvial floodplains with quailbrush and mesquite are not expected to be substantially impacted under any alternative.

Fish. The Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, have monthly releases that would be less than those under the No Action Alternative at the 10th and 50th percentiles. These lower flows could have impacts on razorback sucker and bonytail chub similar to those described for the Reservoir Storage Alternative in the Davis Dam to Lake Havasu reach. The use of High Levee Pond on the Cibola NWR for native fish would not be affected by changes in releases from Parker Dam.

Table 4.8-7 summarizes the potential impacts to special status species in the Parker Dam to the NIB reach for the action alternatives relative to the No Action Alternative.

Table 4.8-7
Parker Dam to NIB Special Status Species Impact Summary
Comparison of Action Alternatives to No Action Alternative

Species	Alternative	Impact	Rationale
Birds	Water Supply	Minor - Positive	Monthly releases closely follow the No Action Alternative. No flow-related impacts anticipated downstream of Imperial Dam. Annual median releases from Parker Dam are higher than under the No Action Alternative, which provides a minor benefit to riparian habitats and associated birds.
	Conservation Before Shortage, Basin States, Reservoir Storage, Preferred Alternative	Minor-negative	Monthly releases lower than under the No Action Alternative at the 10th and 50th percentiles. Small anticipated groundwater level impacts. No flow-related impacts anticipated downstream of Imperial Dam. Annual median releases from Parker Dam are lower than under the No Action Alternative, which results in a minor negative impact to riparian habitats and associated birds.
Mammals	Water Supply	Minor - Positive	Monthly flows under the Water Supply Alternative are similar to those under the No Action Alternative. Flows are not substantially different than those under No Action Alternative to cause indirect impacts to special status bats. Higher annual median releases from Parker Dam could benefit Colorado River cotton rat upstream of Imperial Dam. Two cotton rat species occur downstream of Imperial Dam, where flow impacts are not anticipated.
	Conservation Before Shortage, Basin States, Reservoir Storage, Preferred Alternative	Minor - Negative	Monthly flows are similar to those under the No Action Alternative. Flows are not substantially different than those under the No Action Alternative to cause indirect impacts to special status bats. Lower annual median releases from Parker Dam could benefit Colorado River cotton rat upstream of Imperial Dam. Two cotton rat species occur downstream of Imperial Dam, where flow impacts are not anticipated.
Amphibians	All action alternatives	No Impact	Species not known in this reach.
Invertebrates	All action alternatives	No impact	Action alternatives not expected to adversely impact quailbrush or mesquite communities on alluvial floodplains.
Razorback sucker and bonytail chub	Water Supply	No Impact	Monthly flows closely follow those under the No Action Alternative.
	Conservation Before Shortage, Basin States, Reservoir Storage, Preferred Alternative	Minor-negative	Monthly flows are lower than those under the No Action Alternative at the 10th and 50th percentiles and could result in habitat reduction.

4.8.4.7 NIB to SIB

No Action Alternative. The lack of flows precludes the presence of a significant river fishery in the Colorado River reach between Morelos Diversion Dam and the SIB (Limitrophe Division); the riparian and marsh habitats, and the special status species that rely on those habitats are adversely affected by this condition. Flows past Morelos Diversion Dam tend to benefit downstream vegetated habitats and associated special status species. The probability of these excess flows occurring in the future under the No Action Alternative is relatively low, typically less than 20 percent (Figure P-BCR-56). The infrequency of flows under the No Action Alternative would continue to maintain less than ideal conditions for cottonwood-willow and marsh habitats and the species that rely on such habitats. The special status bird and mammal species identified in the Parker Dam to the NIB reach will continue to experience these adverse effects on their habitat downstream of Morelos Diversion Dam under the No Action Alternative. Special status amphibians, plants or fish will not be affected under the No Action Alternative because none are present in this reach. Infrequent flows in this reach under the No Action Alternative will continue to favor the expansion of saltcedar which may compete with mesquite and quailbrush communities, thus limiting the habitat potential for MacNeill's sooty-winged skipper in this reach.

Action Alternatives. The likelihood of excess flows passing Morelos Diversion Dam under the Basin States and Water Supply alternatives, and the Preferred Alternative, is approximately the same as under the No Action Alternative. Therefore, these action alternatives would have no impact on special status species in this reach. The Reservoir Storage and Conservation Before Shortage alternatives have a higher likelihood of excess flows passing Morelos Diversion Dam than the No Action Alternative (Figure P-BCR-56). In addition, due to modeling assumptions for the Reservoir Storage and Conservation Before Shortage alternatives, water is assumed to be delivered to Mexico and assumed to allow to pass the Morelos Diversion Dam via periodic flows[2] of about 40 kafy to 200 kafy (Section 2.4). These pulse flows would occur approximately every other year during the interim period only. The probability of flows past Morelos Diversion Dam under these two action alternatives returns to the probability of flows under the No Action Alternative after the interim period. These flows would have overall benefits to river flow, riparian and marsh vegetation and special status species that utilize these habitats since substantial flow in this reach is relatively rare. There would be a moderate, positive impact on special status species between Morelos Diversion Dam and the SIB under the Reservoir Storage and Conservation Before Shortage alternatives.

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[2] These flows were modeled as part of the storage and delivery mechanism under the Conservation Before Shortage and Reservoir Storage alternatives. The modeling assumptions were utilized in this Final EIS in order to analyze the potential impacts to environmental resources of the storage and delivery mechanism, particularly with regard to reservoir elevations and river flow impacts. The use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, these releases could be made under current management of the Colorado River.

Birds. The species identified as impacted in the Parker Dam to the NIB reach would be positively impacted by the increased likelihood of flows past Morelos Diversion Dam under the Reservoir Storage and Conservation Before Shortage alternatives. Special status birds would not be impacted under the Basin States and Water Supply alternatives, and the Preferred Alternative, since under these action alternatives flows past Morelos Diversion Dam are just as likely to occur as under the No Action Alternative.

Amphibians, Plants and Fish. There are no special status amphibians, plants or fish in this reach.

Mammals. The increased likelihood of flows past Morelos Diversion Dam under the Reservoir Storage and Conservation Before Shortage alternatives would provide a moderate benefit to riparian and marsh habitats downstream of Morelos Diversion Dam, which would potentially benefit special status bats, the Yuma hispid cotton rat, and Colorado River cotton rat in this reach.

Invertebrates. The *Atriplex* land cover type is present in this reach, which may provide habitat for MacNeill's sooty-winged skipper. Though not specifically known in this reach, the species has been documented in Yuma County, Arizona. Flows past Morelos Diversion Dam under the Basin States and Water Supply alternatives, and the Preferred Alternative, are as likely to occur as under the No Action Alternative. Flows past Morelos Diversion Dam under the Reservoir Storage and Conservation Before Shortage alternatives are more likely to occur. Though an overall benefit to habitat conditions, flows past Morelos Diversion Dam could scour riparian vegetation, potentially including *Atriplex*, which serves as potential habitat for MacNeill's sooty-winged skipper. Thus, these alternatives would potentially have a minor negative impact on this species, despite overall benefits to the conditions in this reach.

Table 4.8-8 summarizes the impacts to special status species in the NIB to the SIB reach for the action alternatives relative to the No Action Alternative.

4.8.5 Summary

4.8.5.1 Vegetation and Wildlife

Lake Powell and Lake Mead. Under the Water Supply Alternative there may be a minor negative impact on obligate phreatophytes, and marsh and the wildlife that use such habitats because lake elevations tend to be lower than under the No Action Alternative. Under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, there may be a minor positive impact on obligate phreatophytes, and marsh and associated wildlife because lake elevations tend to be higher than under the No Action Alternative.

Table 4.8-8
NIB to SIB Reach Special Status Species Impact Summary
Comparison of Action Alternatives to No Action Alternative

Species	Alternative	Impact	Rationale
Birds	Basin States, Water Supply, Preferred Alternative	No Impact	Flows past Morelos Diversion Dam just as likely under the No Action Alternative.
	Reservoir Storage, Conservation Before Shortage	Moderate – positive	Flows past Morelos Diversion Dam more likely than under the No Action Alternative. Flows are rare in this reach, so increased likelihood would benefit the riparian corridor and associated special status species.
Mammals	Basin States, Water Supply, Preferred Alternative	No impact	Flows past Morelos Diversion Dam just as likely under the No Action Alternative.
	Reservoir Storage, Conservation Before Shortage	Moderate-positive	Flows past Morelos Diversion Dam more likely than under the No Action Alternative. Flows are rare in this reach, so increased likelihood would benefit the riparian corridor and associated special status species.
Amphibians, Plants and Fish	All action alternatives	No Impact	Fish occurrence is problematic due to lack of steady flows. No special status plants or amphibians are known in this reach.
MacNeill's sooty-winged skipper	Basin States, Water Supply, Preferred Alternative	No impact	Flows past Morelos Diversion Dam just as likely under the No Action Alternative.
	Reservoir Storage, Conservation Before Shortage	Minor-negative	*Atriplex* vegetation occurs in this reach and could be impacted by scouring by increased likelihood of flow past Morelos Diversion Dam.

Glen Canyon Dam to Lake Mead. All five action alternatives tend to have lower 10th percentile releases from Glen Canyon Dam than the No Action Alternative. These lowered releases may negatively impact obligate phreatophytes, and marsh and associated wildlife downstream of Lake Powell. The impacts are expected to be minor because though lower, they are within the range of recent history and are anticipated for the interim period only.

Hoover Dam to Davis Dam and Lake Havasu to Parker Dam. Under all five action alternatives there would be no impacts to vegetation or wildlife in these river reaches because there may be only small differences in Lake Mead releases and these reaches are dominated by Lake Mohave and its backwater, and Lake Havasu. Vegetated habitats potentially affected by flow changes between Hoover Dam and Lake Mohave are limited. Lake Mohave and Lake Havasu are operated on monthly rule curves so vegetation and wildlife effects at the lakes under the action alternatives are identical to those under the No Action Alternative.

Davis Dam to Parker Dam. Under the Water Supply Alternative there may be higher 10th and 50th percentile monthly releases and a higher annual median release from Davis Dam; this may cause a minor positive impact to obligate phreatophytes, and marsh and associated wildlife as compared to the No Action Alternative. Under the Reservoir Storage Alternative, there may be lower 10th and 50th percentile monthly releases and a lower annual median release from Davis Dam; this may cause a minor negative impact to obligate phreatophytes, and marsh and associated wildlife as compared to the No Action Alternative. These differences remain within the range of annual fluctuations that have historically occurred, and are expected to occur during the interim period only.

Parker Dam to Imperial Dam. Under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, there are lower 10th and 50th percentile monthly releases and a lower annual median release from Parker Dam; these lower releases may have a minor negative impact on obligate phreatophytes, and marsh and associated wildlife. Under the Water Supply Alternative there is a higher annual median release from Parker Dam, which may provide a minor benefit to obligate phreatophytes, and marsh and associated wildlife.

Imperial Dam to NIB. There are no impacts to vegetation or wildlife under any of the action alternatives in this reach. Flow changes in this reach would be limited to the AAC rather than to the Colorado River downstream of Imperial Dam. No impacts to vegetation or wildlife are anticipated from differences in flows within the AAC.

NIB to SIB. Mexico diverts its water at Morelos Diversion Dam (at the NIB) and flows downstream of this dam are rare. There is a higher probability of excess flows passing Morelos Diversion Dam under the Conservation Before Shortage and Reservoir Storage alternatives than under the No Action Alternative, which is expected to cause a moderate positive benefit to river flows, obligate phreatophytes, and marsh and associated wildlife downstream of Morelos Diversion Dam. These benefits were deemed moderate because flows in this reach are currently rare and any additional flow in this reach is assumed to be beneficial.

4.8.5.2 Special Status Species

Lake Powell. Lower Lake Powell elevations under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, at the 10th and 50th percentile of reservoir elevations may increase the amount of riverine habitat available at the inflow areas to Lake Powell. This may provide a minor positive impact to razorback sucker, bonytail, Colorado pikeminnow, and flannelmouth sucker found in the riverine areas at the inflows. The higher lake elevations under the Reservoir Storage Alternative may decrease the amount of riverine habitat at the inflow areas, which may result in a minor negative impact.

Clark’s grebe that may inhabit Lake Powell could be impacted by elevation changes in Lake Powell that affect marsh habitat at the inflow areas. Under the Reservoir Storage and Water Supply alternatives, there may be higher and lower lake elevations, respectively, which would mean a minor positive and a minor negative impact, respectively, to Clark’s grebe.

Glen Canyon Dam to Lake Mead. Under the action alternatives, except for the Reservoir Storage Alternative, there may result higher river temperatures downstream of Glen Canyon Dam at the 10th percentile of elevations and higher to lower temperatures at the 50th percentile of elevations than under the No Action Alternative. Under the Reservoir Storage Alternative there may result higher to lower river temperatures at the 10th and 50th percentiles of elevations, respectively. Higher temperatures may provide a minor positive impact to humpback chub, bluehead sucker and flannelmouth sucker spawning and growth. However, these warmer temperatures also benefit non-native fish species which compete with native fish, and parasites that affect native fish, resulting in a minor negative impact. The lower average temperatures in the summer and winter at the 10th percentile of elevations under the Reservoir Storage Alternative could reduce the growing season for humpback chub, bluehead sucker, and flannelmouth sucker but would not affect spawning, resulting in a minor negative impact. The short duration of warmer average temperatures in the spring followed by cooler temperatures are unlikely to provide any benefit to non-native fish and native fish parasites. Lower annual releases in some years could reduce sediment loss from the Colorado River while higher releases in some years could increase sediment losses. How these changes in sediment transport could affect native fish habitat is unknown. The range in hourly flows could be reduced during lower annual releases and increased during higher annual releases. Lower temperatures may provide a minor negative impact to these native fish species. Under the Reservoir Storage Alternative, average water temperatures above 15ºC (59°F) may occur one month later than under the No Action Alternative and may have a minor negative impact on leopard frogs due to increased potential for thermal shock in July. Under the other action alternatives impacts to the leopard frog are not expected as compared to the No Action Alternative.

Higher 90th percentile releases under the Reservoir Storage Alternative have a potential for increased impact to beach habitat in the lower Grand Canyon, which could adversely impact vegetation and Grand Canyon evening primrose on those beaches. Under the five action alternatives, flows may exceed those under the No Action Alternative and 17,000 cfs in some months, which may cause additional impact to Kanab ambersnail habitat at Vasey’s Paradise. Under the Reservoir Storage Alternative, flows in June could exceed those under the No Action Alternative and exceed 20,000 cfs, thus causing greater impact to Niobrara ambersnail habitat. Under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative at the 90th percentile there may be flows that when above 20,000 cfs are equal to or less than those under No Action Alternative, which would provide a minor positive benefit to the Niobrara ambersnail. Under the five action alternatives there may be a minor negative impact on the southwestern willow flycatcher because of the 10th percentile release flows trend lower than those under the No Action Alternative. These lower potential flows could adversely impact southwestern willow flycatcher habitat in the Grand Canyon.

Lake Mead. The lower and higher Lake Mead elevations that may occur under the Water Supply and Reservoir Storage alternatives, respectively, could cause minor negative and minor positive impacts, respectively, to special status bird species. Impacts on bird species may be caused by increased or decreased potential for dewatering of riparian habitats and headcutting at the Lake Mead inflow areas. Higher lake elevations under the Reservoir Storage Alternative may inundate additional shoreline habitat for the sticky buckwheat, Geyer’s milkvetch and Las Vegas Bearpoppy and be a minor negative impact. Lower Lake Mead elevations under the Water Supply Alternative may expose additional shoreline habitat for these plants and be a minor positive impact. These impacts were deemed minor because all habitats below the full pool elevation of Lake Mead are subject to periodic inundation and exposure as the lake elevation fluctuates in the future. Under the Preferred Alternative, there could be minor positive impacts to special status fish when elevations are above the current razorback spawning areas at the 50^{th} percentile of elevations and when lower elevations would extend riverine habitat in the inflow area for special status fish. Elevations higher than under the No Action Alternative at the 10^{th} percentile would have no impacts on razorback sucker spawning. Lake elevations under both the Basin States and Conservation Before Shortage alternatives could be both above and below those under the No Action Alternative and would have no impact to razorback suckers. The increased amount of riverine habitat at the 10^{th} percentile of elevations could provide a minor positive impact to special status fish in the Colorado River inflow. Under the Water Supply Alternative there may be both minor positive and negative impacts to special status fish species due to providing more riverine habitat and lower elevations relative to razorback spawning areas, respectively, at the 50^{th} percentile. Under the Reservoir Storage Alternative, elevations could be above current razorback sucker spawning areas over 50 percent of the time in about half the modeled years, a moderate positive impact. Higher reservoir elevations would provide less riverine habitat for special status fish in the Colorado River inflow at the10^{th} and 50^{th} percentile elevations for a minor negative impact.

Hoover Dam to Davis Dam and Lake Havasu to Parker Dam. There is no substantial difference between the No Action Alternative and any of the action alternatives in this reach.

Davis Dam to Lake Havasu. Lower monthly and annual median releases from Davis Dam under the Reservoir Storage Alternative may have a minor negative impact on obligate phreatophytes, and marsh and associated special status bird species, and Colorado River cotton rat. Impacts to these species may occur through adverse effects to their habitats from reduced dam releases. Razorback sucker, flannelmouth sucker, and bonytail may experience a minor negative impact because lower potential releases could have adverse impacts to riverine spawning habitat and backwater rearing habitats that these species utilize. Higher monthly and annual median releases from Davis Dam under the Water Supply Alternative may have a minor positive impact on obligate phreatophytes, and marsh and associated special status bird species, and Colorado river cotton rat. razorback sucker, flannelmouth sucker, and bonytail may also benefit from these higher flows because they could maintain more of the spawning and rearing habitats present in this reach.

Parker Dam to Imperial Dam. Lower monthly and annual median flows under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, may have minor negative impacts to the habitats of the special status bird species and Colorado river cotton rat. Obligate phreatophytes, and marsh and associated special status species would be negatively impacted by lower releases. Razorback sucker and bonytail chub may be negatively impacted by lower flows under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative. Lower flows may negatively impact spawning and rearing habitats for these species. Higher annual median flows under the Water Supply Alternative would benefit the habitats of special status birds, mammals and fish and may have a minor positive impact.

Imperial Dam to NIB. Under the No Action Alternative and the action alternatives there would be no impact to special status species in this reach. Flow changes in this reach would be limited to flows in the AAC rather than to the Colorado River downstream of Imperial Dam. No impacts to special status species are anticipated from flow differences in the AAC.

NIB to SIB. Flows past Morelos Diversion Dam are more probable under the Reservoir Storage and Conservation Before Shortage alternatives. The increased probability of flows may have a moderate positive impact on the special status bird species through positive impacts to riparian and marsh habitats these species utilize. These higher probabilities of flows may also positively impact the special status bat species listed in this section, Yuma hispid cotton rat, and Colorado river cotton rat through positive impacts to their riparian and marsh habitats. Though these flows are an overall benefit to the riparian corridor downstream of the NIB, the increased probability of high flows could increase the likelihood of scouring *Atriplex* vegetation in this reach, which would be a minor negative impact to MacNeill's sooty-winged skipper.

4.9 Cultural Resources

This section describes the methods used in the analysis of potential effects to cultural resources, including historic properties, Indian sacred sites, and issues of Tribal concern as a result of implementing the alternatives developed under the proposed federal action.

4.9.1 Methodology

This section provides a general analysis that considers how cultural sites might be exposed and affected by implementation of the proposed federal action. However, the specifics about current integrity of submerged sites and the impacts that might occur to these sites once they are exposed are mostly unknown. Because of this, Reclamation and NPS will work together to develop an agreement acceptable to the consulting parties that implements an appropriate strategy to identify, analyze, and address potential effects to cultural sites as they are exposed in the future as a consequence of implementing the proposed federal action.

For Lake Powell, the 10th percentile was selected as the basis for effect determination because it represents the "worst case" that still has a reasonable probability of occurring. At Lake Mead, elevation 1,080 feet msl was selected as the basis for effect determination.[1] Processes that might result in a loss of integrity vary by reach and property type; consequently, methods of assessing effects differ by reach.

4.9.2 Lake Powell and Glen Canyon Dam

4.9.2.1 No Action Alternative

Under the No Action Alternative, the lowest projected elevation of Lake Powell under the 10th percentile modeled Lake Powell elevations is 3,522 feet msl (Figure P-WAQ-6 in Appendix P). Some 194 unexcavated archaeological sites are at or above this elevation and would therefore be subject to erosion or visitor impacts.

4.9.2.2 Basin States Alternative and Conservation Before Shortage Alternative

Under the Basin States and Conservation Before Shortage alternatives, the lowest projected elevation of Lake Powell at the 10th percentile of modeled Lake Powell elevations is 3,541 feet msl. Some 190 unexcavated archaeological sites are at or above this elevation and would therefore be subject to erosion or visitor impacts. This is essentially the same effect as under the No Action Alternative.

[1] Elevation 1,083 feet msl is the lowest elevation observed since Lake Mead filled.

4.9.2.3 Water Supply Alternative

Under the Water Supply Alternative, the lowest projected elevation of Lake Powell at the 10th percentile of modeled Lake Powell elevations is 3,496 feet msl. Some 227 unexcavated archaeological sites are at or above this elevation and would therefore be subject to erosion or visitor impacts. This is a greater number of affected sites than under the No Action Alternative.

4.9.2.4 Reservoir Storage Alternative

Under the Reservoir Storage Alternative, the lowest projected elevation of Lake Powell at the 10th percentile of modeled Lake Powell elevations is 3,538 feet msl. Some 193 unexcavated archaeological sites are at or above this elevation and would therefore be subject to erosion or visitor impacts. This is essentially the same effect as under the No Action Alternative.

4.9.2.5 Preferred Alternative

Under the Preferred Alternative, the lowest projected elevation of Lake Powell at the 10th percentile of modeled Lake Powell elevations is 3,543 feet msl. Some 190 unexcavated archaeological sites are at or above this elevation and would therefore be subject to potential erosion or visitor impacts. This is essentially the same effect as identified under the No Action Alternative.

4.9.3 Glen Canyon Dam To Lake Mead

The Colorado River reach between Glen Canyon Dam and Separation Canyon contains 336 NRHP-eligible properties. These are actively managed by the NPS, Navajo Nation and Hualapai Indian Tribe. In addition, Reclamation's NHPA Section 106 responsibilities for effects of Glen Canyon Dam operations are managed through a programmatic agreement. A treatment plan for mitigation of adverse impacts to historic properties is in development and will be implemented in 2008. The Grand Canyon Protection Act of 1992 ensures long-term mitigation of effects. Thus, the alternatives currently under analysis pose no additional threat to historic properties not already considered by existing programs.

4.9.4 Lake Mead and Hoover Dam

Some 32 previously recorded cultural resources are located at or below elevation 1,080 feet msl at Lake Mead, although many more undocumented cultural resources are probably submerged in Lake Mead at or below this elevation. If these cultural resources were to emerge, additional impacts would be anticipated as a result of invasion by invasive species of plants and animals (specifically as seen at St. Thomas by tamarisk and Asiatic freshwater clams), cracking and fissuring of sediments as a result of repeated wetting and drying and freeze/thaw cycles (Wyskup 2006), and as a result of visitor impacts. Resources like the B-29 Bomber aircraft, and the aggregate classification plant are currently at depths where they cannot be reached without specialized breathing-gas mixture and diving equipment, but a lowering of the reservoir elevation would bring these resources into the range of recreational divers.

4.9.4.1 No Action Alternative

The probability of Lake Mead elevation falling below 1,080 feet msl was analyzed in Section 4.3 and Table 4.3-22. Figure 4.3-22 present the probabilities of Lake Mead elevation falling below 1,080 feet msl over the period of analysis for all alternatives. Under the No Action Alternative, the probability begins at zero percent in 2008 and increases to 41 percent in 2060. From 2016 through 2040, the probability fluctuates between 39 percent and 45 percent.

4.9.4.2 Basin States Alternative and Conservation Before Shortage Alternative

In 2008, the probability of Lake Mead elevation falling below elevation 1,080 feet msl is zero under these action alternatives. In years 2016 through 2040, the probability is slightly higher (one to five percent) than under the No Action Alternative for several years and ranges between 40 percent and 46 percent. Given these small differences compared to the No Action Alternative, the differential effect on cultural resources would be negligible.

4.9.4.3 Water Supply Alternative

In 2008, the probability of Lake Mead elevation falling below 1,080 feet msl is zero. From 2016 through 2040, the probability fluctuates between 40 percent and 49 percent, a relative difference of about one to nine percent under the Water Supply Alternative compared to the No Action Alternative. Consequently, there is a higher probability that cultural resources submerged at or below elevation 1,080 feet msl would emerge under the Water Supply Alternative.

4.9.4.4 Reservoir Storage Alternative

In 2008, the probability of Lake Mead elevation falling below 1,080 feet msl is zero. The probability of the Lake Mead elevation falling below 1,080 feet msl is substantially lower (one percent to 13 percent) under this alternative compared to the No Action Alternative. Consequently, there is a lower probability that cultural resources submerged at or below elevation 1,080 feet msl would emerge under the Reservoir Storage Alternative.

4.9.4.5 Preferred Alternative

In 2008, the probability of Lake Mead elevation falling below 1,080 feet msl is zero. In 2016 the probability of Lake Mead elevation falling below elevation 1,080 feet msl is slightly lower (five percent) than under the No Action Alternative; and in 2017 through 2040, the probability is slightly higher (one to three percent) than under the No Action Alternative. Given these small differences compared to the No Action Alternative, the differential effect on cultural resources would be negligible.

4.9.5 Hoover Dam to Davis Dam

Under all alternatives, Lake Mohave would continue to be operated to meet monthly target elevations. Because there would be no change in reservoir operations, there is no potential for adverse effects to occur to cultural resources submerged in Lake Mohave as a result of the proposed federal action.

4.9.6 Davis Dam to Parker Dam

Geomorphic processes in lacustrine and fluvial environments differ, therefore, the Davis Dam to Parker Dam reach has been subdivided into sub-reaches for this analysis, a river reach and Lake Havasu.

4.9.6.1 Davis Dam to Upper Lake Havasu

There are ten previously recorded cultural resources located along the reach of the Colorado River from Davis Dam to the upstream end of Lake Havasu. Three of these cultural resources span the Colorado River with their end-points anchored in positions well above the river surface. A lowering of the elevation of the river in the area of these sites would have no direct or indirect effect on these resources. Examination of the site forms and map plots for two other previously recorded cultural resources, both being segments of railroads indicate that these sites are located in elevated positions back from the riverbank. No direct or indirect effects to these resources are anticipated as a result of the proposed federal action due to their elevated locations.

Of the five additional cultural resources in this reach, only two would be directly affected by a drop in river elevation. These two sites represent the remnants of two bridges used by contractors during the construction of Davis Dam.

Although the proposed federal action may result in reductions in the annual volume of water released from Davis Dam and the corresponding mean daily releases, the hourly releases will continue to fluctuate between the historical minimum and maximum ranges due to operational considerations and constraints. The corresponding river flows and associated elevations would also continue to fluctuate between the historical minimum and maximum ranges and therefore it is unlikely that there would be any changes in depositional or erosional processes along tributary streams or washes, or the Colorado River itself. Furthermore, it is highly unlikely that daily or hourly changes in elevation would result in conditions that would allow for more ready access to cultural resources located immediately adjacent to or in the river.

4.9.6.2 Lake Havasu and Parker Dam

Under the alternatives, Lake Havasu will continue to be operated to meet monthly target elevations. Because there will be no change in the manner in which the reservoir has been operated historically, there is no potential for effects to occur to cultural resources submerged in Lake Havasu.

4.9.7 Parker Dam to Imperial Dam

The Implementation Agreement FEIS (Reclamation 2002a) identified several cultural resource sites within or proximal to the Parker Dam to Imperial Dam reach. However, most of the historic resources that may be present in the APE, as suggested from plats and site records, have been destroyed by meandering and relocation of the mainstream channel of the Colorado River and agricultural development. Further, the proposed federal action will have no effect on Parker Dam, Imperial Dam or the Old Parker Road.

Although the proposed federal action may result in reductions in the annual volume released from Parker Dam and the corresponding mean daily releases, the hourly releases will continue to fluctuate between the historical ranges due to operational considerations and constraints. The corresponding river flows and associated elevations would also continue to fluctuate between the historical minimum and maximum ranges and therefore it is unlikely that there would be any changes in depositional or erosional processes along tributary streams or washes, or the Colorado River. Eleven of the twelve sites located proximate to the APE are situated in locations above the river channel, its connected lakes and backwaters, and floodplain. The anticipated changes in river elevations would therefore not impact these sites. Also, the prehistoric habitation site listed on the National Register would not be directly impacted by a drop in river elevation. It is conceivable that it could be indirectly impacted by better accessibility if the river drops in elevation more frequently or for longer periods of time. The probability of this occurring is small and would be countered by the emergence of impenetrable vegetation behind the retreating water line. Furthermore, it is highly unlikely that daily or hourly changes in elevation would result in conditions that would allow for more ready access to cultural resources located immediately adjacent to or in the river.

4.9.8 Sacred Sites and Other Issues of Tribal Concern

As a result of prior government-to-government consultations, several tribes had identified Indian sacred sites located on federal lands within the affected environment. During consultations regarding this proposed federal action, the Hualapai Indian Tribe was the only tribe who specifically raised a concern regarding how the alternatives might adversely affect the physical integrity of sacred sites. The Hualapai Indian Tribe also raised concerns regarding biological resources located in Grand Canyon and on Hualapai Tribal land.

Reclamation, NPS, and FWS (federal agencies who manage lands within the affected environment) remain committed to accommodating access to and ceremonial use of Indian sacred sites by Indian religious practitioners. The agencies also remain committed to avoiding any adverse effects to the physical integrity of such sites in compliance with Exec. Order No. 13007. None of the alternatives are anticipated to adversely affect any identified Indian sacred site or alter access to such a site.

During consultation for this proposed federal action, several tribes expressed concern that the alternatives might result in inadvertent discoveries of Native American human remains or cultural items as defined under the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA). Reclamation and the federal land-managing agencies remain committed to compliance with both the inadvertent discovery and museum inventory sections of this law and its implementing regulations.

With respect to museum inventories from the original Glen Canyon archaeological project, Reclamation is working on cultural affiliation determinations on behalf of tribes seeking repatriation of inventory items from the Glen Canyon archaeological project.

4.9.9 Summary

For Lake Powell, under the Water Supply Alternative at the 10th percentile, there are at least 227 unexcavated sites subject to effect, as compared to about 193 sites under the other alternatives. Consultation is underway regarding eligibility and effect.

For the reach from Glen Canyon to Lake Mead, the alternatives pose no additional threat to cultural resources because of the programs already underway.

For Lake Mead, there are at least 32 cultural resources located below elevation 1,080 feet msl. The probability of exposing sites below this elevation vary by alternative, with the Reservoir Storage Alternative having the lowest probability (up to 13 percent lower compared to the No Action Alternative) and the Water Supply Alternative having the highest probability (up to nine percent higher compared to the No Action Alternative). The Basin States and Conservation Before Shortage alternatives and the Preferred Alternative have probabilities similar to those of the No Action Alternative.

For reaches downstream of Lake Mead, no adverse effects are anticipated from any of the alternatives. However, consultation regarding eligibility and effect will be undertaken.

For Indian sacred sites and other issues of Tribal concern (not including ITAs), none of the alternatives are expected to restrict access or result in loss of physical integrity to sacred sites. Consultations with Indian tribes are ongoing with respect to these issues and other issues and concerns.

4.10 Indian Trust Assets

4.10.1 Water Rights and Trust Lands

No vested water right of any kind, quantified or unquantified, including federally reserved Indian rights to Colorado River water, rights pursuant to the Consolidated Decree or Congressionally-approved water right settlements utilizing CAP water, will be altered as a result of any of the alternatives under consideration.

To the extent that additional Tribal water rights are developed, established or quantified during the interim period of the proposed federal action, the United States will manage Colorado River facilities to deliver water consistent with such additional water rights, if any, pursuant to federal law. Thus, modifications to system operations, in accordance with pertinent legal requirements, will consider Tribal water rights, and will be exercised in accordance with applicable law.

Water deliveries to the Fort Mojave, Chemehuevi, CRIT, and Fort Yuma Indian Reservations will not be affected by the proposed federal action due to their early priority dates. For the Cocopah Indian Reservation, its 1915 and 1917 PPRs would also not be affected. However, the 1974 priority date of 2,026 afy of the Cocopah Indian Reservation may be reduced during certain shortage conditions, as summarized in Section 4.4 (Water Deliveries). Similarly, the CAP Settlement tribes, with their post-1968 CAP Priority, would also be subject to shortages. However, even when water deliveries are reduced to these Indian Reservations, the underlying water rights would not be affected.

Water delivery reductions may result in fallowing of some Indian lands; however, these changes in land-use are expected to be temporary and no permanent changes in land-use would occur. In terms of effects to the shorelines of reservations that abut to the affected reservoirs or river reaches, the fluctuations that might occur as a result of this action downstream of Lake Mead are projected to be within historic levels.

For the action alternatives, the distribution of average daily releases may change (Table 4.3-13) from those under the No Action Alternative, but the operations would still be within the parameters of the 1996 Glen Canyon Dam ROD (Section 3.3). These occasional flow reductions and the concomitant sediment transport difference past the boundaries of the Navajo Nation and the Hualapai Indian Reservation would not affect Indian trust lands.

4.10.2 Hydroelectric Power Generation and Distribution

The energy generated at Headgate Rock Powerplant under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative could potentially be less than the energy generated under the No Action Alternative (Section 4.11). These reductions in energy generation range from 1.3 percent to 2.8 percent (Table 4.11-23). However, Reclamation has determined that water appropriated to non-CRIT entities that flows through Headgate Rock Dam and generates electricity is not an ITA.

4.10.3 Cultural Resources

Reclamation is currently in the process of identifying cultural resources and evaluating potential effects of implementing the proposed federal action (Section 4.9). However, based on what is currently known of Tribal historic and traditional cultural properties, there would be no effect on cultural resources of concern to the tribes. Furthermore, under Exec. Order No. 13007, there would be no change in access to Tribal sacred sites as a result of the proposed federal action.

4.10.4 Biological Resources

While not necessarily ITAs, the Navajo Nation and the Hualapai Indian Tribe have expressed concern over biological resources located on their reservations and in the intervening Grand Canyon. The action alternatives would result in occasional changes of flows past the Navajo Nation and the Hualapai Indian Reservation, compared with the No Action Alternative (Section 4.8). These flows would have some potential to affect phreatophytes such as willow (a plant of concern to many tribes); however, the effects are likely to be short-term, especially in comparison to the long-term trends favoring tamarisk expansion.

The Navajo Nation and the Hualapai Indian Tribe also expressed concern over native fish. The Hualapai Indian Tribe is particularly concerned with razorback sucker in the upper end of Lake Mead. The modeling of Lake Mead elevations indicates that the minimum Lake Mead elevations under the action alternatives would be similar to those under the No Action Alternative (Section 4.8). Therefore, the proposed federal action is expected to have either no effects or only minor effects on razorback sucker and other fish of Tribal concern.

4.10.5 Summary

After analyzing each resource, it is concluded that Tribal trust assets identified in the study area would not be adversely affected by any of the anticipated environmental impacts stemming from the proposed federal action.

4.11 Electrical Power Resources

This section analyzes the potential effects of the proposed federal action on electrical power (or hydropower) resources. The following issues are addressed:

- change in electrical power generated and the associated change in economic value;
- effect on Upper and Lower Colorado Basin funds that pay for operation, maintenance, replacements of power facilities, and other programs supported by these funds;
- financial implications associated with implementation of surcharges;
- potential impact to ancillary services; and
- change in annual cost of electrical power for pumping water associated with the Navajo Generating Station, City of Page water supply system, SNWA water supply system, and CAP pumping load.

4.11.1 Methodology

Reclamation conducted a study of the potential effects of the action alternatives on electrical power resources of the Colorado River system that included all major facilities with the exception of generation capacity at the Glen Canyon Powerplant. Western conducted a parallel analysis of the potential effects of the action alternatives only on Glen Canyon Powerplant (Appendix O). The two studies show very similar trends among the alternatives and the relative findings of each study are comparable. Western's analytical methodology includes a more detailed hourly analysis of the capacity of the Glen Canyon Powerplant because of operational limitations of hydropower facilities resulting from the 1996 Glen Canyon Dam ROD. The results of Reclamation's analysis are used throughout this section with the exception of the analysis of generation capacity and the economic value of generation capacity of the Glen Canyon Powerplant, which uses the results of the hourly analysis conducted by Western.

4.11.1.1 Electrical Energy Generated

The basis for the electrical power analysis is the CRSS model described in Section 4.2 and Appendix A of this final EIS. Among other variables, the model simulates monthly turbine release (af) and end-of-month reservoir elevation (feet msl) and calculates monthly generation (MWh) and monthly capacity (MW). The monthly generation data were then aggregated to produce estimates of annual generation. Using the resulting annual data, the mean, median, 90th percentile, and 10th percentile annual energy generation statistics were calculated for each year for the Glen Canyon, Hoover, Parker, and Davis Powerplants.

Since the reservoir behind Headgate Rock Dam is maintained at a relatively constant elevation, electrical power generation at the Headgate Rock Powerplant was calculated based on modeling changes in river flows provided by the CRSS model for the

No Action Alternative and the action alternatives. The modeled flows available to pass through the Headgate Rock Powerplant were first reduced by a factor of 5.96 percent to account for water that is likely to be bypassed through the Colorado River gates. This factor was derived from actual 2001 through 2005 data. Energy was then calculated using a conversion factor of 12.97 kWh/af, derived by averaging the monthly kWh/af values for the Headgate Rock Powerplant from 1996 through 1998.

In general, mean values provide an assessment of the overall impact to hydropower. The mean is the average of all modeled traces, which includes all hydrologic extremes, while the median is the midpoint of all values. Mean energy values higher than median values reflect water released from Glen Canyon Dam for equalization and the existence of the minimum objective release. Mean energy values lower than median values at the Hoover Powerplant are likely due to extreme dry conditions when Hoover Powerplant may not be generating power.

4.11.1.2 Generation Capacity

Using the capacity relationships for each powerplant, their respective monthly availability factors and the monthly forebay elevations simulated by the CRSS model, the monthly generation capacity for each powerplant was computed. The mean, median, 90^{th} percentile and 10^{th} percentile capacity values were then computed for the No Action Alternative and the action alternatives for the Glen Canyon, Hoover, Parker, and Davis Powerplants. For the Glen Canyon Powerplant, the analysis was conducted by Western (Appendix O). Capacity was not calculated for the Headgate Rock Powerplant because no changes in capacity are anticipated due to the constant elevation that is maintained in the upstream impoundment.

4.11.1.3 Economic Values

The economic value of operating an existing hydroelectric powerplant varies considerably with time of day. The cost of meeting demand varies on a second-by-second basis depending on the load, the mix of powerplants being operated to meet load, and their output levels. During off-peak periods, demand is typically satisfied with lower-cost coal, run-of-river hydropower, and nuclear units. During on-peak periods, the additional load is met with more expensive sources such as gas turbine units. Consequently, the economic value of hydropower is greatest during the hours when the demand for electricity, and the variable cost of meeting demand, is the highest.

The electrical energy prices used in this analysis were developed from both an hourly price forecast keyed to the Palo Verde Interchange and mean monthly reported price indices for the Palo Verde Interchange obtained from Dow Jones, Inc. The hourly forecast of 2004 electricity prices at the Palo Verde Interchange was developed using the AURORA model (Electric Power Information Solutions, Inc. 2005).

AURORA model simulations used in this analysis were developed for and used in the Northwest Power and Conservation Council's (NWPCC) Fifth Northwest Electric Power and Conservation Plan (NWPCC 2005). The NWPCC is primarily interested in Northwestern electricity markets. Relatively less attention is devoted to characterizing market conditions in other areas. Consequently, the forecast described in this analysis primarily reflects the default data supplied with the AURORA model.

For purposes of this analysis, the hourly prices developed using the AURORA model were scaled to match the mean monthly reported prices purchased from Dow Jones, Inc. The resulting (scaled) hourly prices exhibit the expected daily, weekly and monthly patterns of price behavior and reflect the mean values actually observed in each month.

The underlying hourly prices yielded by this process are for 2004. These prices were escalated by 2.2 percent per year to estimate 2008 prices. For this analysis, estimates of the economic value for the No Action Alternative and each of the action alternatives were analyzed using monthly generation data simulated by the CRSS model. The monthly generation values were then analyzed using the escalated mean price of electricity for that month. The monthly economic value was then aggregated to produce estimates of annual economic value.

The costs and benefits associated with electrical power generation are incurred at different times over a long period of time. Because the timing of these costs and benefits differ across the alternatives, the present value of the future stream of costs and benefits for each alternative was computed as a means of assessing the economic value of electrical power for each alternative.

All economic value estimates reported in this Final EIS are measured in present value 2008 dollars (PV 2008 $). All annual costs and benefits subsequent to 2008 were escalated by 2.2 percent per year and discounted back to the 2008 base year using a discount rate of 4.875 percent.

Similar to the process used in the economic analysis of electrical energy generation, the present value of generation capacity was analyzed. In this instance, the capacity was valued at $6.32/kW-month based upon the alternative market cost of capacity.

4.11.2 Electrical Power Generation Facilities

4.11.2.1 Glen Canyon Powerplant

No Action Alternative. The No Action Alternative values for annual energy generation, monthly generation capacity, and economic value at Glen Canyon Powerplant for the mean, median, 90th percentile, and 10th percentile values are presented in Table 4.11-1.

Table 4.11-1
No Action Alternative Values at Glen Canyon Powerplant

Measure	Mean	Median	90th Percentile	10th Percentile
Annual Energy Generation (MWh)	4,247,880	3,748,420	6,312,730	3,130,880
Monthly Capacity (MW)	606	546	839	451
Economic Value of Electrical Power Generation - Total (PV 2008 $ million)	7,350	6,523	10,663	5,436

Comparison of Action Alternatives to No Action Alternative. Table 4.11-2 presents the change in annual electrical energy generation for each alternative in MWh in comparison to the No Action Alternative, for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-2
Change in Glen Canyon Powerplant Annual Energy Generation (MWh)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(3,610)	51,210	(38,020)	(92,680)
Conservation Before Shortage	(2,990)	50,570	(36,450)	(92,910)
Water Supply	(109,120)	34,830	(98,710)	(226,660)
Reservoir Storage	33,170	20,360	61,490	3,600
Preferred Alternative	3,460	46,250	(26,610)	(75,130)

Table 4.11-3 presents the percent change in annual energy generation for each alternative, in comparison to the No Action Alternative, for the mean, median, 90th percentile, and 10th percentile values.

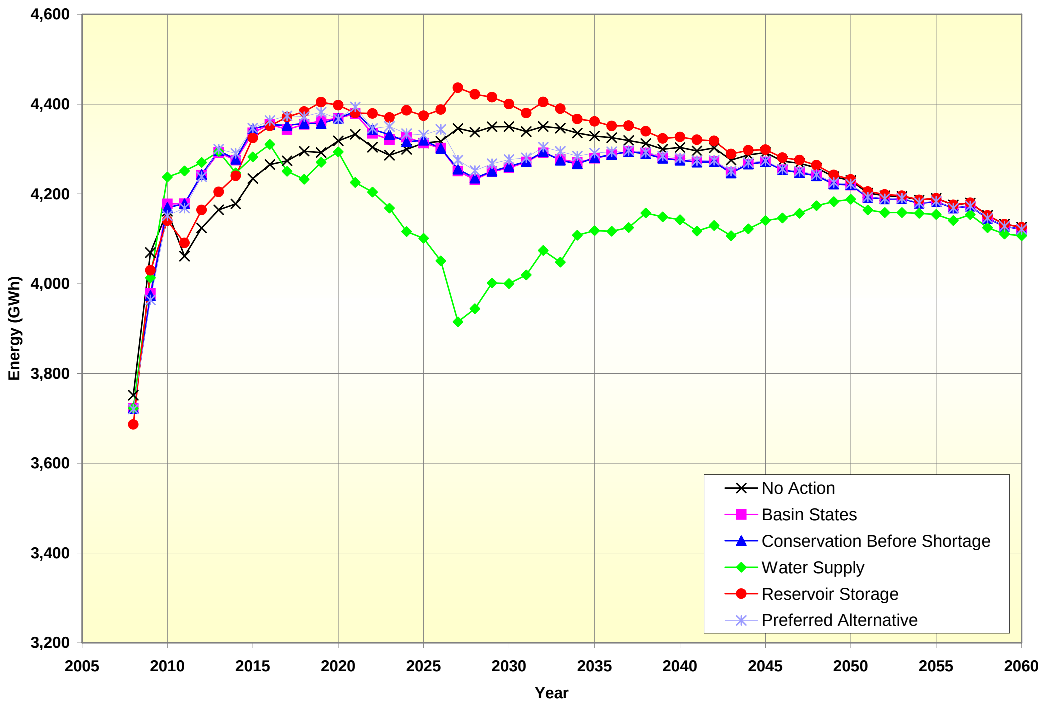
Table 4.11-3
Change in Glen Canyon Powerplant Annual Generation (percent)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(0.08)	1.37	(0.60)	(2.96)
Conservation Before Shortage	(0.07)	1.35	(0.58)	(2.97)
Water Supply	(2.57)	0.93	(1.56)	(7.24)
Reservoir Storage	0.78	0.54	0.97	0.11
Preferred Alternative	0.08	1.23	(0.43)	(2.40)

Figure 4.11-1 shows average values of annual electrical energy production in gigawatt-hours (GWh) for the Glen Canyon Powerplant, over the period of study, for the action alternatives, and the No Action Alternative. Differences in mean generation values between the No Action Alternative and the action alternatives are the greatest from 2020 through 2050.

Western conducted a complementary study of energy generation and associated economic value using an hourly time-step to simulate hourly Glen Canyon Powerplant generation levels. Western's model was used to determine the hourly operation schedule that maximized the economic value of the hydropower resource. Hourly pricing data, inflation and discount rates used in Western's study were the same as those used by Reclamation.

Figure 4.11-1
Glen Canyon Powerplant
Average Annual Electrical Energy Production



The Western study also included an analysis of the impacts to generation capacity at the Glen Canyon Powerplant. Table 4.11-4 presents the change in generation capacity for each alternative, as compared to the No Action Alternative, for the mean, median, 90th percentile, and 10th percentile values. The corresponding percentage changes are identified in Table 4.11-5.

Table 4.11-4
Change in Glen Canyon Powerplant Generation Capacity (MW)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(0.88)	6.04	(0.79)	(15.12)
Conservation Before Shortage	(0.79)	6.09	(0.74)	(15.01)
Water Supply	(16.50)	3.71	(9.65)	(33.91)
Reservoir Storage	4.81	2.87	6.75	(2.55)
Preferred Alternative	0.18	5.49	0.24	(12.41)

Table 4.11-5
Change in Glen Canyon Powerplant Generation Capacity (percent)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(0.15)	1.11	(0.09)	(3.35)
Conservation Before Shortage	(0.13)	1.12	(0.09)	(3.33)
Water Supply	(2.72)	0.68	(1.15)	(7.52)
Reservoir Storage	0.79	0.53	0.80	(0.57)
Preferred Alternative	0.03	1.01	0.03	(2.75)

Table 4.11-6 presents the change in total economic value of electrical power generation for each alternative, as compared to the No Action Alternative for the mean, median, 90th percentile, and 10th percentile values. Table 4.11-7 presents the corresponding percentage change in net present value for each alternative as compared to the No Action Alternative for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-6
Change in Glen Canyon Powerplant Total Economic Value of Electrical Power Generation (PV 2008 $ million)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	1.70	126.57	(60.55)	(212.78)
Conservation Before Shortage	2.86	125.07	(57.90)	(212.17)
Water Supply	(165.72)	112.08	(151.39)	(426.17)
Reservoir Storage	64.72	41.70	108.40	(35.31)
Preferred Alternative	14.26	111.43	(40.61)	(178.60)

Table 4.11-7
Change in Glen Canyon Powerplant Total Economic Value of Electrical Power Generation (percent)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	0.02	1.94	(0.57)	(3.91)
Conservation Before Shortage	0.04	1.92	(0.54)	(3.90)
Water Supply	(2.25)	1.72	(1.42)	(7.84)
Reservoir Storage	0.88	0.64	1.02	(0.65)
Preferred Alternative	0.19	1.71	(0.38)	(3.29)

Under all the action alternatives, the greatest impact to power would occur in the dry years. The Reservoir Storage Alternative provides an increased electrical power generation value, as a result of higher reservoir elevations, while the other action alternatives show generally decreased electrical power generation values.

4.11.2.2 Hoover Powerplant

No Action Alternative. The No Action Alternative values for annual energy generation, monthly generation capacity, and economic value at the Hoover Powerplant for the mean, median, 90th percentile, and 10th percentile values are presented in Table 4.11-8.

Table 4.11-8
No Action Alternative Values at Hoover Powerplant

Measure	Mean	Median	90th Percentile	10th Percentile[1]
Annual Energy Generation (MWh)	3,127,523	3,675,298	5,188,960	0.0
Monthly Capacity (MW)	1,191	1,424	2,069	0.0
Economic Value of Electrical Power Generation - Total (PV 2008 $ million)	7,223	8,395	10,453	3,185

1 *The 10th percentile value for capacity and energy is zero on cumulative distribution function graphs of end-of-December capacity and energy, a result of Lake Mead elevation being less than 1,050 feet msl (the assumed minimum power head). This result cascades in calculating total generation and percentage changes in Tables 4.11-9 through 4.11-14.*

Comparison of Action Alternatives to No Action Alternative. Table 4.11-9 presents the change in annual electrical energy generation in MWh for each action alternative, in comparison to the No Action Alternative, for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-9
Change in Hoover Powerplant Annual Electrical Energy Generation (MWh)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(6,960)	(46,952)	(15,193)	0.0
Conservation Before Shortage	(1,544)	(51,927)	(10,080)	0.0
Water Supply	(74,646)	(22,550)	(70,747)	0.0
Reservoir Storage	283,813	(55,065)	96,443	0.0
Preferred Alternative	43,772	(71,765)	6,843	0.0

Table 4.11-10 presents the percent change in annual electrical energy generation for each action alternative, in comparison to the No Action Alternative, for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-10
Change in Hoover Powerplant Annual Electrical Energy Generation (percent)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(0.22)	(1.28)	(0.29)	0.0
Conservation Before Shortage	(0.05)	(1.41)	(0.19)	0.0
Water Supply	(2.39)	(0.61)	(1.36)	0.0
Reservoir Storage	9.07	(1.50)	1.86	0.0
Preferred Alternative	1.40	(1.95)	0.13	0.0

Figure 4.11-2 depicts average values of annual electrical energy production for Hoover Powerplant over the period of study for each alternative, including the No Action Alternative. Differences in mean generation values between the No Action Alternative and the action alternatives are the greatest from 2020 through 2050.

Figure 4.11-2
Hoover Powerplant
Average Annual Electrical Energy Production

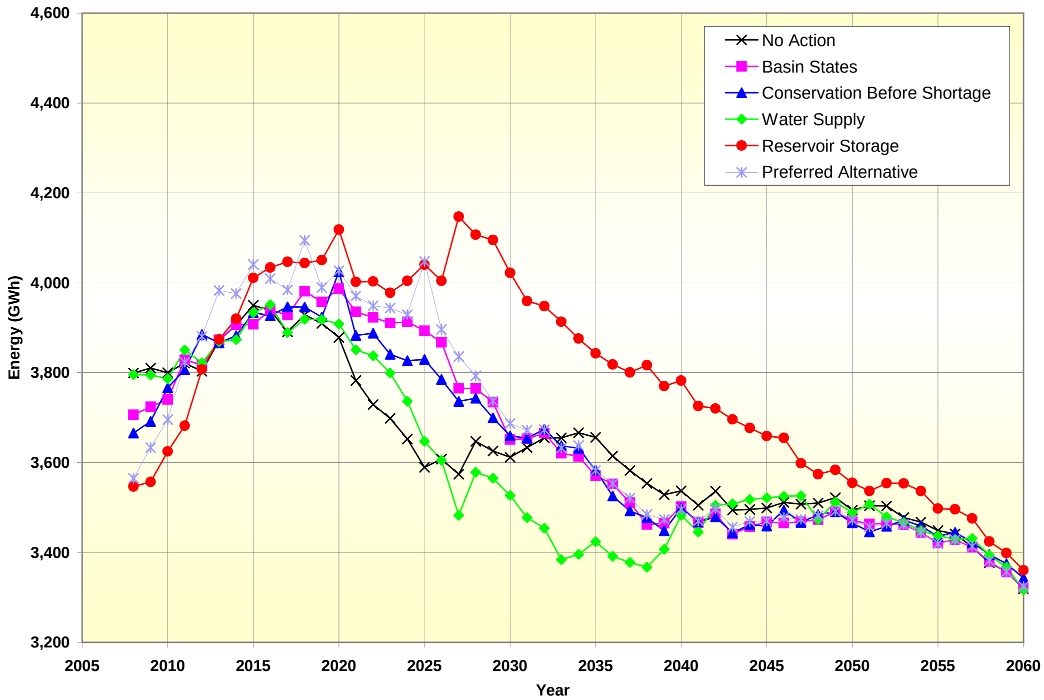


Table 4.11-11 presents the change in Hoover Powerplant monthly generation capacity (MW) for the action alternatives compared to the No Action Alternative for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-11
Change in Hoover Powerplant Monthly Generation Capacity (MW)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	3.7	2.2	0.6	0.0
Conservation Before Shortage	6.9	5.1	0.9	0.0
Water Supply	(30.5)	(13.0)	(0.5)	0.0
Reservoir Storage	137.2	56.6	4.9	0.0
Preferred Alternative	27.6	16.1	1.3	0.0

Table 4.11-12 presents the percentage change in the Hoover Powerplant monthly capacity for each of the action alternatives as compared to the No Action Alternative for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-12
Change in Hoover Powerplant Monthly Generation Capacity (percent)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	0.31	0.15	0.03	0.0
Conservation Before Shortage	0.58	0.36	0.04	0.0
Water Supply	(2.56)	(0.91)	(0.03)	0.0
Reservoir Storage	11.52	3.97	0.24	0.0
Preferred Alternative	2.31	1.13	0.06	0.0

Table 4.11-13 presents the change in each of the action alternatives as compared to the net present value of the total electrical power generation under the No Action Alternative for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-13
Change in Hoover Powerplant Total Economic Value of Electrical Power Generated (PV 2008 $ million)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	5.86	(269.01)	(16.1)	(87.19)
Conservation Before Shortage	24.34	(265.45)	(8.7)	(82.9)
Water Supply	(181.0)	(479.69)	(30.34)	(270.47)
Reservoir Storage	768.15	307.14	49.13	1,551.99
Preferred Alternative	172.13	(163.23)	25.62	163.95

Table 4.11-14 presents the corresponding percentage change in net present value for each alternative as compared to the No Action Alternative for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-14
Change in Hoover Powerplant Total Economic Value of Electrical Power Generated (percent)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	0.08	(3.20)	(0.15)	(2.74)
Conservation Before Shortage	0.34	(3.16)	(0.08)	(2.60)
Water Supply	(2.51)	(5.71)	(0.29)	(8.49)
Reservoir Storage	10.63	3.66	0.47	48.73
Preferred Alternative	2.38	(1.94)	0.25	5.15

In general, the Reservoir Storage Alternative and the Preferred Alternative provide the greatest increase in electrical power generation value at the Hoover Powerplant, while the Water Supply Alternative proves most adverse to power generation. The Basin States and Conservation Before Shortage alternatives show similar results and they are ranked between the Reservoir Storage Alternative and the Water Supply Alternative in their effect on power resources at the Hoover Powerplant.

4.11.2.3 Parker and Davis Powerplants

No Action Alternative. The No Action Alternative values for annual energy generation, monthly generation capacity, and total economic value for the Parker and Davis Powerplants for the mean, median, 90th percentile, and 10th percentile values are presented in Table 4.11-15.

Table 4.11-15
No Action Alternative Values at Parker and Davis Powerplants

Measure	Mean	Median	90th Percentile	10th Percentile
Annual Energy Generation (MWh)	1,639,687	1,581,530	1,820,271	1,506,057
Monthly Capacity (MW)	331.4	364.0	364.0	285.8
Economic Value of Electrical Power Generation - Total (PV (2008 $ million)	2,268	2,288	2,380	2,156

Comparison of Action Alternatives to No Action Alternative. Table 4.11-16 presents the change in annual electrical energy generation in MWh for each action alternative, in comparison to the No Action Alternative, for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-16
Change in Parker and Davis Powerplants Annual Electrical Energy Generation (MWh)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(9,188)	(9,406)	(574)	(9,325)
Conservation Before Shortage	(11,363)	(12,380)	(176)	(11,029)
Water Supply	1,737	14,057	(12,449)	2,976
Reservoir Storage	(17,478)	(24,259)	(29,860)	(22,397)
Preferred Alternative	(11,214)	(14,561)	3,039	(13,763)

Table 4.11-17 presents the percent change in generation between the No Action Alternative and the action alternatives for the Parker and Davis Powerplants for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-17
Change in Parker and Davis Powerplants Annual Electrical Energy Generation (percent)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(0.56)	(0.59)	(0.03)	(0.62)
Conservation Before Shortage	(0.69)	(0.78)	(0.01)	(0.73)
Water Supply	0.11	0.89	(0.68)	0.20
Reservoir Storage	(1.07)	(1.53)	(1.64)	(1.49)
Preferred Alternative	(0.68)	(0.92)	0.17	(0.91)

Table 4.11-18 shows that no changes are anticipated in monthly generation capacity under the action alternatives for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-18
Change in Parker and Davis Powerplants Monthly Generation Capacity (MW)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	0.0	0.0	0.0	0.0
Conservation Before Shortage	0.0	0.0	0.0	0.0
Water Supply	0.0	0.0	0.0	0.0
Reservoir Storage	0.0	0.0	0.0	0.0
Preferred Alternative	0.0	0.0	0.0	0.0

Figure 4.11-3 and Figure 4.11-4 depict average values of annual electrical energy production for the Parker Powerplant and Davis Powerplant, respectively, comparing the action alternatives to the No Action Alternative.

An observation from Figures 4.11-3 and 4.11-4 is a spike in energy production in 2025. This spike is due to a modeling assumption with regard to the storage and delivery mechanism and the modeled depletion schedules which withdraw a large volume of the storage credits in 2025.

Figure 4.11-3
Parker Powerplant
Average Annual Electrical Energy Production

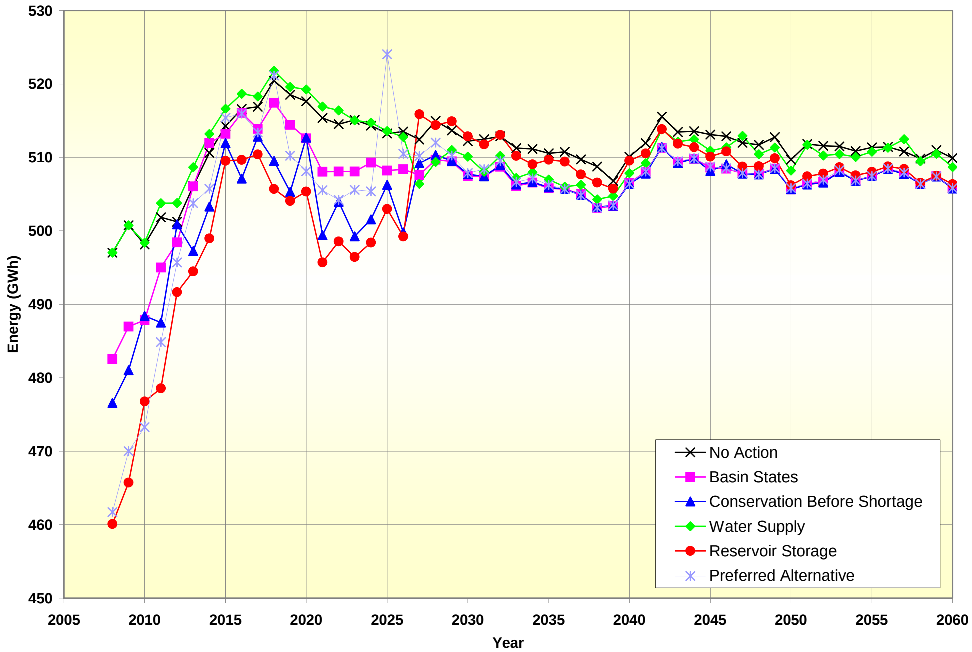
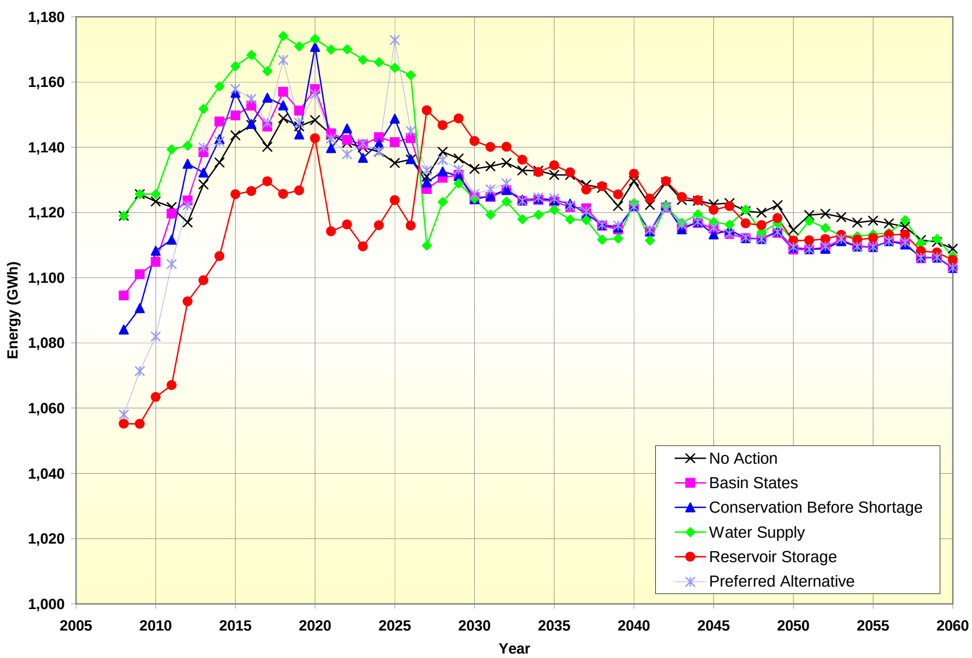


Figure 4.11-4
Davis Powerplant
Average Annual Electrical Energy Production



Economic value comparisons between the No Action Alternative and the action alternatives are presented in Table 4.11-19 for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-19
Change in Parker and Davis Powerplants Total Economic Value of Electrical Power Generation (PV 2008 $ million)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(12.02)	(10.95)	(11.31)	(12.99)
Conservation Before Shortage	(16.66)	(16.50)	(12.09)	(19.16)
Water Supply	7.05	7.32	3.68	8.70
Reservoir Storage	(34.94)	(30.61)	(27.38)	(49.61)
Preferred Alternative	(18.32)	(17.57)	(14.23)	(20.08)

Table 4.11-20 presents the percent change in economic value between the No Action Alternative and each of the action alternatives for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-20
Change in Parker and Davis Powerplants Total Economic Value of Electrical Power Generated (percent)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(0.53)	(0.48)	(0.48)	(0.60)
Conservation Before Shortage	(0.73)	(0.72)	(0.51)	(0.89)
Water Supply	0.31	0.32	0.15	0.40
Reservoir Storage	(1.54)	(1.34)	(1.15)	(2.30)
Preferred Alternative	(0.81)	(0.77)	(0.60)	(0.93)

In general, the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative could potentially provide a slight decline in the economic value of electrical power generated at Parker and Davis Powerplants. The Reservoir Storage Alternative is expected to result in a greater decline in economic values. The Water Supply Alternative results in slight increases in economic value for the Parker and Davis Powerplants.

Because of downstream requirements (i.e., environmental, plant operations, water requirements) the forebay elevations at Parker and Davis Powerplants remain relatively constant and electrical power generation is proportional to inflow. Consequently, the maximum generation capacity at Parker and Davis Powerplants will not be affected by the any of the action alternatives.

4.11.2.4 Headgate Rock Powerplant

No Action Alternative. The No Action Alternative values for annual generation and economic value at the Headgate Rock Powerplant for the mean, median, 90th percentile, and 10th percentile values are presented in Table 4.11-21.

Table 4.11-21
No Action Alternative Values at Headgate Rock Power Plant

Measure	Mean	Median	90th Percentile	10th Percentile
Annual Energy Generation (MWh)	77,482	73,698	85,069	69,611
Economic Value of Electrical Power Generation (PV 2008 $ million)	103	98	113	93

Comparison of Action Alternatives to No Action Alternative. Table 4.11-22 presents the change in annual generation in MWh for each action alternative relative to the No Action Alternative. The Water Supply Alternative provides higher median electrical energy generation due to the higher observed flows as compared to the No Action Alternative. The Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative provided lower electrical energy generation as compared to the No Action Alternative for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-22
Change in Headgate Rock Powerplant Annual Electrical Energy Generation (MWh)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(934)	(972)	(444)	(1,168)
Conservation Before Shortage	(1,322)	(1,252)	(509)	(1,946)
Water Supply	(216)	168	(716)	83
Reservoir Storage	(1,319)	(2,078)	1,164	(2,233)
Preferred Alternative	(1,164)	(1,283)	(437)	(1,817)

Table 4.11-23 presents the percent change in annual electrical energy generation for each action alternative relative to the No Action Alternative for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-23
Change in Headgate Rock Powerplant Annual Electrical Energy Generation (percent)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(1.21)	(1.32)	(0.52)	(1.68)
Conservation Before Shortage	(1.71)	(1.70)	(0.60)	(2.80)
Water Supply	(0.28)	0.23	(0.84)	0.12
Reservoir Storage	(1.70)	(2.82)	1.37	(3.21)
Preferred Alternative	(1.50)	(1.74)	(0.51)	(2.61)

Figure 4.11-5 depicts average values of annual electrical energy production for Headgate Rock Powerplant, comparing the No Action Alternative and the action alternatives.

Figure 4.11-5
Headgate Rock Powerplant
Average Annual Electrical Energy Production

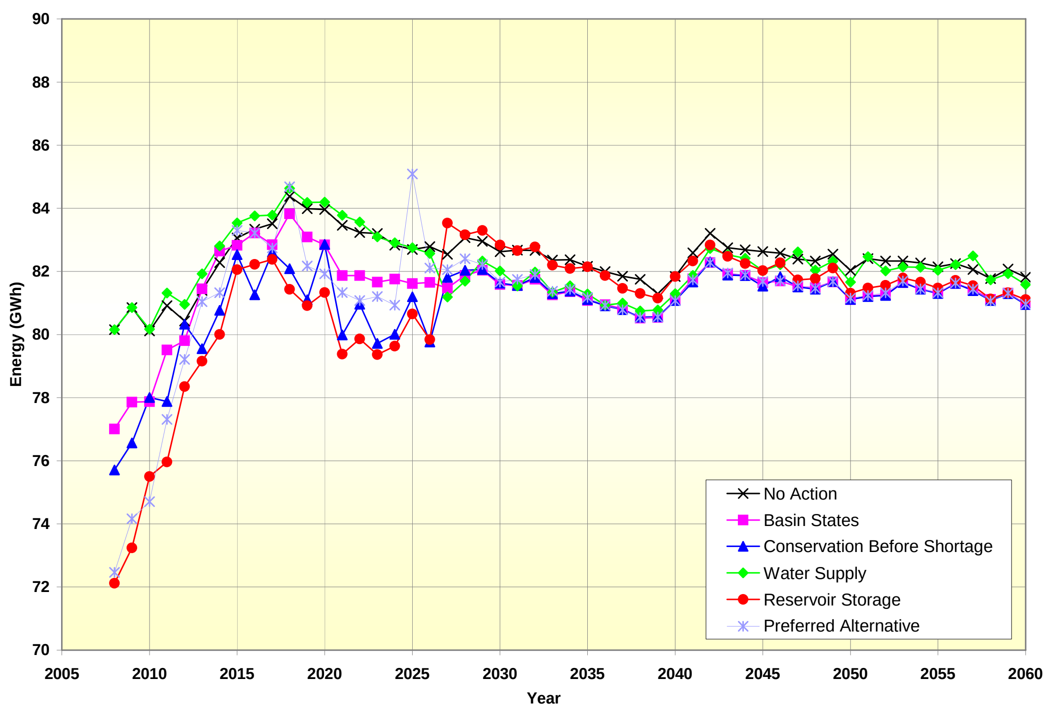


Table 4.11-24 provides an overview of the potential change in economic value of electrical power generated for each action alternative relative to the No Action Alternative for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-24
Change in Headgate Rock Powerplant Total Economic Value of Electrical Power Generated (PV 2008 $ million)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(1.33)	(1.43)	(0.43)	(1.89)
Conservation Before Shortage	(2.08)	(2.08)	(0.52)	(3.52)
Water Supply	(0.18)	0.30	(0.86)	0.23
Reservoir Storage	(2.38)	(3.73)	1.46	(4.32)
Preferred Alternative	(1.89)	(2.19)	(0.54)	(3.41)

Table 4.11-25 provides an overview of the potential percent change in economic value of electrical power generated for each action alternative relative to the No Action Alternative for the mean, median, 90th percentile, and 10th percentile values.

Table 4.11-25
Change in Headgate Rock Powerplant Total Economic Value of Electrical Power Generated (percent)

Action Alternative	Mean	Median	90th Percentile	10th Percentile
Basin States	(1.29)	(1.46)	(0.38)	(2.03)
Conservation Before Shortage	(2.02)	(2.12)	(0.46)	(3.78)
Water Supply	(0.17)	0.31	(0.76)	0.25
Reservoir Storage	(2.31)	(3.81)	1.29	(4.65)
Preferred Alternative	(1.83)	(2.23)	(0.48)	(3.67)

In general, the value of electrical power generated under the Water Supply Alternative could potentially be slightly higher than under the No Action Alternative. The value of electrical power generated under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative could potentially be less than under the No Action Alternative.

Currently Headgate Rock Powerplant generates more electrical power than is needed by CRIT. Implementation of any of the action alternatives is not expected to impact Headgate Rock Powerplant's ability to meet CRIT's current electrical power demands. However, a reduction in Headgate Rock Powerplant generation could impact BIA's ability to meet new Tribal energy demands.

4.11.2.5 Basin Power Funds

Upper Colorado River Basin Fund. Approximately $175 million is needed each year to fund Reclamation and Western operating needs. Western is responsible for transmission and marketing of CRSP power, collecting payment for the power, and the transfer of revenues for repayment to the General Treasury.

Implementation of the various alternatives will likely result in more variation in the Basin Fund, and could lead to additional actions such as power rate adjustments, rate surcharges, or reductions to customer allocations to respond to shortfalls in revenue under dry conditions. Western and its power customers need to quickly respond to changing hydrological conditions to forestall possible financial problems.

In addition, if an alternative were to increase or decrease Glen Canyon Powerplant electrical power generation over an extended period of time, Western and its power customers might decide to increase or decrease allocations in response, which could, in turn, affect the rate Western charges for the power and its financial reserves in the Basin Fund. A rate increase could affect customers' generation and power purchase decisions as well as their overall financial condition.

An important aspect associated with power delivery is whether and how much one or more of the alternatives alters the probability of a total loss of generation from Glen Canyon Powerplant. Loss of Glen Canyon Powerplant generation would result in a loss of revenue to Western, Reclamation, and various environmental programs in the Upper Basin; loss of generation and replacement costs for power customers; and degradation to power system reliability.

In the cases of such a loss of power, potential mitigation measures may need to be evaluated to offset or replace power revenue reductions and impacts to the Basin Fund and programs supported by this fund. A significant portion of the annual funding of the Endangered Fish Recovery Implementation Program is provided by power revenues. As such, any significant reduction in the power revenues would require that funds be secured from other sources.

Figure 4.11-6 shows the percentage of Lake Powell end-of-March elevations from Reclamation's CRSS modeling output that are less than or equal to elevation 3,490 feet msl. March typically has the lowest Lake Powell reservoir elevation of the year and elevation 3,490 feet msl is the point at which electrical power can no longer be produced at the Glen Canyon Powerplant. Using this measure, the Water Supply Alternative is more likely to provide conditions that would result in Lake Powell elevations falling below the minimum power pool elevation of 3,490 feet msl, as compared to the No Action Alternative. The Reservoir Storage, Basin States, and Conservation Before Shortage alternatives, and the Preferred Alternative have equal or slightly lower probabilities than the No Action Alternative. An analysis of end-of-July elevations indicated that these values are less pronounced than the end-of-March elevations, but similar.

Lower Colorado River Basin Development Fund. The functions of the Development Fund are to collect revenues and repayment associated with CAP, and to fund expenses related to the Colorado River Basin Salinity Control Program and projects as directed by the Arizona Water Rights Settlements Act (Public Law 108-451).

An important aspect associated with power delivery is whether and how much one or more of the alternatives alters the probability of a total loss of generation from Hoover Powerplant. Loss of Hoover Powerplant generation would result in a loss of revenue to Western, Reclamation and various environmental programs in the Lower Basin; loss of generation and replacement costs for power customers; and, degradation to power system reliability.

Figure 4.11-7 shows the percentage of end-of-July elevations from Reclamation's CRSS modeling output that are less than or equal to elevation 1,050 feet msl. This elevation is the point at which it is currently assumed that power can no longer be produced at the Hoover Powerplant.

Figure 4.11-6
Lake Powell End-of-March Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less Than or Equal to Elevation 3,490 feet msl

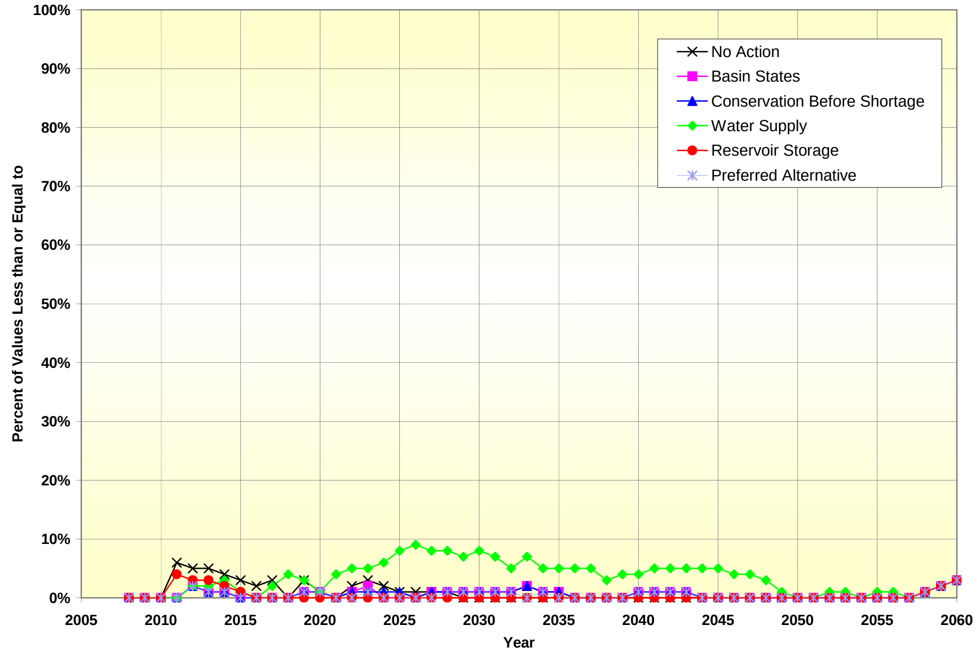
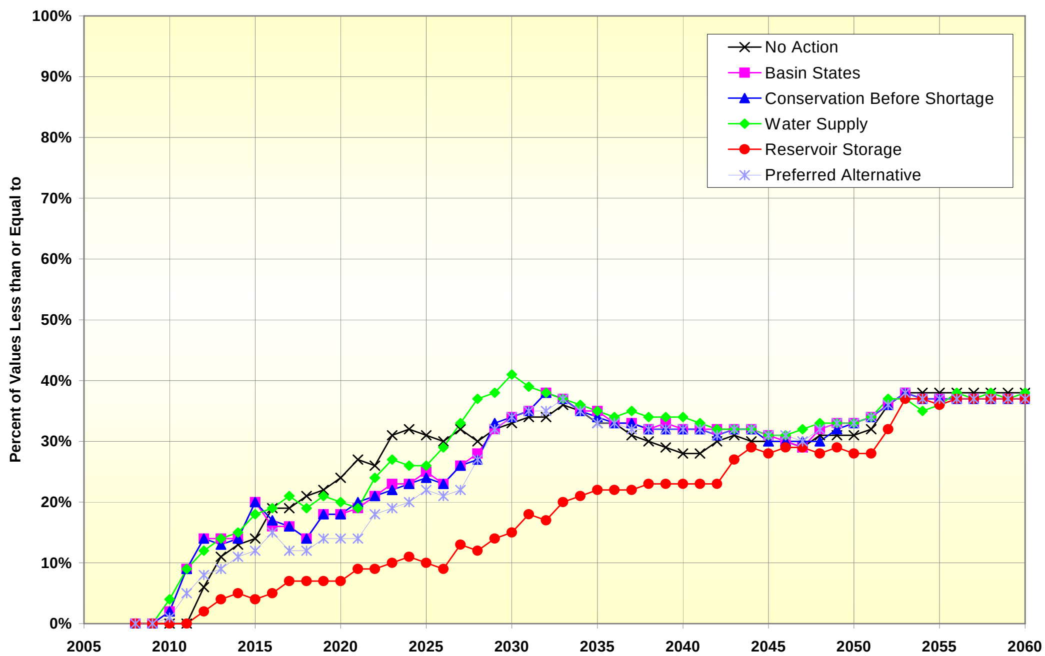


Figure 4.11-7
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less than or Equal to Elevation 1,050 feet msl



Using this measure, the Water Supply Alternative is slightly more likely to produce conditions that would result in Lake mead elevations falling below the minimum power pool elevation of 1,050 feet msl than the No Action Alternative, while the Basin States and Conservation Before Shortage alternatives have equal or slightly lower probabilities than the No Action Alternative. The Preferred Alternative has slightly lower probability of having elevations below the power pool elevation through 2028, while the Reservoir Storage Alternative has much lower probability of having elevations below the power pool elevation. Values for end-of-July Lake Mead elevations are less pronounced, but similar.

Any of the alternatives that reduce electrical power production would reduce the surcharge revenues available to defray costs associated with the Colorado River Basin Salinity Control Act (Title II) and the CAP repayment.

Colorado River Dam Fund. The Dam Fund is utilized to fund operation and maintenance payments to states, visitor services, up-rating program, replacements, investment repayment, and interest expenses of the Boulder Canyon Project. The annual revenue requirement is typically approximately $60 to $70 million per fiscal year.

Since implementation of the various alternatives could result in more variation in the Dam Fund cash reserves, this could lead to additional actions such as power rate adjustments, or reductions to contractors allocations to respond to shortfalls in capacity, energy and revenues under dry conditions.

4.11.2.6 System-Wide Electrical Power Issues

Conservation Before Shortage Surcharge. The Conservation Before Shortage proposal submitted to Reclamation (Appendix K) suggests that a portion of the funding for the proposed voluntary conservation program could be derived from a conditional surcharge on power rates under existing or renewed contracts for hydropower produced at Hoover Dam. It is suggested that this surcharge could be imposed in years when Reclamation’s August 24-month study projects that storage in Lake Mead falls below 50 percent of its active capacity. The revenues generated by this surcharge could be collected in a power pool protection fund, to be maintained by Reclamation for expenditure when and if lake elevations reach a conservation trigger.

This surcharge is not included in the current economic analysis at any of the Upper or Lower Basin facilities or Basin Funds. Surcharges imposed are typically not included within Western's or Reclamation's electrical power rate structure. For example, the current 4.5 mil and the 2.5 mil rate imposed on Hoover Powerplant, and Parker and Davis Powerplant power contractors to help repay Reclamation’s CAP project construction costs and to provide funding for salinity projects are a separate part of the contractor’s bill.

Imposing a surcharge on power revenues would require separate legislation. Rate-making authority, except for Reclamation's project use power, lies with Western, therefore such changes would be under the purview of the Secretary of the Department of Energy and the United States Congress.

Ancillary Service Impacts. In addition to generating electrical power, each of the power generation facilities in the study area provides other electrical products and services referred to as ancillary services. Ancillary services are those services necessary to keep the power grid functioning continuously, safely, and reliably.

Western, as an operator of multiple control areas (referred to also as balancing authorities), is required by the Federal Energy Regulatory Commission to offer ancillary services to entities purchasing transmission services in its control areas. Entities purchasing transmission are required to self-supply ancillary services or purchase ancillary services from third parties. Hoover Powerplant capacity and energy is dynamically scheduled and made available to the contractors which allows certain ancillary services to be utilized in other control areas. The Hoover Powerplant is also a significant source of reserves, regulation and frequency control for non-Western control areas in Arizona, California, and Nevada.

Reserves. Because of low load factors at the Glen Canyon Powerplant and Hoover Powerplant, at any given time there are hundreds of megawatts of spinning or supplemental reserves that can be called on to respond to generating unit outages and power system emergencies. The available unscheduled capacity at the Parker and Davis Powerplants is used primarily for reserves. In addition, the generation units at Davis Powerplant have a portion of their capacity used exclusively for reserves.

Action alternatives that reduce or eliminate capacity at the Glen Canyon Powerplant and Hoover Powerplant will reduce or eliminate reserve capacity as well, impacting reliability of the power system, and impacting revenue to Western or to specific projects. None of the alternatives are expected to have a significant impact on reserves at the Parker and Davis Powerplants since the associated reservoir elevations are not affected. A reduction in electrical power production at these powerplants would create a slight increase in the average reserve capacity available.

Regulation and Frequency Control. Regulation and frequency control is needed to maintain power system stability and the moment-to-moment balance between load and generation. Reductions in electrical power generation from the Glen Canyon Powerplant and Hoover Powerplant would impact the ability of these powerplants to provide regulation services. Although the generating units are able to regulate throughout most of their operating range, the amount of regulation available decreases as generating capability decreases.

The Hoover Powerplant is primarily used to provide regulation for the control area. However, the Davis Powerplant has some capability for regulation and frequency control, but the available unscheduled capacity at the Davis Powerplant is used almost exclusively for reserves.

Any of the alternatives that cause the Glen Canyon Powerplant or Hoover Powerplant to stop generating completely due to low reservoir elevation (below the minimum power pool elevation), could potentially eliminate regulation as well. As shown on Figures 4.11-6 and 4.11-7, the Water Supply Alternative poses the greatest risk to regulation and frequency control at the Glen Canyon Powerplant and Hoover Powerplant, respectively.

Reactive Supply and Voltage Control. Reactive power is power required to charge the transmission lines and associated electrical equipment that comprise the power grid. Unlike other ancillary services that can assist the power system over large geographical areas, reactive supply and voltage control are limited to small areas. The Glen Canyon Powerplant supplies reactive power to northern Arizona and southern Utah, and the Hoover Powerplant supplies reactive power to northwestern Arizona, Southern Nevada, and southeastern California. Without an adequate supply of reactive power and constant monitoring, power system voltages can increase or decrease beyond acceptable limits, leading to system instability, cascading outages, and damage to electrical equipment.

Black Start Capability. Black Start Service, also referred to as Startup Service consists of providing the electrical power needed to start up a generating plant, usually after a system emergency (e.g., large scale blackout) that causes loss of electricity from the generating station.

The Glen Canyon Powerplant is relied upon to provide Black Start Service capability to the power system. The Hoover Powerplant is relied upon to provide the same capability to the power system and also for Palo Verde Nuclear Generating Station located outside Phoenix, Arizona. Similar to regulation and frequency control, the Water Supply Alternative is most prone to cause Glen Canyon Powerplant and Hoover Powerplant to stop generating completely due to low reservoir elevation conditions. The Parker and Davis Powerplants do not provide Black Start Service.

Contract Commitments. Western contracts with preference power customers to supply firm energy and capacity. Currently, about 243 municipalities, rural electric cooperatives, Indian tribes, irrigation districts, and state and federal facilities in Arizona, Nevada, New Mexico, Colorado, Utah, and Wyoming are served from SLCA/IP power facilities, which includes the Glen Canyon Powerplant. The Hoover Powerplant contractors have an allocation from Western for a specific quantity of contingent capacity and associated firm energy.

At the Glen Canyon Powerplant, the current contracts went into effect in October 2004 and extend through September 2024. At the Hoover Powerplant, the current contracts went into effect in June 1987 and extend through September 2017. For the Parker and Davis Powerplants, current contracts went into effect in October 1988 and extend through September 2008.

Each contractor has an allocation from Western for a specific quantity of energy and capacity each month. Western guarantees that the minimum quantity of energy will be available for contractors, and purchases power to meet that level whenever hydropower generation is insufficient to supply the required amount (referred to as firming purchases). Hydropower generation above the minimum level is also allocated to contractors on an as-available basis as operational and hydrological conditions allow.

An alternative may increase or decrease energy generation and capacity at the Glen Canyon Powerplant or Hoover Powerplant. Western has the ability to modify its contract commitments to its electrical power customers when a change in the volume of water released at these dams results in changes in electrical generation and capacity. For example, if an alternative reduces energy generation and capacity at the Glen Canyon Powerplant over the long-term average, Western would have the ability to lower its contract commitments to those customers who have contracts that include Glen Canyon Powerplant electrical power. The lower commitments would cause these customers (electrical utilities) to add new generating facilities, speed up planned construction of new generating facilities or take other action to make up for the reduction in Western's contract commitment. The estimated values of these actions by customers are what is portrayed in the tables in this section.

Energy and capacity allocations to contractors can be revised when the contracts are renewed. Allocations to contractors after contract terms expire will depend upon projections of future capacity and energy.

4.11.2.7 Electrical Power Use Associated with Water Supply Systems

This section discusses potential changes in pumping costs for the following entities that pump water from reservoirs: the NGS which obtains cooling water from Lake Powell; the City of Page which obtains municipal water from Lake Powell; SNWA which obtains water from Lake Mead; and CAP and MWD which pump water from Lake Havasu. Incremental differences in pumping costs are associated with differences in modeled average Lake Powell, Lake Mead, and Lake Havasu elevations between the No Action Alternative and the action alternatives.

River system modeling provided the average elevations for Lake Powell, Lake Mead, and Lake Havasu under the No Action Alternative and the action alternatives. Increases or decreases in net effective pumping head correspond with decreases or increases in average reservoir elevations. Estimates of the differences in pumping costs were calculated using these changes in pumping head, as well as estimates of annual pumping volumes, unit electrical power costs and pump efficiency.

Navajo Generating Station. The SRP estimates that water use at NGS will be approximately 29,000 afy in the future. Power for the intake pumps is obtained from auxiliary power units at NGS at a cost of $0.0104 per kWh. Table 4.11-26 identifies changes in electrical power requirements for the alternatives and the associated increase or decrease in cost.

Table 4.11-26
Change in Navajo Generating Station Intake Electrical Power Requirements at Lake Powell [1]

Action Alternative	Change in Annual Electrical Power Requirement (kWh)[2]	Change in Associated Annual Cost ($)
Basin States	122,484	1,170
Conservation Before Shortage	107,701	1,120
Water Supply	307,748	3,201
Reservoir Storage	(102,580)	(1,067)
Preferred Alternative	84,684	881

1. *Assumes 29,000 afy of pumping; Cost = E (kWh) = $0.0104*
2. *E (kWh) = 1.024 * V (afy) * H (ft) / E (%)*

City of Page Water Supply. The average annual water demand by the City of Page in recent years has been around 2,650 af (Section 3.12). Annual electrical power demand to deliver the water has averaged around 3,900,000 kWh per year over the past 10 years. Under the No Action Alternative, using the current rate of $.03286 per kWh (includes overhead), the annual cost of electrical power for pumping the water is around $130,000 per year.

Table 4.11-27 summarizes the differences in pumping costs for the Reclamation-operated raw water intake serving the City of Page. The greatest increase would occur under the Water Supply Alternative, an average increase of about $919 per year, in comparison to the No Action Alternative total annual cost of $130,000, an approximate increase of less than one percent. In general the effect on City of Page pumping costs would be minor under all alternatives.

Table 4.11-27
Change in City of Page Intake Electrical Power Requirements at Lake Powell [1]

Action Alternative	Change in Annual Electrical Power Requirement (kWh)[2]	Change in Associated Annual Cost ($)
Basin States	10,280	336
Conservation Before Shortage	9,842	322
Water Supply	28,122	919
Reservoir Storage	(9,374)	(306)
Preferred Alternative	7,738	253

1. *Assumes 2,650 afy of Pumping; Cost = E (kWh) = $0.03286*
2. *E (kWh) = 1.024 * V (afy) * H (ft) / E(%)*

SNWA Water Supply. Under the No Action Alternative, the average Lake Mead elevation declines from 2007 through 2060. The chance that lake elevations could drop below the minimum power pool elevation of 1,050 feet msl increases for all alternatives, with the Reservoir Storage Alternative resulting in the smallest increase in probability. These results also suggest that under the No Action Alternative, SNWA can expect pumping costs to increase due to the increase in net effective pumping head. The cost of pumping varies with each of the action alternatives as an increase or decrease compared to the No Action Alternative. Table 4.11-28 shows the potential differences between pumping costs under the action alternatives to those under the No Action Alternative.

Table 4.11-28
Change in Estimated SNWA Pumping Costs

Action Alternative	Change in Cost ($)
Basin States	(22,780)
Conservation Before Shortage	(38,726)
Water Supply	227,803
Reservoir Storage	(2,144,115)
Preferred Alternative	(501,720)

The change in pumping costs shown in Table 4.11-28 considers the difference in the average of the 50th percentile (median) Lake Mead annual elevation values from 2008 to 2060 under each action alternative to that of the No Action Alternative. The differences in the average of the median elevations (between each action alternative and the No Action Alternative) was multiplied by the estimated annual SNWA combined pumping costs for the two SNWA intake pump stations (Levy 2006 personal communication) corresponding to the respective Lake Mead elevations. A positive number in Table 4.11-28 indicates an increase in annual SNWA pumping costs and a negative number (in parenthesis) indicates a potential savings in annual SNWA pumping costs when compared to pumping costs required under the No Action Alternative.

CAP Pumping Load. Under all alternatives, when shortages are imposed on the CAP, there is an associated reduction in electrical power requirements to pump water, and more of CAP's share of NGS generation is available to be marketed (after 2011). For a 500,000 af shortage (at $48/MWh), the annual market value of the electrical power available to be marketed is approximately $41 million.

This revenue would benefit all CAP users to the extent it would be used to offset CAWCD's repayment obligation, as well as Indian tribes that benefit from the AWSA. The Reservoir Storage Alternative would result in the greatest overall shortages, and therefore the greatest reduction in CAP pumping load. Increased power revenues on the CAP water would likely be offset by increased delivery charges to CAP water users when CAP deliveries are reduced because of shortages.

4.11.2.8 Summary Comparison of Alternatives

Tables 4.11-29, 4.11-30, 4.11-31, and 4.11-32 summarize effects of each of the action alternatives compared to the No Action Alternative for electrical energy generation, generation capacity, and associated economic effects for the Glen Canyon, Hoover, Parker and Davis, and Headgate Rock Powerplants.

Table 4.11-29
Glen Canyon Powerplant
Summary Comparison of Action Alternatives to No Action Alternative
Mean Values for Electrical Energy Generation, Generation Capacity, and Economic Value

	Action Alternative					
	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Annual Energy Generation (MWh)	4,247,880	4,244,270	4,244,890	4,138,760	4,281,050	4,251,340
Change in Annual Energy Generation (MWh)	0.0	(3,610)	(2,990)	(109,120)	33,170	3,460
Change in Annual Energy Generation (percent)	0.0	(0.08)	(0.07)	(2.57)	0.78	0.08
Monthly capacity (MW)	606	605	605	589	611	606
Change in Monthly Capacity (MW)	0.0	(1)	(1)	(17)	5	0
Change in Monthly Capacity (percent)	0.0	(0.15)	(0.13)	(2.72)	0.79	0.0
Economic Value of Electrical Power Generation – Total (PV 2008 $ million)	7,350	7,352	7,353	7,184	7,415	7,364
Change in Present Value of Electrical Power Generation (PV 2008 $ million)	0.0	2	3	166	65	14
Change in Present Value of Electrical Power Generation (percent)	0.00	0.02	0.04	(2.25)	0.88	0.19

Table 4.11-30
Hoover Powerplant
Summary Comparison of Action Alternatives to No Action Alternative
Mean Values for Electrical Energy Generation, Generation Capacity, and Economic Value

	Action Alternative					
	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Annual Energy Generation (MWh)	3,127,523	3,120,563	3,125,979	3,052,877	3,411,336	3,171,295
Change in Annual Energy Generation (MWh)	0	(6,960)	(1,544)	(74,646)	283,813	43,772
Change in Annual Energy Generation (percent)	0.0	(0.22)	(0.05)	(2.39)	9.07	1.40
Monthly capacity (MW)	1,191	1,195	1,198	1,160	1,328	1,219
Change in Monthly Capacity (MW)	0.0	4	7	(31)	137	28
Change in Monthly Capacity (percent)	0.0	0.31	0.58	(2.56)	11.52	2.31
Economic Value of Electrical Power Generation – Total (PV 2008 $ million)	7,223	7,229	7,247	7,042	7,991	7,395
Change in Present Value of Electrical Power Generation (PV 2008 $ million)	0.0	6	24	(181)	768	172
Change in Present Value of Electrical Power Generation (percent)	0.0	0.08	0.34	(2.51)	10.63	2.38

Table 4.11-31
Parker and Davis Powerplant
Summary Comparison of Action Alternatives to No Action Alternative
Mean Values for Electrical Energy Generation, Generation Capacity, and Economic Value

	Action Alternative					
	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Annual Energy Generation (MWh)	1,639,687	1,630,499	1,628,324	1,641,424	1,622,209	1,628,473
Change in Annual Energy Generation (MWh)	0	(9,188)	(11,363)	1,737	(17,478)	(11,214)
Change in Annual Energy Generation (percent)	0.0	(0.56)	(0.69)	0.11	(1.07)	(0.68)
Monthly capacity (MW)	331	331	331	331	331	331
Change in Monthly Capacity (MW)	0	0	0	0	0	0
Change in Monthly Capacity (percent)	0.0	0.0	0.0	0.0	0.0	0.0
Economic Value of Electrical Power Generation – Total (PV 2008 $ million)	2,268	2,256	2,251	2,275	2,233	2,250
Change in Present Value of Electrical Power Generation (PV 2008 $ million)	0.0	(12)	(17)	7	(35)	(18)
Change in Present Value of Electrical Power Generation (percent)	0.0	(0.53)	(0.73)	0.31	(1.54)	(0.81)

Table 4.11-32
Headgate Rock Powerplant
Summary Comparison of Action Alternatives to No Action Alternative
Mean Values for Electrical Energy Generation, Generation Capacity, and Economic Value

	Action Alternative					
	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Annual Energy Generation (MWh)	77,482	76,548	76,160	77,266	76,163	76,318
Change in Annual Energy Generation (MWh)	0	(934)	(1,322)	(216)	(1,319)	(1,164)
Change in Annual Energy Generation (percent)	0.0	(1.21)	(1.71)	(0.28)	(1.70)	(1.50)
Monthly capacity (MW)	331	331	331	331	331	331
Change in Monthly Capacity (MW)	0	0	0	0	0	0
Change in Monthly Capacity (percent)	0.0	0.0	0.0	0.0	0.0	0.0
Economic Value of Electrical Power Generation – Total (PV 2008 $ million)	103	102	101	103	101	101
Change in Present Value of Electrical Power Generation (PV 2008 $ million)	0.0	(1)	(2)	(0.2)	(2)	(2)
Change in Present Value of Electrical Power Generation (percent)	0.0	(1.29)	(2.02)	(0.17)	(2.31)	(1.83)

Glen Canyon and Hoover Powerplants. Tables 4.11-29 and 4.11-30 presents potential changes in generation, capacity, and economic value of electrical power. The Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative result in minor variations for each of these parameters. The Water Supply Alternative would have the greatest adverse effect on electrical power production and value because of generally lower elevations. Most of these changes are less than one percent, however, and these alternatives result in both positive and negative variations. Therefore, these impacts are considered minor. The Reservoir Storage Alternative generally results in greater positive changes with respect to electrical power production and value because of higher reservoir elevations and would result in moderate beneficial effects, particularly in the case of the Hoover Powerplant.

Parker, Davis, and Headgate Rock Powerplants. These facilities are generally considered to be "run of the river" electrical power generation facilities and are affected primarily by release volumes from Hoover Dam. As presented in Tables 4.11-31 and 4.11-32, the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, all generally result in minor decreases in electrical power production and value at these facilities as compared to the No Action Alternative because they result in lower release volumes downstream of Hoover Dam, with the Reservoir Storage Alternative having the greatest adverse effects. Again, these changes are relatively minor (most less than one percent). The Water Supply Alternative results in greater release volumes downstream and therefore slight increases in electrical power production and value as compared to the No Action Alternative. These increases are considered beneficial but also minor as compared to overall electrical power production at these facilities.

Water Supply Systems. As presented in Table 4.11-29, the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative would generally result in lower elevations at Lake Powell, as compared to the No Action Alternative, and therefore could potentially result in increased pumping costs for NGS and City of Page, with the Water Supply Alternative resulting in approximately twice the increase in costs as compared to the other action alternatives.

At Lake Mead, all of the action alternatives, with the exception of the Water Supply Alternative, provide higher reservoir elevations as compared to the No Action Alternative and therefore could potentially provide a decrease in pumping costs. As presented in Table 4.11-28 the Water Supply Alternative could potentially increase pumping costs.

The Reservoir Storage Alternative would result in generally higher reservoir elevations and therefore reduced pumping costs as compared to the No Action Alternative. This beneficial effect is also considered minor.

Basin Power Funds. Reductions in power revenues could reduce the amount of money available to meet the intended uses of these funds, possibly leading to reductions in allocations to power contractors or power rate adjustments. The action alternatives generally have a minor impact on the economic value of electrical power generation at the Glen Canyon and Hoover Powerplants. However, total loss of electrical power generation capabilities would have a substantial effect on the basin power funds. At the Glen Canyon Powerplant, the probability of this type of loss in electrical power generation capability is very small (less than five percent) except under the Water Supply Alternative, which would result in as much as a nine percent probability. At Hoover Powerplant, the probability of total loss of generation is higher, increasing from the current negligible probability to about 30 percent in 2026. However, as shown in Figure 4.11-7, the Reservoir Storage Alternative is the exception to this, while the remaining alternatives are very similar to the No Action Alternative.

4.12 Recreation

This section discusses the recreational resources within the study area that may be affected by the proposed federal action. The potentially affected recreational resources include:

- shoreline public use facilities;
- reservoir boating;
- river and whitewater boating; and
- sport fishing.

4.12.1 Methodology

The following methods were used to determine the effects of the alternatives on recreational resources.

4.12.1.1 Method Used to Assess Shoreline Public Use Facilities

These sections examine the probabilities that reservoir elevations would decrease below critical thresholds for use of selected marinas, boat docks, and boat launch ramps. These sections also assess whether impacts would occur in access to or use of attraction features. Threshold reservoir elevations were determined by reviewing published sources and through personal communication with Reclamation, NPS, and resource specialists, and from public comments provided during scoping for this EIS. The threshold elevations were used as indicators of recreational facilities that might be rendered inoperable or require relocation or modification to maintain their operation. Projections of reservoir elevations for 2008, 2016, 2026, 2030, 2040, 2050, and 2060 are provided in Section 4.3. The narrative of effects of the alternatives is provided below for selected facilities in July or September, representing relatively high visitation months for both Lake Powell and Lake Mead. These facilities are representative of potential effects of the alternatives on shoreline recreation opportunities at each reservoir. Results are presented for 2026, representing the end of the interim period. For Lake Powell, Wahweap Marina was selected for description in the narrative due to its popularity with boaters. For Lake Mead, Pearce Ferry at the inflow area to the reservoir is described. Effects on Echo Bay public launch ramp are also described in the narrative because it represents a facility that closes at the relatively low reservoir elevation of 1,050 feet msl.

4.12.1.2 Method Used to Assess Reservoir Boating

This analysis assesses the probabilities of reservoir elevations decreasing below critical thresholds, resulting in boating navigation hazards, changing navigable areas, and passage ways, and assesses whether corresponding decreases in reservoir surface areas might affect safe boating capacities. Threshold pool elevations were determined by reviewing published sources and through personal communication with Reclamation, NPS, and resource specialists, and from public comments.

In general, the surface area of the reservoirs available for boating is reduced when the reservoir elevation drops, which may affect the number of boats that can safely operate at one time, referred to as safe boating density. The safe boating density value can be used to assess the effects of each alternative on boating safety if levels of daily boating use were available. However, recent and consistent information on the level of daily or peak boating use, such as whether the current boating densities on the reservoirs have approached or exceeded the safe boating density is not available. Without information on current reservoir boating densities, it cannot be determined whether any reductions in pool elevations at Lake Powell and Lake Mead associated with the alternatives would result in unsafe boating conditions due to a corresponding increase in boating density. Personal communications with boaters and NPS managers suggest that Lake Mead and Lake Powell have not exceeded safe boating densities.

Navigation hazards and shallow waters require boaters to take detours around inaccessible areas. This may add mileage to trips and may influence recreational boaters to remain in specific areas, which can result in congestion in those areas. Additionally, as reservoir elevations drop and surface area decreases, congestion may become more noticeable in popular areas that receive high-use or where narrow travel corridors exist.

4.12.1.3 Method Used to Assess River and Whitewater Boating

This analysis uses river flow data from Section 4.3 to analyze whether there would be increased exposures to boating navigation hazards, changes in access or use of rest areas and take-outs, or changes in trip durations resulting under the action alternatives as compared to the No Action Alternative. Whitewater boating is the key recreational activity in Grand Canyon downstream of Lees Ferry and upstream of Lake Mead. Other river reaches do not provide whitewater boating opportunities and, therefore, are not addressed in this EIS.

Threshold river flows were determined by reviewing published sources and through personal communication with river managers and from comments received during scoping. These representative river flows were chosen as indicators for whitewater boating safety and the availability of rest areas and take-out points.

This analysis also includes a discussion of areas on the Colorado River that could become unsafe for whitewater boating at certain flows due to hazards such as exposed rocks, changes in navigation patterns caused by obstructions, and increased or decreased flow velocities. These flows were also analyzed to determine elevations at or below which various whitewater boating facilities (rest areas and take-out points) might be rendered inoperable or require modification to maintain their operation.

4.12.1.4 Method Used to Assess Sport Fishing

This analysis evaluates changes in sport fishing opportunities by river reach under the action alternatives as compared to the No Action Alternative. The assessment of sport fishing was based on literature review to determine the current status of fish assemblages in the study area. No specific reservoir elevation thresholds related to sport fishing were found. A general discussion about changes in flow and salinity and possible effects on sport fish is also provided.

A more detailed analysis of effects to rainbow trout based on changes in water temperature is used for the Colorado River reach between Glen Canyon Dam and Lake Mead. Water temperature changes may affect sport fish. Rainbow trout were chosen for the analysis based on the importance of its recreational fishery in the Colorado River reach below Glen Canyon Dam.

Striped bass and threadfin shad in Lake Powell and Lake Mead were selected to represent the reservoir sport fishery; striped bass are a sports fish and threadfin shad are their food source. Striped bass feed on threadfin shad, and when shad are abundant, striped bass are able to reproduce and grow quickly. The resulting increased bass population continues feeding on the threadfin shad, and they deplete the shad populations. As striped bass decline in numbers predation on threadfin shad decreases. This causes the threadfin shad population to increase again. This cycle has been occurring since the first introduction of striped bass into Lake Powell in 1974 and is expected to continue in the future (Gustaveson 1999).

Rainbow trout and its water temperature thresholds were used to analyze potential differences in impacts between the alternatives downstream of Glen Canyon Dam. Minimum, maximum, and lethal water temperatures for various life history stages were determined and the months during which spawning, incubation, and growth occur were established. The 10^{th} percentile data were used to analyze potential effects because the 50^{th} and 90^{th} percentile data are essentially identical between the alternatives and no meaningful differences exist. It is important to note that the 10^{th} percentile elevations are unlikely to occur in any given year or consistently over time (Section 4.2). Modeled temperature data at Glen Canyon Dam and Lees Ferry, the Little Colorado River confluence, and at Diamond Creek were used in the trout fishery analysis. A qualitative analysis of potential water temperature changes and effects on rainbow trout were made by comparing the differences between water temperatures under the No Action Alternative and the action alternatives.

Water Temperature Assessment. Minimum and maximum monthly surface water temperature data (up to ten feet below the surface) for Lake Powell were provided and compared to striped bass and threadfin shad thresholds to determine whether potential surface water temperatures would exceed the lethal tolerances of striped bass or threadfin. The lower lethal limit for striped bass is 5°C and the upper lethal limit is 33°C. The lower lethal limit for threadfin shad is 5°C and the upper lethal limit is 37°C.

Modeled river water temperatures (Section 4.5 and Appendix P) were used to assess the possible effects on rainbow trout in the river reach from Glen Canyon Dam to Diamond Creek (Tables 4.5-4 to 4.5-9 and Appendix P). Conditions supporting rainbow trout spawning and incubation were assumed to deteriorate as temperature of river water warms beyond 15ºC (Table 4.12-1). Trout eggs that are subjected to temperatures warmer than 15ºC are prone to increased mortality (Table 4.12-1). Juvenile rearing success is assumed to deteriorate at water temperatures ranging from 17ºC to 25ºC. Rainbow trout can be expected to show significant mortality at temperatures exceeding 25ºC (Myrick and Cech 2001; Raleigh et al. 1984) (Table 4.12-1).

Table 4.12-1
Water Temperature Tolerances of Rainbow Trout (ºC)

Species	Species Code	Spawning			Incubation			Growth			Lethal	
		Minimum	Maximum	Optimum	Minimum	Maximum	Optimum	Minimum	Maximum	Optimum	Low	High
Rainbow Trout	RBT	8	13	10	7	15	10	12	21	16	0	25

In the Colorado River, rainbow trout are year-round residents. Spawning typically begins in January and continues into May, with peak spawning occurring in March and April (Korman et al. 2005) (Table 4.12-2). During spawning, the female digs a redd (i.e., gravel nest) where the eggs are deposited, and they are then fertilized by the male. The optimal water temperature for trout spawning and incubation has been reported to fall between 7ºC and 15ºC (Table 4.12-1). Incubation lasts from 1.5 months to 4 months, depending on water temperature (Table 4.12-2).

Newly emerged fry move to shallow, protected areas along stream banks, but as they grow, they move to faster, deeper areas of the river. Shallow riffles are the most important channel type for trout during their first year (Barnhart 1986). Juvenile trout generally use riffles and runs in the main and secondary channels, along with the head and tail of pools. Juvenile rearing success is assumed to deteriorate at water temperatures ranging from 17ºC to 25ºC. Juvenile trout feed on a variety of aquatic and terrestrial insects and other small invertebrates.

Table 4.12-2
Life History of the Rainbow Trout, Phases by Months

Phases	Citations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning	2,4,5	■	■	■	■	■							
Egg Incubation	2,4,5	■	■	■	■	■	■	■	■				
Juvenile Rearing	2,4,5	■	■	■	■	■	■	■	■	■	■	■	■
Residence	1, 2, 3	■	■	■	■	■	■	■	■	■	■	■	■

1 *Lake Powell n.d. Available at: http://www.waterquality.utah.gov/watersheds/lakes/LAKEPOWL.pdf. Accessed October 27, 2006.*

2 *GCDAMP (Glen Canyon Dam Adaptive Management Program). n.d. Lees Ferry trout fishery. Available at: http://www.pn.usbr.gov/keyresc/tf.html. Accessed October 27, 2006.*

3 *Fishing in Laughlin, Nevada. 2006. Available at: http://www.laughlinnevadaguide.com/fish.htm. Accessed October 27, 2006.*

4 *Valdez 1993. Non-native fishes of Grand Canyon. Available at: http://www.gcrg.org/bqr/6-4/fishes.htm. Accessed: October 27, 2006.*

5 *Korman et al. 2005.*

Salinity Assessment. Salinity levels were assessed downstream of Hoover Dam and it was determined that future salinity levels would not affect rainbow trout (Section 4.5). Striped bass are naturally a brackish to salt water species, so any slight increase in salinity should have no effect on striped bass or threadfin shad. Therefore this issue is not discussed further.

Flow Assessment. Flow reductions that occur outside of spawning periods of fish are expected to have minimal impacts on fish species because habitat is likely not a factor limiting their populations. Extreme reductions, however, could result in the loss of fish through stranding and reduction in water quality (e.g., dissolved oxygen, temperature). The abundance of sports fishes, however, would be expected to recover following flow reduction periods through natural reproduction and through augmentations under fish stocking programs.

Flow reductions during the spawning period could desiccate eggs or strand juvenile fish. Impacts on sport fishes are expected to be minimal because their populations are relatively large and would be expected to recover following reduced flow conditions through natural reproduction and through augmentations under fish stocking programs.

Given that releases from Glen Canyon Dam would remain within their historic range, it was concluded that changes in flow would not be a useful tool to analyze effects on sport fish in this reach of the river. The reaches downstream of Hoover Dam are also expected to continue with operations similar to historic conditions. Therefore, flow assessment was not used in this analysis.

4.12.2 Recreation at Lake Powell

Threshold elevations below which shoreline recreational facilities at Lake Powell could be affected are identified in Section 3.12, Table 3.12-3. Below these elevations, facility adjustments or capital improvements would be required, creating potential impacts on recreation at Lake Powell. The percentages of values less than or equal to these threshold elevations during the study period are presented in Section 4.3, Figures 4.3-3 through 4.3-11 and Tables 4.3-2 through 4.3-10.

4.12.2.1 Access or Use of Lake Powell Boating Facilities

No Action Alternative. In September 2026, there is a 16 percent chance that the boat launch ramp at Antelope Point marina, located at elevation 3,588 feet msl, would close or need to be modified. In September 2026, there is a seven percent chance that elevations will be less than 3,560 feet msl, resulting in the closure or modification of Wahweap and lower Bullfrog launch ramps. Section 4.3, Table 4.3-7 and Figure 4.3-8 provide data for all years and all alternatives.

Basin States and Conservation Before Shortage Alternatives. In September 2026, there is a 20 percent chance of Closing Antelope Point and a nine percent chance of closing Wahweap launch ramps and a 10 percent chance of closing lower Bullfrog launch ramp under these two alternatives, respectively.

Water Supply Alternative. In September 2026, there is a 35 percent chance of closing Antelope Point launch ramp and a 23 percent chance of closing Wahweap and lower Bullfrog launch ramps under this alternative.

Reservoir Storage Alternative. In September 2026, there is an eight percent chance of closing Antelope Point launch ramp or modifying it, and a three percent chance of closing Wahweap and lower Bullfrog launch ramps under this alternative.

Preferred Alternative. In September 2026, there is a 19 percent chance of closing Antelope Point launch ramp and an eight percent chance of closing Wahweap and lower Bullfrog launch ramps under this alternative.

4.12.2.2 Safe Boating Capacities and Exposure to Navigation Hazards

In general, as reservoir elevations drop, hazards such as submerged snags and boulders can become exposed or become closer to the surface, increasing the likelihood that boats can come in contact with such hazards. The elevations of such hazards are often unknown until the hazards become exposed. At Lake Powell elevation of 3,620 feet msl, hazardous obstructions result in NPS prohibiting boating around Castle Rock and Gregory Butte; data for all years and all alternatives are provided in Section 4.3, Table 4.3-5 and Figure 4.3-6.

No Action Alternative. In September 2026, there is a 28 percent chance NPS would have to prohibit boating around Castle Rock and Gregory Butte due to navigational hazards.

Basin States and Conservation Before Shortage Alternatives. In September 2026, there is a 36 percent and 35 percent chance of boating restrictions around Castle Rock and Gregory Butte under these two alternatives, respectively.

Water Supply Alternative. In September 2026, there is a 52 percent chance of boating restrictions around Castle Rock and Gregory Butte.

Reservoir Storage Alternative. In September 2026, there is a 24 percent chance of boating restrictions around Castle Rock and Gregory Butte.

Preferred Alternative. In September 2026, there is a 32 percent chance of boating restrictions around Castle Rock and Gregory Butte.

4.12.2.3 Lake Powell Sport Fish Populations

The maximum lethal limits of 37°C and 33°C for threadfin shad and striped bass, respectively, would not be exceeded under any of the alternatives. Further, these water temperatures are for the upper ten feet of the reservoir, and lower depths provide cooler water. It is assumed that striped bass and threadfin shad would be able to move into the cooler thermocline during the summer months (Gustaveson 1999). Water temperatures would not drop below the lower lethal limit of 5°C for striped bass or threadfin shad under any alternative. The coldest winter temperature could be 7°C. Because surface temperatures would not exceed the lethal tolerances of either species, and it is assumed that both species would have adequate thermal refugia; substantial temperature-related impacts to the reservoir sport fishery are not anticipated to occur under any of the alternatives.

The general trend for the alternatives indicates that Lake Powell elevations under the Basin States and Conservation Before Shortages alternatives, and the Preferred Alternative, do not differ substantially from the No Action Alternative. Therefore, Lake Powell sport fishing populations are expected to be similar to those under the No Action Alternative for lake sport fish under these three action alternatives. The Water Supply Alternative tends to have lower reservoir elevations, which makes the lake more susceptible to atmospheric temperature influence. The Reservoir Storage Alternative has generally higher Lake Powell elevations as compared to the No Action Alternative, which makes the lake less susceptible to atmospheric temperature influence. However, threadfin shad and striped bass should still be able to survive potential winter and summer temperature variations.

4.12.2.4 Access or Use of Rainbow Bridge

Above Lake Powell elevation of 3,650 feet msl, Rainbow Bridge is visible from the floating walkway and interpretive platforms at Rainbow Bridge National Monument. If Lake Powell elevations fall below 3,650 feet msl, Rainbow Bridge is no longer visible from the lake and the floating walkway and interpretive platforms are removed and stored. Under this circumstance, dock facilities would be moved to a lower elevation and connected to the land trail with a short walkway, and the old land trail through Bridge Canyon (submerged at full pool elevation) would be used. Reservoir elevation data for all years and all alternatives are provided in Section 4.3, Table 4.3-3 and Figure 4.3-4.

No Action Alternative. In September 2026, there is a 43 percent chance that NPS would have to close or modify facilities at Rainbow Bridge.

Basin States and Conservation Before Shortage Alternatives. In September 2026, there is a 58 percent and 57 percent chance that NPS would have to close or modify facilities at Rainbow Bridge under these two alternatives, respectively.

Water Supply Alternative. In September 2026, there is a 61 percent chance that NPS would have to close or modify facilities at Rainbow Bridge.

Reservoir Storage Alternative. In September 2026, there is a 39 percent chance that NPS would have to close or modify facilities at Rainbow Bridge.

Preferred Alternative. In September 2026, there is a 56 percent chance that NPS would have to close or modify facilities at Rainbow Bridge.

4.12.3 Recreation from Glen Canyon Dam to Lake Mead

4.12.3.1 Boating

Current operation of Glen Canyon Dam requires a minimum flow release of 8,000 cfs between 7 a.m. and 7 p.m., and 5,000 cfs at night. Therefore, daytime flows will not drop lower than the safe whitewater boating threshold flow of 5,000 cfs. In addition, flow releases from Glen Canyon Dam will be within the historical operating range. Releases from Glen Canyon Dam would generally be much higher than these minimum flows under all alternatives and hydrological conditions (Section 4.3, Tables 4.3-12 through 4.3-14). Therefore, there would be no change in exposure to unsafe boating conditions caused by change in river levels. Minor changes in exposure to boating navigation hazards caused by change in river velocity; changes in access or use of rest areas and take-out points; changes in trip duration caused by changes in river velocity; or ability to use sport fishing sites caused by change in flows, may occur under all alternatives. These changes would not be substantial and would not affect recreation use or opportunities.

4.12.3.2 Sport Fish Populations

Water temperature data from Lees Ferry, Little Colorado River confluence, and downstream of Diamond Creek gage were used for the Glen Canyon Dam to Lake Mead river reach to compare the No Action Alternative to the action alternatives (Tables P-BCR-1 to P-BCR-3 in Appendix P). Rainbow trout are the major sport fish in this Colorado River reach and they are therefore used for this assessment.

Glen Canyon Dam to Lees Ferry Reach:

- **No Action Alternative.** The historical range of release temperatures from Glen Canyon Dam was relatively stable between 1990 and 2002 and typically ranged from 7°C to 12°C (Section 4.8). These relatively stable cold temperatures were favorable for rainbow trout. Beginning in 2002, the range of release temperatures increased and the higher end of the range approached 16°C (Figure F-5 in Appendix F). Whirling disease was recently discovered in Lees Ferry trout. Research on whirling disease in other states indicates that water temperatures between approximately 10°C and 16°C appear to result in the highest prevalence of whirling disease infection (Montana Fish, Wildlife and Parks 1998). The intermediate host of the parasite that causes whirling disease is the tubifex worm. Water temperatures above and below the optimal range have been observed to reduce infection in trout. Under the No Action Alternative at the 10^{th} percentile, water temperatures have the highest potential to affect spawning, incubation, growth, and mortality of rainbow trout. Average temperatures at Lees Ferry will remain colder than the low end of the preference range for trout growth (less than 12°C) and within the historic range most of the time at Lees Ferry. In summer and fall months at the 10^{th} percentile release, average temperatures may exceed 12°C (Table P-BCR-1 in Appendix P). Average temperatures at Lees Ferry (Table P-BCR-1 in Appendix P) are always above the minimum suitable spawning temperature of 8°C (Table 4.12-1). The coldest months tend to be February, March, and April and average temperatures approach 8°C in these months, particularly at Lees Ferry. During potential egg incubation months of January through August, average temperatures may exceed the maximum temperature preference for incubation in August. Average temperatures at Lees Ferry are not expected to exceed 25°C but will be the warmest in summer and fall months at 10^{th} percentile releases. Temperatures under the No Action Alternative will continue to correspond with the optimal range for whirling disease in some months in the future, as has been occurring more frequently since 2002. However, temperatures could be both above and below the optimal range at certain times (Table P-BCR-1 in Appendix P). Since the parasite can persist in river sediments for a long time, temporary deviations from the ideal temperature range are not likely to result in eradication of this fish parasite once it is established in a particular river. Therefore, temperatures will continue to favor whirling disease downstream of Glen Canyon Dam into the future under the No Action Alternative. Overall, rainbow trout are expected to continue to persist downstream of Glen Canyon Dam under the No Action Alternative, though occasionally temperatures may be less than ideal for certain life history stages and parasites, as has occurred more often since 2002. Substantial impacts to the aquatic foodbase are not anticipated (Section 4.8).

- **Action Alternatives.** While the action alternatives as compared to the No Action Alternative are similar, the 10th percentile water temperatures show a potential slight warming trend for all of the alternatives except the Reservoir Storage Alternative. Under the Reservoir Storage Alternative, the 10th percentile average temperatures are above the minimum for growth (12°C) from July through November, which is similar to the No Action Alternative, though temperatures in these months remain lower than the No Action Alternative. The Water Supply Alternative shows the most potential warming but average water temperatures do not exceed the preferred growth temperature. Growth temperatures under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, are similar to those under the No Action Alternative. During the potential egg incubation period of January through August, the high end of the egg incubation temperature preference range (15°C) may be exceeded in July and August under the Basin States, Conservation Before Shortage, and Water Supply alternatives (Table P-BCR-1 in Appendix P). The Reservoir Storage Alternative, and the Preferred Alternative may exceeded incubation preferences in August. These higher average temperatures during the potential incubation period could cause egg mortality to a similar degree as under the No Action Alternative. The severity of egg mortality would depend on the duration of water temperatures above the limits for incubation, which is not known. Lethal limits for rainbow trout are not exceeded in any month for any action alternative. The Water Supply Alternative has the highest potential temperatures and thus may result in a shorter spawning season. Potential temperature effects on whirling disease under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, are similar to those under the No Action Alternative. The Water Supply Alternative has the warmest potential temperatures and could result in more often favorable conditions for whirling disease infection, though also a higher likelihood of temperatures too warm to favor whirling disease. The Reservoir Storage Alternative has the coldest temperatures and thus could be less likely to favor whirling disease infection. Substantial impacts to the aquatic foodbase are not anticipated (Section 4.8).

Little Colorado River Confluence:

- **No Action Alternative.** Under the No Action Alternative, the 10th percentile water temperatures were compared against the preferred water temperatures for spawning, incubation, growth and mortality of rainbow trout. From December through April average temperatures may be below the preferred ranges for growth (Table P-BCR-2 in Appendix P). Average temperatures are within the tolerance ranges for spawning during the spawning season and mortality for all months (Table P-BCR-2 in Appendix P). Average temperatures during the egg incubation period may exceed the temperature tolerance in July and August. Temperatures are within the ideal range for whirling disease in many months, though both warmer and colder than the ideal range sometimes. Conditions for whirling disease will be similar to those under the No Action Alternative for Lees Ferry.

- **Action Alternatives.** While the action alternatives as compared to the No Action Alternative are similar, the 10th percentile water temperatures show a slight potential warming trend for all of the alternatives except the Reservoir Storage Alternative, which is slightly cooler. The Water Supply Alternative shows the most potential warming and may exceed spawning temperatures in May (Table P-BCR-2 in Appendix P). Therefore, the Water Supply Alternative could potentially provide the shortest spawning season. Average temperatures under the remaining action alternatives remain suitable for spawning and are similar to those under the No Action Alternative, though the spawning season could be shortened in some years due to the warming trend of the remaining action alternatives. Warmer temperatures under the Water Supply Alternative would benefit trout growth, while the colder temperatures under the Reservoir Storage Alternative would reduce trout growth. The remaining action alternatives would result in growth conditions similar to those under the No Action Alternative. During the egg incubation period, the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, may exceed the egg incubation tolerance in June through August. The colder temperatures under the Reservoir Storage Alternative would only exceed this threshold in July and August. The severity of egg mortality would depend on the duration of water temperatures above the limits for incubation, which is not known. Lethal limits for rainbow trout are not exceeded in any month under any action alternative. Under all the action alternatives, temperatures are projected to be both within, above and below the ideal range for whirling disease. Temperature conditions for whirling disease under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative, are similar to those under the No Action Alternative. Temperature conditions for whirling disease under the Water Supply and Reservoir Storage Alternatives relative to the No Action Alternative are similar to the description for Lees Ferry, though the Reservoir Storage Alternative is above the ideal whirling disease range more often than others at Lees Ferry.

Diamond Creek:

- **No Action Alternative.** Under the No Action Alternative for Diamond Creek, the 10th percentile water temperatures show that from December through March average temperatures may be below the suitable range for growth. Higher average temperatures in May could exceed the temperature tolerance for spawning of 13°C (Table P-BCR-3 in Appendix P). Egg incubation temperatures may be exceeded in May through August and reduce reproductive success. Lethal water temperatures may be reached in the summer under the No Action Alternative though average temperatures remain below 25°C and it is anticipated that fish would be able to find thermal refugia.

- **Action Alternatives.** While the action alternatives as compared to the No Action Alternative are similar, the 10th percentile water temperatures show a potential warming trend for all of the alternatives, except for the Reservoir Storage Alternative. All of the action alternatives may meet or exceed spawning temperatures in April and May and exceed the egg incubation temperatures from May through August (Table P-BCR-3 in Appendix P). The Water Supply and Reservoir Storage Alternatives may potentially provide the shortest and longest spawning seasons, respectively, of the alternatives. The severity of egg mortality due to warmer temperatures would depend on the duration of water temperatures above the limit for incubation, which is not known. All of the action alternatives result in average temperatures from December through March that are below the threshold for trout growth, though similar to those under the No Action Alternative. The Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, could result in average temperatures above the growth threshold (21°C) for trout in some months (Table P-BCR-3 in Appendix P). Overall, the Water Supply Alternative would result in the least favorable conditions for trout, while the Reservoir Storage Alternative would result in the best conditions. Lethal water temperatures above 25°C may be reached in July, August and September, though the average temperatures would remain below this threshold. These summer high temperatures would be greater than those under the No Action Alternative for these months except for the Reservoir Storage Alternative. However, juvenile and adult fish are able to find thermal refugia by moving upstream into cooler water habitats such as pools and may not be substantially affected by warmer water temperatures. Further, Diamond Creek is not as important for trout as Lees Ferry is.

4.12.4 Recreation at Lake Mead

Threshold elevations below which shoreline recreational facilities at Lake Mead could be affected are identified in Section 3.12, Table 3.12-7. Facility adjustments or capital improvements would be required below these elevations, creating potential impacts on recreation at Lake Mead. The percentages of values less than or equal to these thresholds during the study period are provided in Section 4.3, Figures 4.3-18 through 4.3-23 and Tables 4.3-18 through 4.3-23.

4.12.4.1 Access or Use of Lake Mead Boating Facilities

No Action Alternative. In July 2026, there is a 74 percent probability that Lake Mead elevations may be lower than 1,175 feet msl, resulting in the closure of the Pearce Bay launch ramp and the addition of another 16 miles that boaters would have to travel downstream to take-out (Section 4.3, Table 4.3-18 and Figure 4.3-18). The Echo Bay public launch ramp would close at elevation 1,050 feet msl (Section 4.3, Figure 4.3-22 and Table 4.3-22). In July 2026, there is a 30 percent chance that this facility would close under the No Action Alternative.

Basin States and Conservation Before Shortage Alternatives. In July 2026, there is a 76 and 75 percent chance of closing the Pearce Bay launch ramp under these two alternatives, respectively. In July 2026, there is a 23 percent chance under both of these alternatives that the Echo Bay public launch ramp would close due to low reservoir elevations.

Water Supply Alternative. In July 2026, there is a 78 percent chance of closing the Pearce Bay launch ramp. In July 2026, there is a 29 percent chance that the Echo Bay public launch ramp would close due to low reservoir elevations.

Reservoir Storage Alternative. In July 2026, there is a 66 percent chance of closing the Pearce Bay launch ramp and adding 16 miles to river trips. In July 2026, there is a nine percent chance that the Echo Bay public launch ramp would close.

Preferred Alternative. In July 2026, there is a 74 percent chance of closing the Pearce Bay launch ramp. In July 2026, there is a 21 percent chance that the Echo Bay public launch ramp would close.

4.12.4.2 Safe Boating and Navigation Hazards

Over the years, sediment has built up in the section of the reservoir between Grand Wash Cliffs and Pearce Ferry. When Lake Mead elevation drops below 1,170 feet msl, there is no well-defined river channel in this upper portion of Lake Mead, making it dangerous for boaters (NPS 2005a).

No Action Alternative. In July 2026, there is a 73 percent probability that boaters may encounter navigational hazards in upper Lake Mead (Section 4.3, Figure 4.3-19 and Table 4.3-19).

Basin States and Conservation Before Shortage Alternatives. In July 2026, there is a 73 percent probability that boaters may encounter navigational hazards in upper Lake Mead.

Water Supply Alternative. In July 2026, there is a 76 percent probability that boaters may encounter navigational hazards in upper Lake Mead.

Reservoir Storage Alternative. In July 2026, there is a 64 percent probability that boaters may encounter navigational hazards in upper Lake Mead.

Preferred Alternative. In July 2026, there is a 72 percent probability that boaters may encounter navigational hazards in upper Lake Mead.

4.12.4.3 Sport Fish Populations

No Action Alternative. Rainbow trout and razorback suckers are raised in the Lake Mead Fish Hatchery by Nevada Department of Wildlife (NDOW). NDOW obtains its water supply for the fish hatchery from Lake Mead. This water comes from the Basic Management, Inc. (BMI) intake at reservoir elevation of 1,060 feet msl. Under recent conditions, the hatchery has experienced problems with water temperature and total dissolved solids in its water from the intake (Parke 2006). Water temperature taken at the intake is approximately 24°C, which is too warm for trout. NDOW has noticed that the increase in water temperatures start when Lake Mead's elevation is less than 100 feet above the BMI intake (elevation 1,160 feet msl and less). The 50th and 10th percentile monthly elevations are never above 1,160 feet msl so temperature problems are likely to persist for future hatchery operations. The 90th percentile elevations are identical for all alternatives and would alleviate the hatchery's temperature problems. The 50th percentile elevations are always above 1,060 feet msl, but the 10th percentile elevations for all alternatives fall below 1,060 feet msl in the future. Thus, the hatchery may have water supply problems at the 10th percentile elevation values.

The situation for striped bass and threadfin shad in Lake Powell is expected to be similar at Lake Mead. However, threadfin shad are near the northern limit of their range at Lake Powell. Threadfin shad are less likely to be affected by cold winter temperatures at Lake Mead.

Action Alternatives. The Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative, would be similar to the No Action Alternative. The Reservoir Storage Alternative is the most beneficial to the hatchery's water supply and the Water Supply Alternative would have the most adverse effects on water temperature. Effects on threadfin shad and striped bass are expected to be similar to the effects at Lake Powell, and substantial temperature-related impacts to the reservoir sport fishery are not anticipated to occur under any of the alternatives.

4.12.5 Recreation from Hoover Dam to SIB

Flow releases from Hoover Dam, Davis Dam, Parker Dam, and Imperial Dam will all be within historical operating range. Therefore, there would be minimal changes in exposure to boating navigation hazards caused by changes in river elevation; changes in exposure to boating navigation hazards caused by changes in river velocity; changes in access or use of rest areas and take-out points; changes in trip duration caused by changes in river velocity; or decrease in access or use of sport fishing sites caused by changes in flows. The sport fishery in this reach is primarily in warm water. The minor changes in water temperatures that may occur downstream of Hoover Dam are not expected to affect warm water sport fish.

4.12.6 Summary

4.12.6.1 Shoreline Facilities

For shoreline public use facilities at Lake Powell, there is a 16 percent chance that the launch ramp at Antelope Point marina would close or need to be modified under the No Action Alternative. Under the Preferred Alternative, the chance is 19 percent. There is a three to 10 percent probability that the Wahweap and lower Bullfrog launch ramps may close in 2026 under the No Action Alternative, the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative, while under the Water Supply Alternative there is a 23 percent probability of this occurrence. Other marinas and launch ramps are similarly affected under the different alternatives.

There is a 43 percent probability under the No Action Alternative that in 2026 NPS would have to close or modify recreational facilities at the Rainbow Bridge National Monument. The probability of facility closures under the action alternatives would be 39 to 61 percent.

At Lake Mead, under all of the alternatives there is a 74 to 78 percent probability that the Pearce Bay launch ramp would be closed to boaters, except under the Reservoir Storage Alternative this probability is 66 percent. Similarly, there is a 21 to 30 percent probability of closure of the Echo Bay public launch ramp (in the north end of the reservoir) under all of the alternatives, except under the Reservoir Storage Alternative this probability is nine percent.

4.12.6.2 Safe Boating and Navigation

For safe boating at Lake Powell, probabilities range from 24 to 28 percent that NPS would have to prohibit boating around Castle Rock and Gregory Butte under the No Action Alternative and the Reservoir Storage Alternative. Under the Basin States Alternative there is a 36 percent probability and under the Conservation Before Shortage Alternative there is a 35 percent probability that boating prohibitions would need to be put in place. Under the Water Supply Alternative the probability of this occurrence is 52 percent. Under the Preferred Alternative there is a 32 percent probability that prohibitions would be put in place. For Lake Mead, all the alternatives except the Reservoir Storage Alternative in July 2026 provide a 72 to 76 percent probability that boaters may encounter navigational hazards upstream end of Lake Mead due to reservoir elevations being drawn down to below 1,170 feet msl. Under the Reservoir Storage Alternative there is a 69 percent probability of a similar recreational impact. Similar effects would occur in the Overton Arm of Lake Mead.

For whitewater boating through Grand Canyon, the Glen Canyon Dam ROD flows will be maintained. Even in a 7.0 maf Glen Canyon Dam release year, the minimum daily flow will remain at or above 5,000 cfs, a safe boating threshold.

4.12.6.3 Sport Fish Populations

Sport fish populations would not be adversely affected at Lake Powell under any of the alternatives. Although surface water temperatures may approach lethal levels in the upper 10 feet of the reservoir under any alternative, lethal levels for striped bass and threadfin shad are not expected to be exceeded by any alternative. Moreover, cooler temperatures below the lake surface would serve as a refuge for the fish. The situation for striped bass and threadfin shad in Lake Mead is similar to Lake Powell. Higher water temperatures could impair the Lake Mead Fish Hatchery, particularly under the Water Supply Alternative.

Under the No Action Alternative, 10^{th} percentile temperatures are suitable for growth, spawning, and incubation in the months presented in Table 4.12-2. Higher water temperatures under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, could affect various life history stages of rainbow trout downstream of Glen Canyon Dam. Under the action alternatives, 10^{th} percentile modeling results indicate that there could be minor impacts to rainbow trout due to warmer temperatures. The Water Supply Alternative shows the most warming and potential to negatively impact trout. The Reservoir Storage Alternative shows the least warming and will often result in colder temperatures than the No Action Alternative. Conditions for trout under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, will be similar to slightly worse than under the No Action Alternative.

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4.13 Transportation

This section describes the methods of analysis and potential effects on transportation, focusing on ferry services and river taxis.

4.13.1 Methodology

4.13.1.1 Effects on Lake Powell Ferry Service

The John Atlantic Burr Ferry becomes inoperable when Lake Powell elevation falls below 3,550 feet msl, requiring additional driving of approximately 130 miles between the Bullfrog and Halls Crossing marinas. Consequently, for each action alternative, the analysis evaluates the probability of the ferry becoming inoperable and compares that to the probability under the No Action Alternative. These comparisons were based on Lake Powell end-of-September elevations between 2008 through 2060 (Table 4.13-1, Figure 4.3-10, and Table 4.3-9).

4.13.1.2 Effects on Laughlin River Taxis and Tour Boats

Changes in releases from Davis Dam have the potential to impact the operations of river taxi services and tour boats in Laughlin, Nevada. The projected discharges or flows were compared to the flows required by the river taxis and the tour boats.

4.13.1.3 Effects on Lake Havasu Ferry Service

Changes in Lake Havasu elevations could affect the existing ferry service and recreational uses. Effects of changes in Lake Havasu elevations on recreational uses are discussed in the recreational impacts discussion (Section 4.12). The discussion presented below is limited to the potential effects on ferry service provided on Lake Havasu.

4.13.2 Lake Powell Ferry Service

Table 4.13-1 lists the range of probabilities of Lake Powell elevations being less than or equal to 3,550 feet msl for each alternative. An analysis for each alternative is provided below.

Table 4.13-1
Range of Probabilities (percent) of Lake Powell Elevations Less Than or Equal 3,550 feet msl

Alternative	2008 through 2026	2026 through 2060
No Action	0 to 5	4 to 7
Basin States	0 to 7	5 to 7
Conservation Before Shortage	0 to 7	5 to 7
Water Supply	0 to 17	8 to 17
Reservoir Storage	0 to 3	1 to 7
Preferred Alternative	0 to 7	5 to 7

4.13.2.1 No Action Alternative

The likelihood that Lake Powell elevations would fall below 3,550 feet msl under the No Action Alternative is not greater than seven percent for all years (zero to seven percent; Table 4.13-1, Figure 4.3-10, and Table 4.3-9). Consequently, the Lake Powell ferry service would be able to operate 93 percent or more of the time under the No Action Alternative.

4.13.2.2 Basin States Alternative

The Basin States Alternative would result in very similar or slightly higher probabilities (zero to seven percent) of Lake Powell elevations being less than 3,550 feet msl when compared to the No Action Alternative for the period 2008 through 2026 (Table 4.13-1, Figure 4.3-10, and Table 4.3-9). For the period 2026 through 2060, the Basin States Alternative would result in similar or slightly higher probabilities (five to seven percent) as compared to the No Action Alternative. The net effect under this alternative is minor.

4.13.2.3 Conservation Before Shortage Alternative

The Conservation Before Shortage Alternative would result in very similar or slightly higher probabilities (zero to seven percent) of Lake Powell elevations being less than 3,550 feet msl when compared to the No Action Alternative for the period 2008 through 2026 (Table 4.13-1, Figure 4.3-10, and Table 4.3-9). For the period 2026 through 2060, the Conservation Before Shortage Alternative would result in similar or slightly higher probabilities (five to seven percent) as compared to the No Action Alternative. The net effect under this alternative is minor.

4.13.2.4 Water Supply Alternative

The Water Supply Alternative would result in similar or higher probabilities (zero to 17 percent) of Lake Powell elevations being less than 3,550 feet msl when compared to the No Action Alternative for the period 2008 through 2026 (Table 4.13-1, Figure 4.3-10, and Table 4.3-9). For the period 2026 through 2060, the Water Supply Alternative would result in higher probabilities (eight to 17 percent) as compared to the No Action Alternative. The net effect under this alternative is moderately adverse.

4.13.2.5 Reservoir Storage Alternative

The Reservoir Storage Alternative would result in similar or slightly lower probabilities (zero to three percent) of Lake Powell elevations being less than 3,550 feet msl compared to the No Action Alternative for the period 2008 through 2026 (Table 4.13-1, Figure 4.3-10, and Table 4.3-9). For the period 2026 through 2060, the Reservoir Storage Alternative would result in similar or slightly lower probabilities (one to seven percent) as compared to the No Action Alternative. The net effect under this alternative is beneficial.

4.13.2.6 Preferred Alternative

The Preferred Alternative would result in similar or slightly higher probabilities (zero to seven percent) of Lake Powell elevations being less than 3,550 feet msl compared to the No Action Alternative for the period 2008 through 2026 (Table 4.13-1, Figure 4.3-10, and Table 4.3-9). For the period 2026 through 2060, the Preferred Alternative would result in similar or slightly higher probabilities (five to seven percent) as compared to the No Action Alternative. The net effect under the Preferred Alternative is minor.

4.13.3 Laughlin River Taxis and Tour Boats

The minimum future flow under the No Action Alternative and under the action alternatives will continue to be 2,300 cfs, the minimum flow needed to run one turbine of the Davis Powerplant at about one-half capacity. The duration of flows in the 2,300 to 4,600 cfs range would not be affected by the proposed federal action. However, the duration of flows in the 4,600 cfs to 9,200 cfs range may be affected by the proposed federal action. For example, due to changes in annual releases, the duration of hourly flows in the 4,600 to 9,200 cfs range may increase during some days under the Water Supply Alternative and decrease during some days under the Reservoir Storage Alternative. These changes have a minor effect on transportation. The duration of hourly flows in the 4,600 cfs to 9,200 cfs range under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative are expected to be nearly the same as those under the No Action Alternative.

4.13.4 Lake Havasu Ferry Service

Lake Havasu will continue to be operated to meet monthly elevation targets; therefore, adoption of any of the alternatives would not affect the operation of the Lake Havasu ferry service.

4.13.5 Summary

For the Lake Powell ferry, the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative would have minor effects on ferry service; the Water Supply Alternative could result in potential moderate adverse effects; and the Reservoir Storage Alternative could have beneficial effects. The probability varies from year to year, but there is up to a 17 percent probability that the Lake Powell ferry may become inoperable under the Water Supply Alternative for some period of time. Conversely, the ferry would remain operable with the highest probabilities and greatest durations of time under the Reservoir Storage Alternative.

For the Colorado River ferry service downstream of Davis Dam, only under the Reservoir Storage Alternative are there any measurable effects and these potential effects would be minor. The other action alternatives show no difference from the No Action Alternative.

The Lake Havasu ferry service would be unaffected under all of the action alternatives.

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4.14 Socioeconomics

This section describes the potential impacts of the proposed federal action with respect to socioeconomics and describes the methods used to determine and analyze those impacts. Included in this analysis are the potential impacts to employment, income and tax revenue due to changes in agricultural production. Also included are the potential socioeconomic impacts to M&I and recreation uses. The study area and issues associated with these resources are described in Section 3.14. Additional details on the assessment of the socioeconomic effects is provided in Appendix H. Cumulative impacts related to socioeconomics use are discussed in Chapter 5.

4.14.1 Methodology

This section describes the methods used to estimate the effects on socioeconomics resulting from the proposed federal action. The assessment focused on estimating the socioeconomic effects that might occur as a result of potential changes in agricultural production, reservoir-related and river-related recreation, and the change in M&I water availability.

4.14.1.1 Agriculture

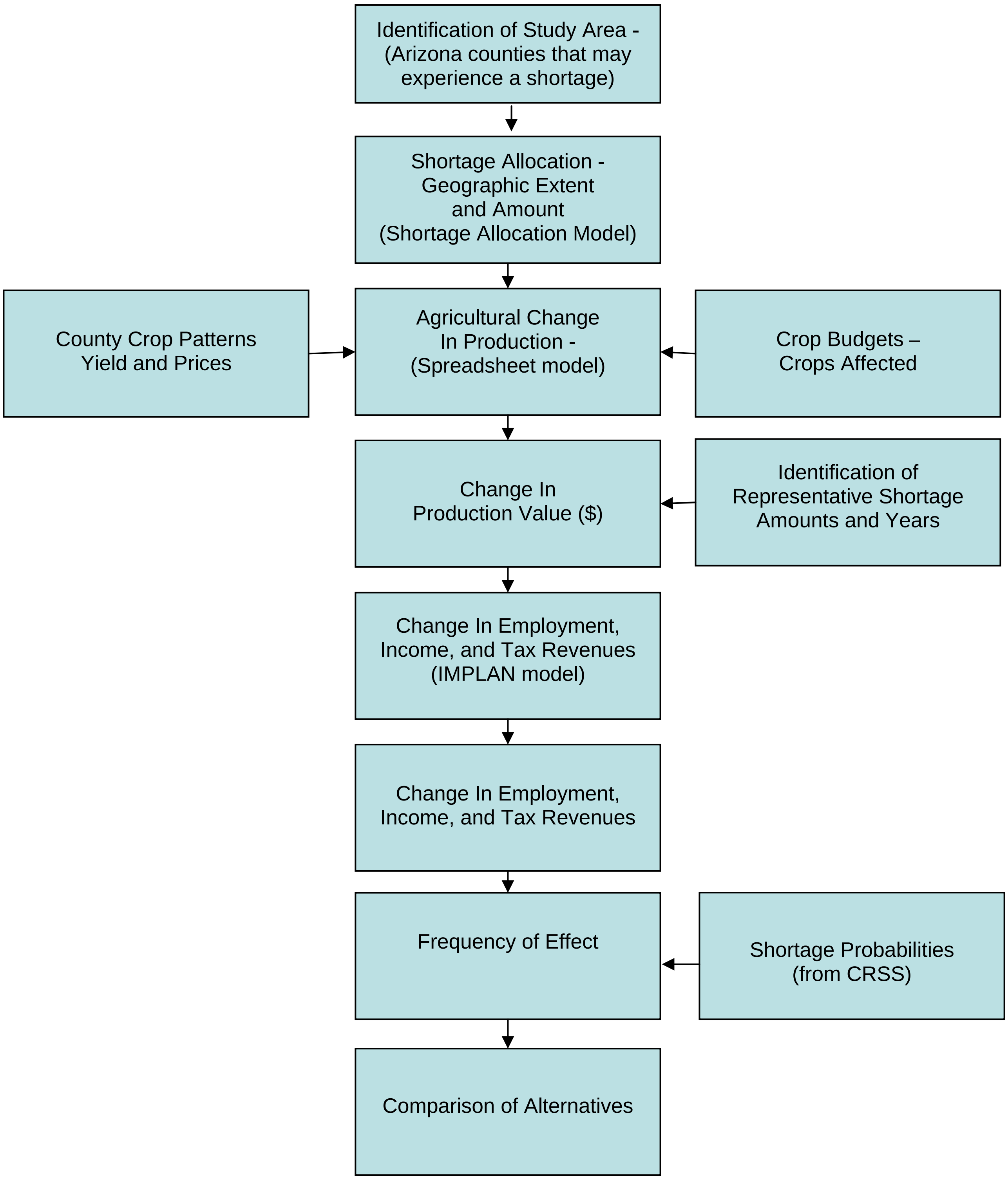
The potential socioeconomic effects due to changes in agricultural production were quantitatively assessed for Arizona agricultural districts and the corresponding counties that would likely experience shortages (i.e., within the CAP service area and the 4th priority agricultural use along the river). An assessment of potential socioeconomic effects due to changes in agricultural production in Nevada was not necessary since shortages of the magnitudes generated by the alternatives would only affect the M&I sector. An assessment of potential socioeconomic effects in California was also not necessary since shortages of the magnitudes generated by the alternatives would primarily affect the M&I sector. Shortages of significant magnitude that would affect agricultural users in California were observed to be very unlikely to occur, and if shortages of this nature occurred, the result would be limited to insignificant reductions in water use relative to California agricultural entitlements.

The quantitative assessment was conducted in three major steps:

- ♦ estimating changes in agricultural production as the result of reduced water deliveries;
- ♦ estimating the potential changes in employment, income, and tax revenue as a result of reduced water deliveries; and
- ♦ applying the shortage probabilities for a particular shortage amount and year to assess the likelihood that the potential changes would occur.

Figure 4.14-1 provides an overview of the steps followed in conducting the assessment of changes in agricultural production and resulting changes in employment, income, and tax revenues.

Figure 4.14-1
Steps in Analyzing Changes in Agricultural Production
and Resulting Changes in Employment, Income, and Tax Revenue



Estimating Changes in Agricultural Production Value:

Involuntary Shortages. The purpose of the impact assessment for agriculture is to estimate the change in agricultural production values as a result of the proposed federal action. Specifically, this section focuses on the incidence of these impacts on non-Indian and Indian agricultural production in Pinal, Maricopa, Pima, Mohave, La Paz, and Yuma counties for 2008, 2017, 2026, 2027, 2040, and 2060. The six counties were selected because the agricultural districts that may experience shortages are located within these counties. Impacts to agriculture in the six-county area were examined by observing modeled changes in industry output and acreage of fallowed lands for agriculture. The years 2008, 2017, and 2026, were selected because they represent the beginning, midpoint, and end of the interim period. The years 2027, 2040, and 2060 were selected because they represent the beginning, midpoint, and end of the remaining period of analysis.

The objectives of this study were to quantify potential:

- changes in agricultural production for various levels of shortage; and
- amounts of fallowed land for various levels of shortage.

Key to this impact analysis is the assumption that the most conservative way to estimate impacts is to assume that, if a shortage occurs, farmers would react by fallowing irrigated lands. The decision to fallow lands would rest on the ability of the farmer to cover the variable costs of production for crops grown in the study area. These assumptions are discussed in more detail later in this section.

While fallowing of lands may occur during shortages, there are other sources of water that may be used by farmers in order to offset shortages. For example, a farmer may have a groundwater well available and may be able to mitigate shortages in surface water supply by pumping additional groundwater. Other farmers may be able to take delivery of groundwater that is recovered from a groundwater bank. It is difficult to project exactly how individual farmers, irrigation districts, or each of the Lower Division states may mitigate potential, future agricultural impacts from shortages. Therefore, for the purposes of this analysis, the projected change in agricultural production was based on the conservative assumption that other sources of water would not be available.

The potentially affected crops considered included cotton, wheat, alfalfa, vegetables and melons, and trees and vines. The primary focus is on cotton, wheat, and alfalfa because these crops have lower earnings per acre-foot of water than fruit, vegetable, and nut crops and, therefore, are more vulnerable to changes in water costs and shortages. Farm budgets were developed for cotton, wheat, and alfalfa to determine the maximum water cost a farmer can pay and still produce a particular crop. These budgets represent a generalization of the variable production costs for a particular crop exclusive of water costs. When the cost of water exceeds the maximum water cost a farmer can pay or if water is not available, a crop is taken out of production and the land is fallowed for the year in which a shortage occurs. The data from all of the model runs for the action alternatives were compared to those of the No Action Alternative.

General Assumptions and Data Sources:

Crop Patterns, Yields, and Prices. Crop patterns, yield per acre, and prices were assumed to remain constant for non-Indian and Indian agricultural output for all alternatives during the study period. Crop patterns for the CAP and other irrigation districts in this study are based on historical crop patterns that were reported by irrigation districts to Reclamation for the years 1999 through 2004. These data were averaged and aggregated at the county level for the impact analysis. Cropping patterns for Indian agriculture come from a variety of sources and may be incomplete. Accordingly, it was assumed that cropping patterns on Indian lands were similar to that of nearby irrigation districts. Appendix H includes information on cropping patterns for CAP and other irrigation districts.

Yield data was based on five-year average county-level yields for the period 2000 through 2005. Prices are based on five-year average statewide prices for Arizona for the period 2000 to 2005. The yield and price data are published by the USDA's National Agricultural Statistics Service (NASS) for Arizona. Information on county-level yield and price data is provided in Appendix H.

Water Costs. The cost of water used in the analysis of agricultural impacts is a blended cost that reflects the price of CAWCD excess water pools, groundwater pumping, and other water. The price of CAWCD excess water was obtained directly from the CAWCD. Cost estimates for groundwater pumping and other water were obtained from various irrigation districts. These data were aggregated to a county-level basis for use in the agricultural impacts analysis. The blended cost of water data for each county is included in Appendix H.

Crop Budgeting and Impacts upon Crop Selection due to Water Cost and Water Shortages. Crop budgets were developed to determine the crop types that would be affected as a result of water shortages. A detailed description of how the crop budgets were developed is included in Appendix H.

Assessment of Changes in Agricultural Production. It is assumed that the agricultural impacts for involuntary shortages are the same for various levels of shortage for each alternative. As an example, a 600,000 af shortage occurring under the Reservoir Storage Alternative would result in the same change in agricultural production as a 600,000 af shortage occurring under the Basin States Alternative. Shortages may occur more or less frequently under various alternatives, but the change in agricultural production during a particular volume of shortage was assumed to be the same across the alternatives. This is due to the modeling assumptions made with regard to how shortages might be distributed to various water users (Section 4.2, Appendix A, and Appendix G). These assumptions are the same across all alternatives. Changes in agricultural production and resulting changes in production value due to voluntary shortages would likely be different than the changes due to involuntary shortages, discussed in additional detail below.

Output from Reclamation's Shortage Allocation Model (Section 4.2 and Appendix G) was used as input for assessing changes in agricultural production during the involuntary fallowing of agricultural lands. The various levels of shortage were input into the model and the amount of shortage that would be allocated to various agricultural users was generated. These results were aggregated on a county-level basis for use in the agricultural impacts analysis.

Impacts for both non-Indian and Indian agriculture were analyzed independently. For both analyses, the shortage allocated to non-Indian and Indian water users in each county for various levels of overall shortage were input into a spreadsheet model developed by Reclamation that estimates changes in agricultural production and production value. Model input includes output from the partial crop budgets, the amount of available surface water in each county, county-wide shortage amounts from the water allocation model, the amount of water applied per acre for each crop, and county-wide water distribution patterns with respect to cotton, wheat, and alfalfa production. Based on the amount of shortage realized in each county, the model estimates the amount of land that would be fallowed using the relative profitability of each crop. The model assumes that the least profitable crops are fallowed first. Once all of the irrigated land associated with the least profitable crop is fallowed, the model assumes that fallowing of the next-least profitable crop would commence. The irrigated acreage associated with fallowing is estimated based on the amount of water allocated to various crops and the crop water use per acre associated with those crops. The resulting direct economic impacts are calculated by multiplying the number of acres fallowed for various crops by the gross output for those crops.

The federal government has reserved a volume of CAP water in the range of 47,000 to 67,000 af for future water settlements. At some time, this water may be allocated to tribes in Arizona for agricultural or M&I use. Once allocated, this water would potentially be vulnerable to shortages. However, it is not known where or when this water may be allocated. Because of this uncertainty, the reserved federal government water has not been included in the analysis.

Shortages. The partial farm budgets used in the analysis of involuntary shortages are a potential means to estimate the minimum amount of compensation a farmer would accept to fallow agricultural ground. However, compensation rates included in recently established fallowing programs do not reflect these minimum amounts. It appears that market forces have contributed significantly to the compensation rates paid in fallowing programs for conserved water. As a result, available data from several fallowing programs were used to estimate a range of costs for conserved water and to estimate potential amounts of land that would be fallowed under various levels of shortage.

Data from several sources suggest that fallowing agricultural lands would result in a reduction in the consumptive use of water ranging between 4.2 and 6.9 af per acre (Colby et al. 2006). The amount of acreage that would be fallowed would be dependent on the crops grown and the consumptive use of those crops. However, again, it is difficult to project which irrigators or districts would fallow their land and what crops would not be grown. In lieu of attempting to project the crops that would not be grown, for the purposes of this study, it was assumed that the amount of fallowed land per acre-foot of conserved water would be similar to the range shown above. It was assumed that all of the potentially conserved water results from agricultural water conservation.

Voluntary shortages may result in a beneficial effect on farmers rather than a detriment. The minimum amount of water a farmer would likely accept would be at a break-even price. However, given the demand for water conservation under voluntary shortages, a farmer would be less likely to accept a minimum payment and would be more likely to attempt to maximize economic gain.

Implementation of voluntary shortages is the focus of the Conservation Before Shortage Alternative. The water conservation (voluntary shortage) prior to involuntary shortage included in this alternative assumes that farmers would be compensated to initiate voluntary water conservation measures. These conservation measures could be implemented in a variety of ways such as on-farm efficiency improvements, canal lining, etc. It is, however, difficult to project what actions individual farmers or irrigation districts might take in the future to conserve water. Land fallowing programs have frequently been used as a means to voluntarily conserve water and fallowing would likely result in the most significant impacts with regard to land use. For the purposes of this study, it is assumed that land fallowing would be the means of conserving water for the Conservation Before Shortage Alternative.

Estimating Changes in Employment, Income, and Tax Revenue. The socioeconomic effects of changes in agricultural production in Arizona were analyzed using the IMPLAN model. IMPLAN is a regional economic model that describes the flows from producers to intermediate and final consumers using a series of economic multipliers. The IMPLAN model describes for each county the transfers of money between all industries and institutions. This model of county-level economic interactions is used to project, using the input-output multipliers, total regional economic activity based on a change in expenditures.

In addition to the direct loss in agricultural output, reduced expenditures occur from a drop in business-to-business purchases and in reduced household expenditures. These changes, known as indirect and induced economic effects were also estimated using IMPLAN. The resulting socioeconomic effects were quantified as changes in employment, income, and tax revenue.

The qualitative assessment for changes in agricultural production and resulting changes in employment, income, and tax revenues was based on the probability of shortages occurring in the agricultural sector in California and Nevada.

4.14.1.2 Municipal and Industrial Water Uses

The potential socioeconomic consequences of shortages occurring in the M&I sector were qualitatively assessed for Arizona, California, and Nevada. The effects were qualitatively assessed because it was not known to what degree a specific economic sector considered an M&I use would be affected. The analysis was based on the shortage amounts and shortage allocations reported in Section 4.4.

The analysis first examined the probability of a range of water shortages occurring in different years. The shortages analyzed included 400,000 af, 500,000 af, 600,000 af, 800,000 af, 1 maf, 1.2 maf, 1.8 maf, and 2.5 maf. Consistent with the assessment of the effects to agriculture, the M&I analysis examined years 2008, 2017, 2026, 2027, 2040, and 2060 for each of the shortage amounts.

The analysis focused on those years and shortage levels having the highest probability of occurrence and where the probability was substantially different under the action alterative compared to the No Action Alternative. The analysis then examined whether a particular shortage event would affect the M&I sector as compared to the No Action Alternative. For example, a shortage in Arizona would affect the agricultural sector first. In contrast, a shortage in Nevada would affect M&I, primarily because Nevada has a small agricultural sector that is dependant on Colorado River water.

For situations likely to have an effect on the M&I sector, the ability of each state to manage shortages to the M&I sector were analyzed. The M&I shortages allocated to each state were compared to the drought plans or actions that state or local agencies could institute during a shortage. The analysis then qualitatively discussed whether such drought planning mechanisms are adequate to address shortages to the M&I sector.

4.14.1.3 Recreation

The recreation-related socioeconomic effects resulting from changes in Lake Powell and Lake Mead elevations and flows in the Colorado River downstream of Lake Powell and Lake Mead were qualitatively assessed. The conclusions regarding the extent of changes in reservoir elevations and river flows reported in Section 4.3 and recreation opportunities reported in Section 4.12 were used to help determine the magnitude of socioeconomic effects.

Lake Powell and Lake Mead. The assessment of changes in recreation-related economic activity was based on changes in Lake Powell and Lake Mead elevations. Particular months representative of the primary recreational season were selected for each lake to analyze the potential elevation changes (September for Lake Powell; July for Lake Mead).

Figure 4.14-2 depicts the end-of-September Lake Powell elevations and Figure 4.14-3 depicts the end-of-July Lake Mead elevations used in this analysis. The years considered in the assessment are 2008, 2016, 2026, and 2060. For each year, lake elevations for each alternative were compared to the No Action Alternative. This comparison was conducted for the 90th, 50th, and 10th percentiles as shown in Figures 4.14-2 and 4.14-3.

Colorado River Downstream of Lake Powell and Lake Mead. The assessment of socioeconomic effects as a result of changes in recreation-related economic activity was based on the results of the recreation assessment. The results of this assessment are provided in Section 4.12.

Figure 4.14-2
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

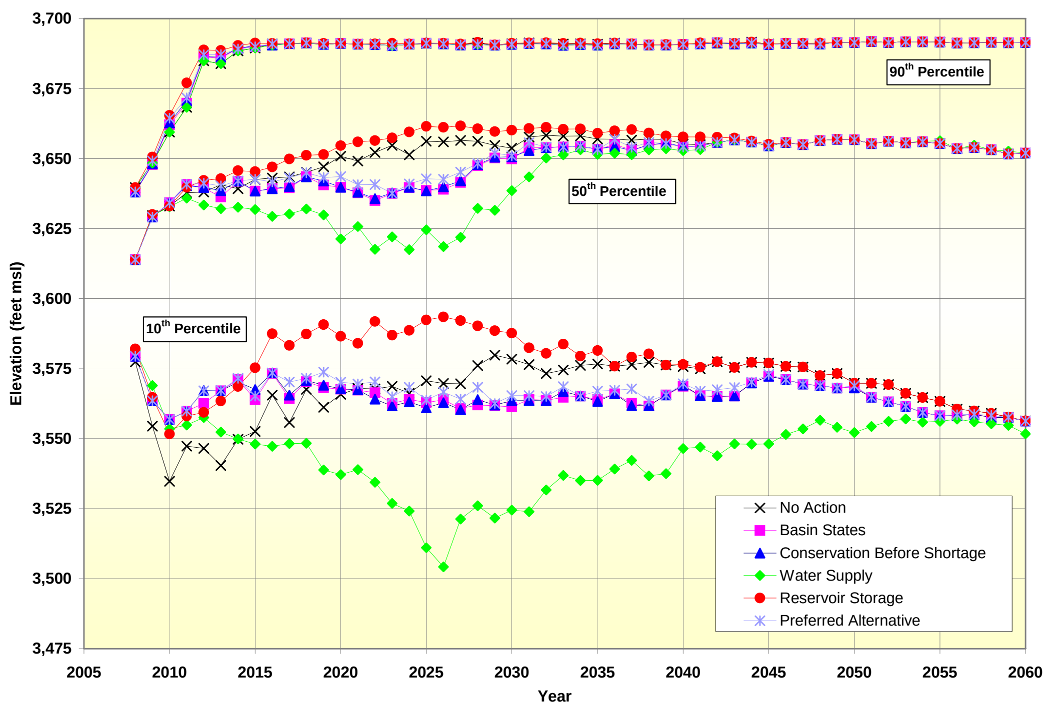
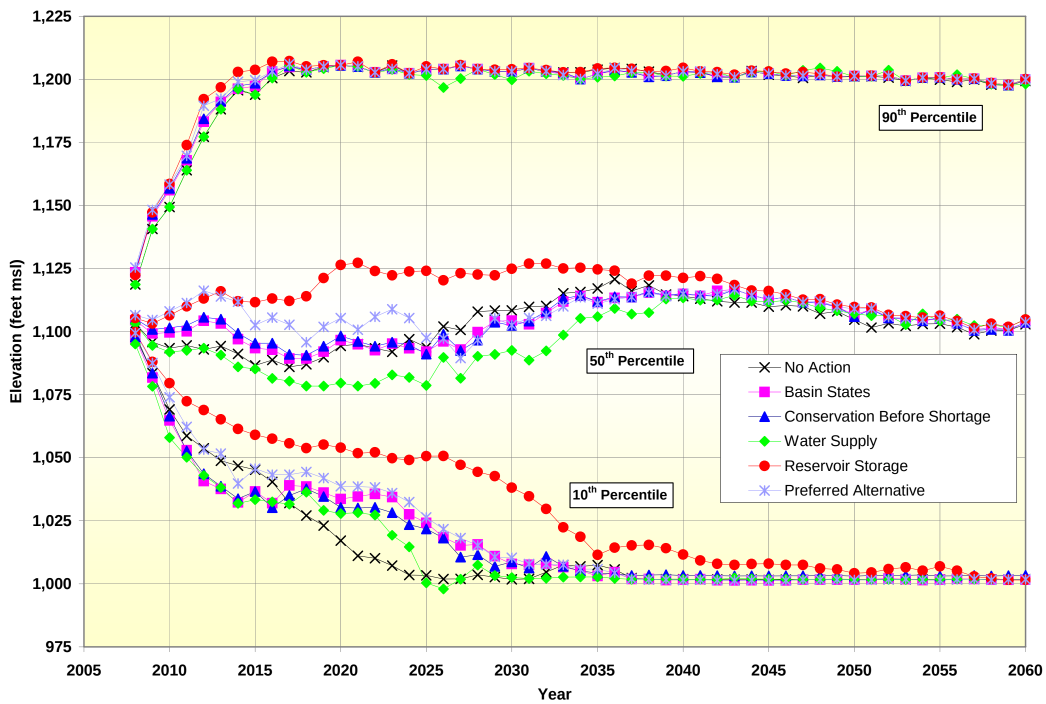


Figure 4.14-3
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values



4.14.2 Potential Impacts to Agriculture

This section provides the assessment of potential effects on agricultural production and resulting changes in employment, income, and taxes. The potential socioeconomic effects due to changes in agricultural production were only assessed for Arizona agricultural districts and the corresponding counties that would likely experience shortages (i.e., within the CAP service area and the 4th priority agricultural use along the Colorado River). Table 4.14-1 provides estimates of involuntary fallowed agricultural land for each shortage amount. Table 4.14-2 provides estimates of changes in agricultural production value for each shortage amount. The change in production value was used as input to IMPLAN to estimate changes in employment, income, and tax revenue.

Table 4.14-1 provides the total estimated fallowed acreage for each shortage amount for 2008, 2017, 2026, 2027, 2040, and 2060. No change in production would occur in 2008 because no shortages are projected to occur in that year. In general, for each shortage amount, the amount of fallowed non-Indian agricultural land decreases between 2017 and 2060 reflecting the trend of fewer acres of agricultural land being in production in the future. No permanent change in land uses would occur under any of the alternatives because shortages would be of a temporary nature and agricultural lands would likely not be permanently removed from production.

The changes in agricultural production values are shown in Table 4.14-2. These changes are a direct result of the amount of land fallowed for each shortage amount. Similar to the acreages of fallowed land, the changes in production value is expected to decrease as a result of less land being fallowed in the future for non-Indian agriculture.

Table 4.14-1
Estimate of Involuntarily Fallowed Acres in Arizona under Various Levels of Shortage for Various Years

Shortage Amount (af)	Non-Indian Agriculture					
	2008	2017	2026	2027	2040	2060
400,000	-	75,923	32,849	-	-	-
500,000	-	78,395	34,450	119,966	6,582	6,365
600,000	-	80,071	35,445	21,061	7,683	7,466
800,000	-	82,253	37,603	23,251	9,884	9,668
1,000,000	-	84,383	39,767	25,385	12,024	11,810
1,200,000	-	86,073	41,453	27,070	13,702	13,485
1,800,000	-	-	-	37,521	24,750	24,534
2,500,000	-	-	-	92,489	-	-
Shortage Amount (af)	Indian Agriculture					
	2008	2017	2026	2027	2040	2060
400,000	-	1,391	34,515	-	-	-
500,000	-	6,878	48,226	54,936	52,704	50,009
600,000	-	24,171	54,503	61,276	59,442	56,709
800,000	-	42,171	67,026	72,594	69,876	67,373
1,000,000	-	54,517	76,758	83,674	81,641	78,443
1,200,000	-	65,285	88,655	95,899	93,822	90,615
1,800,000	-	-	-	127,254	124,458	121,246
2,500,000	-	-	-	129,826	-	-
Shortage Amount (af)	Total Agriculture					
	2008	2017	2026	2027	2040	2060
400,000	-	77,314	67,364	-	-	-
500,000	-	85,273	82,577	74,902	59,286	56,374
600,000	-	104,241	89,948	82,337	67,124	64,175
800,000	-	124,424	104,630	95,845	79,760	77,040
1,000,000	-	138,900	116,525	109,059	93,665	90,254
1,200,000	-	151,358	130,108	122,969	107,524	104,100
1,800,000	-	-	-	164,774	149,208	145,780
2,500,000	-	-	-	222,315	-	-

Note: a dash indicates that a shortage of the given magnitude did not occur in that particular year and therefore there is no change in production value.

Table 4.14-2
Estimated Reduction in Agricultural Production Value Resulting from Involuntary Land Fallowing in Arizona under Various Levels of Shortage for Various Years

Shortage Amount (af)	Non-Indian Agriculture					
	2008	2017	2026	2027	2040	2060
400,000	-	$52,036,229	$13,822,198	-	-	-
500,000	-	$54,123,481	$14,619,316	$8,736,471	$3,262,717	$3,173,387
600,000	-	$55,368,017	$15,246,164	$9,363,844	$3,893,755	$3,804,424
800,000	-	$56,618,464	$16,488,324	$10,618,453	$5,155,026	$5,065,695
1,000,000	-	$57,927,001	$17,817,032	$11,935,945	$6,485,636	$6,397,060
1,200,000	-	$59,415,581	$19,309,607	$13,428,638	$7,985,489	$7,896,159
1,800,000	-	-	-	$19,747,836	$14,530,354	$14,441,155
2,500,000	-	-	-	$43,070,889	-	-
Shortage Amount (af)	Indian Agriculture					
	2008	2017	2026	2027	2040	2060
400,000	-	$564,460	$19,041,437	-	-	-
500,000	-	$2,804,264	$25,723,590	$30,509,432	$27,414,204	$25,220,110
600,000	-	$9,896,242	$29,191,532	$33,983,138	$31,040,001	$28,806,579
800,000	-	$17,766,536	$36,693,514	$41,541,445	$38,520,958	$36,089,626
1,000,000	-	$25,899,839	$45,587,059	$52,706,860	$50,613,664	$47,274,619
1,200,000	-	$34,755,657	$57,905,625	$65,467,934	$63,331,456	$59,982,397
1,800,000	-	-	-	$98,266,029	$95,374,120	$92,019,841
2,500,000	-	-	-	$100,988,860	-	-
Shortage Amount (af)	Total Agriculture					
	2008	2017	2026	2027	2040	2060
400,000	-	$52,600,689	$32,863,635	-	-	-
500,000	-	$56,927,744	$40,342,906	$39,245,903	$30,676,921	$28,393,497
600,000	-	$65,264,259	$44,437,696	$43,346,982	$34,933,755	$32,611,003
800,000	-	$74,385,000	$53,181,838	$52,159,899	$43,675,984	$41,155,322
1,000,000	-	$83,826,840	$63,404,091	$64,642,805	$57,099,300	$53,671,680
1,200,000	-	$94,171,238	$77,215,231	$78,896,572	$71,316,945	$67,878,556
1,800,000	-	-	-	$118,013,865	$109,904,474	$106,460,995
2,500,000	-	-	-	$144,059,749	-	-

Note: a dash indicates that a shortage of the given magnitude did not occur in that particular year and therefore there is no change in production value.

4.14.2.1 Changes in Agricultural Production and Resulting Changes in Employment and Income in Arizona

This section describes the potential changes in employment and income for each alternative as a result of changes in agricultural production. The discussion is a summary of the impact analysis conducted for the Arizona counties that may experience a shortage resulting in changes in agricultural production. The results of this county-level assessment of changes in employment and income for each shortage amount, year, and county are provided in Appendix H. The counties analyzed are Maricopa, Pinal, Pima, Mohave, La Paz, and Yuma. A summary comparison of the effects on employment and income among the alternatives is provided at the end of this subsection.

Table 4.14-3 presents a comparison of the shortage amounts with the estimated changes in employment and income and lists the probabilities of occurrence for each alternative, based on Tables 4.4-5 through 4.4-9. Shortages generated by the alternatives that were not exactly equal to the amounts shown in Table 4.14-3 were counted at the next highest value for the probabilities listed in Table 4.14-3.

Table 4.14-3
Estimated Reduction in Employment as a Result of Shortages to Agricultural Lands for the Action Alternatives and the No Action Alternative
by Selected Years and Shortage Amounts

Shortage Amount (af)	2017							
	Shortage Probabilities for Each Alternative (percent)						Jobs	Income ($ million)
	NA	BS	CBS	WS	RS	PA		
400,000	-	-	-	2	-	-	(577)	(22.6)
500,000	45	15	-	-	-	16	(627)	(23.8)
600,000	-	13	-	-	-	8	(776)	(28.2)
800,000	-	3	-	-	18	3	(860)	(30.8)
1,000,000		-	1	-	16	-	(937)	(30.4)
1,200,000	1	-	-	-	2	-	(1,161)	(43.1)
1,800,000	-	-	-	-	-	-	-	-
2,500,000	-	-	-	-	-	-	-	-
Shortage Amount (af)	**2026**							
	Shortage Probabilities for Each Alternative (percent)						Jobs	Income ($ million)
	NA	BS	CBS	WS	RS	PA		
400,000	-	-	-	12	-	-	(425)	(13.5)
500,000	34	15	1	-	-	24	(561)	(18.0)
600,000	-	13	-	-		11	(600)	(18.8)
800,000	7	7	3	-	18	6	(683)	(21.6)
1,000,000	6	-	2	-	14	-	(770)	(25.0)
1,200,000	1	-	-	-	5	-	(1,105)	(39.7)
1,800,000	-	-	-	-	-	-	-	-
2,500,000	-	-	-	-	-	-	-	-

Table 4.14-3
Estimated Reduction in Employment as a Result of Shortages to Agricultural Lands for the Action Alternatives and the No Action Alternative by Selected Years and Shortage Amounts

Shortage Amount (af)	2027							
	Shortage Probabilities for Each Alternative (percent)						Jobs	Income ($ million)
	NA	BS	CBS	WS	RS	PA		
400,000	-	-	-	-	-	-	-	-
500,000	38	48	44	37	38	50	(522)	(17.3)
600,000	1		-	-	-	-	(557)	(17.5)
800,000	3	2	2	1	-	-	(657)	(21.3)
1,000,000	2	-	2	-	-	1	(741)	(25.0)
1,200,000	1	-	1	1	-	-	(1,012)	(36.9)
1,800,000	3	-	-	3	-	-	(1,271)	(46.4)
2,500,000	-	1	-	4	-	-	(1,693)	(56.5)
Shortage Amount (af)	2040							
	Shortage Probabilities for Each Alternative (percent)						Jobs	Income ($ million)
	NA	BS	CBS	WS	RS	PA		
400,000	-	-	-	-	-	-	-	-
500,000	37	35	33	34	44	36	(419)	(13.4)
600,000	2	-	2	1	-	-	(460)	(14.6)
800,000	4	5	3	5	-	4	(534)	(17.7)
1,000,000	2	2	2	3	2	1	(649)	(22.3)
1,200,000	2	3	7	1	1	4	(777)	(27.5)
1,800,000	3	3	2	2	2	3	(1,181)	(43.5)
2,500,000	-	-	-	-	-	-	-	-
Shortage Amount (af)	2060							
	Shortage Probabilities for Each Alternative (percent)						Jobs	Income ($ million)
	NA	BS	CBS	WS	RS	PA		
400,000	-	-	-	-	-	-	-	-
500,000	54	54	50	51	53	52	(397)	(12.3)
600,000	1	1	3	2	1	1	(434)	(13.5)
800,000	4	6	6	4	6	6	(510)	(16.5)
1,000,000	3	1	1	2	1	1	(602)	(20.6)
1,200,000	3	3	4	3	4	3	(741)	(26.0)
1,800,000	3	3	3	3	3	3	(1,149)	(42.0)
2,500,000	-	-	-	-	-	-	-	-

Note:
NA = No Action Alternative
WS = Water Supply Alternative
CBS = Conservation Before Shortage Alternative
BS = Basin States Alternative
RS = Reservoir Storage Alternative
PA = Preferred Alternative
- = No shortage occurring

No Action Alternative. Potential decreases in employment attributable to a shortage occurring under the No Action Alternative for the period 2008 through 2026 would range from a low of 561 jobs during a 500,000 af shortage in 2026 to a high of 1,161 jobs during a 1.2 maf shortage in 2017. Resulting losses in personal income range from a low of approximately $18.0 million to a high of approximately $43.1 million (Table 4.14-3).

For the period 2008 through 2026, a shortage of approximately 500,000 af would have the greatest probability of occurring, estimated at 34 percent in 2026 and 45 percent in 2017. This shortage amount would result in an estimated loss of up to 627 jobs and resulting reduction in personal income of approximately $23.8 million (Table 4.14-3). Even if considered to be permanent, these potential changes in jobs and personal income are not considered substantial because the changes represent less than one percent of total employment and personal income generated within the six-county study area in Arizona.

Potential decreases in employment attributable to a shortage occurring under the No Action Alternative for the period 2027 through 2060 would range from a low of 397 jobs during a 500,000 af shortage in 2060 to high of 1,271 jobs during a 1.8 maf shortage in 2027. Resulting losses in personal income over the same period would range from a low of approximately $12.3 million to a high of approximately $46.4 million (Table 4.14-3).

For the period 2027 through 2060, a shortage of approximately 500,000 af would have the greatest probability of occurring, ranging from 37 percent in 2040 to 54 percent in 2060. In 2060, a 500,000 af shortage would result in an estimated loss of 397 jobs and reduction in personal income of approximately $12.3 million (Table 4.14-3). Even if considered to be permanent, these potential changes in jobs and personal income are not considered substantial because the changes represent less than one percent of total employment and personal income within the six-county study area in Arizona.

Basin States Alternative. Potential decreases in employment attributable to a shortage occurring under the Basin States Alternative for the period 2008 through 2026 would range from a low of 561 jobs during a 500,000 af shortage in 2026 to a high of 860 jobs during an 800,000 af shortage in 2017 resulting in a loss in personal income ranging from approximately $18 million to $30.8 million (Table 4.14-3).

For the period 2008 through 2026, a shortage of 500,000 af would have the greatest probability of occurring at 15 percent in 2017 and 2026 with corresponding job losses of 561 in 2026 and 627 in 2017. Reductions in personal income would range form $18 million in 2026 to $23.8 million in 2017. Even if considered to be permanent, these potential changes in jobs and personal income are not considered substantial because the changes represent less than one percent of total employment and personal income within the six-county study area in Arizona. Potential decreases in employment attributable to a shortage occurring under the Basin States Alternative between 2027 and 2060 would range from a low of 397 jobs during a 500,000 af shortage in 2060 to a high of 1,693 jobs during a 2.5 maf shortage in 2027. Resulting losses in personal income would range from a low of approximately $12.3 million to a high of approximately $56.5 million (Table 4.14-3).

For the period 2027 through 2060, a shortage of 500,000 af would have the greatest probability of occurring, ranging from 35 to 54 percent. Corresponding losses in jobs would range from 397 in 2060 to 522 in 2027. Losses in personal income would range from $12.3 million to $17.3 million. (Table 4.14-3). Even if considered to be permanent, these changes in jobs and personal income are not considered substantial because the changes represent less than one percent of total employment and personal income within the six-county study area in Arizona.

Conservation Before Shortage Alternative. The results of the analysis reported in this discussion may underestimate the socioeconomic effects of particular shortages occurring under the Conservation Before Shortage Alternative. This analysis assumes that the voluntary conservation targets (400 kaf, 500 kaf, and 600 kaf at Lake Mead elevations 1,075 feet msl, 1,050 feet msl, and 1,025 feet msl, respectively) would be met, assuming that farmers would participate voluntarily in the program and that losses resulting from voluntary shortages would be offset by payments made to farmers to forgo raising crops. With these assumptions, only the potential impacts of involuntary shortages were analyzed in this section.

Potential decreases in employment attributable to an involuntary shortage occurring under the Conservation Before Shortage Alternative for the period 2008 through 2026 would range from a low of 561 jobs during a 500,000 af shortage in 2026 to a high of 937 jobs during a 1 maf shortage in 2017. Estimated losses in personal income would range from a low of approximately $18 million to a high of approximately $25 million (Table 4.14-3).

Shortages have a much greater probability of occurring under the No Action Alternative than under the Conservation Before Shortage Alternative. This suggests for the period 2008 through 2026 the probability of adverse socioeconomic effects occurring under the Conservation Before Shortage Alternative would be much less when compared to the No Action Alternative.

Potential decreases in employment attributable to a shortage occurring under the Conservation Before Shortage Alternative for the period 2027 through 2060 would range from a low of 397 jobs during a 500,000 af shortage in 2060 to a high of 1,181 jobs during a 1.8 maf shortage in 2040. Similarly, estimated losses in personal income over the same period would range from a low of approximately $12.3 million to a high of approximately $43.5 million (Table 4.14-3).

For the period 2027 through 2060, a shortage of 500,000 af would have the greatest probability of occurring, ranging from 33 percent to 50 percent. Estimated losses in jobs would range from 387 in 2060 to 522 in 2017. Corresponding losses in personal income would range from $12.3 million to $17.3 million (Table 4.14-3). Even if considered permanent, these job losses and reductions in personal income are not considered substantial because the changes represent less than one percent of total employment and personal income within the six-county study area in Arizona.

When compared to the No Action Alternative, the probabilities of shortages in 2027 under the Conservation Before Shortage Alternative are higher for shortages of 500,000 af and similar for greater shortages. However, in 2060 shortages of 500,000 af have a slightly lower probability of occurring under the Conservation Before Shortage Alternative and similar probabilities for higher shortage levels.

Water Supply Alternative. For the period 2008 through 2026, potential decreases in employment attributable to a shortage under the Water Supply Alternative would occur only during a 400,000 af shortage in 2017 and 2026. This would result in an estimated loss of 425 jobs in 2026 and 577 jobs in 2017. Losses in personal income would range from $13.5 million and $22.6 million (Table 4.14-3). This lack of shortages is a result of this alternative’s strategy to provide full water deliveries until no water remains in Lake Mead, a reservoir draw down situation which has a low probability of occurring during the interim period.

Potential decreases in employment attributable to a shortage occurring under the Water Supply Alternative for the period 2027 through 2060 would range from a low of 397 jobs during a 500,000 af shortage in 2060 to a high of 1,693 jobs during a 2.5 maf shortage in 2060. Resulting losses in personal income over the same period would range from a low of approximately $12.3 million to a high of approximately $56.5 million (Table 4.14-3).

For the period 2040 through 2060, the probability of shortages under the Water Supply Alternative are very similar to those of the other alternatives, and shortages of 500,000 af would have the greatest probability of occurring, ranging from 37 percent to 51 percent. A 500,000 af shortage would result in an estimated loss of up to 527 jobs and reduction in personal income of up to $17.3 million. Even if considered to be permanent, these changes in jobs and personal income are not considered substantial because the changes represent less than one percent of total employment and personal income within the six-county study area in Arizona.

Reservoir Storage Alternative. Potential decreases in employment attributable to a shortage occurring under the Reservoir Storage Alternative for the period 2008 through 2026 would range from a low of 683 jobs during an 800,000 af shortage in 2026 to a high of 1,161 jobs during a 1.2 maf shortage in 2017. Resulting losses in personal income over the same period would range from a low of approximately $21.6 million to a high of approximately $43.1 million (Table 4.14-3).

For the period 2008 through 2026, a shortage of 800,000 af would have the greatest probability of occurring at 18 percent. Job losses during an 800,000 af shortage would range from 600 in 2026 to 860 in 2017 (Table 4.14-3). Losses in personal income would range from $18.8 million to $30.8 million. Even if considered to be permanent, these changes in jobs and personal income are not considered substantial because the changes represent less than one percent of total employment and personal income within the six-county study area in Arizona.

Shortages of 400,000 to 600,00 af have a much greater potential of occurring under the No Action Alternative whereas shortages of 800,000 af to 1.2 maf have a greater probability of occurring under the Reservoir Storage Alternative. This suggests that for the period 2008 through 2026 the probability of adverse socioeconomic effects occurring under the Reservoir Storage Alternative may be slightly less than under the No Action Alternative, but when shortages of greater than 800,000 af do occur, they are greater in magnitude with increased socioeconomic effects.

Potential decreases in employment attributable to a shortage occurring under the Reservoir Storage Alternative for the period 2027 through 2060 would range from a low of 397 jobs during a 500,000 af shortage in 2060 to a high of 1,181 jobs during a 1.8 maf shortage in 2040 (Table 4.14-3). Losses in personal income would range from a low of approximately $12.3 million to a high of approximately $43,5 million (Table 4.14-3).

For the period 2027 through 2060, a shortage of 500,000 af would have the greatest probability of occurring, ranging from 38 percent to 53 percent. Job losses during a 500,000 af shortage would range from 397 jobs in 2060 to 552 jobs in 2027. Losses in personal income would range from $12.3 million to $17.3 million (Table 4.14-3). Even if considered to be permanent, these changes in jobs and personal income are not considered substantial because the changes represent less than one percent of total employment and personal income within the six-county study area and Arizona.

The probabilities of shortages occurring under the Reservoir Storage Alternative during a 500,000 af shortage would be similar to the probabilities under the No Action Alternative.

Preferred Alternative. Potential decreases in employment attributable to a shortage occurring under the Preferred Alternative for the period 2008 through 2026 would range from a low of 561 jobs during a 500,000 af shortage in 2026 to a high of 860 jobs during an 800,000 af shortage in 2017. Resulting losses in personal income over the same period would range from a low of approximately $18 million to a high of approximately $30.8 million (Table 4.14-3).

For the period 2008 through 2026, a shortage of 500,000 af would have the greatest probability of occurring at 16 percent in 2017 and 24 percent in 2026. Job losses during an 500,000 af shortage would range from 561 in 2017 to 627 in 2017 (Table 4.14-3). Corresponding losses in personal income would range from $18 million to $23.8 million. Even if considered to be permanent, these changes in jobs and personal income are not considered substantial because the changes represent less than one percent of total employment and personal income within the six-county study area in Arizona.

Shortages of 500,000 af have a lower probability of occurring under the Preferred Alternative compared to the No Action Alternative whereas shortages of 600,000 and 800,000 af have a greater probability of occurring under the Preferred Alternative. This suggests that for the period 2008 through 2026 the probability of adverse socioeconomic effects occurring under the Preferred Alternative may be slightly lower during a 500,000 af shortage but greater for shortages between 600,000 and 800,000 af.

Potential decreases in employment attributable to a shortage occurring under the Preferred Alternative for the period 2027 through 2060 would range from a low of 397 jobs during a 500,000 af shortage in 2060 to a high of 1,181 jobs during a 1.8 maf shortage in 2040 (Table 4.14-3). Losses in personal income would range from a low of approximately $12.3 million to a high of approximately $43.5 million (Table 4.14-3).

For the period 2027 through 2060, a shortage of 500,000 af would have the greatest probability of occurring, ranging from 36 percent to 52 percent. Job losses during a 500,000 af shortage would range from 397 jobs in 2060 to 552 jobs in 2027. Losses in personal income would range from $12.3 million to $17.3 million (Table 4.14-3). Even if considered to be permanent, these changes in jobs and personal income are not considered substantial because the changes represent less than one percent of total employment and personal income within the six-county study area and Arizona.

The probabilities of shortages occurring under the Preferred Alternative in 2040 and 2060 are similar to the probabilities under the No Action Alternative. The probability of a 500,000 af shortage occurring under the Preferred Alternative in 2027 is greater when compared to the No Action Alternative.

4.14.2.2 Changes in Tax Revenues in Arizona

This section describes the potential changes in tax revenue for each alternative as a result of changes in agricultural production. Changes in tax revenue would result from the direct reduction in agricultural production, from reduced business-to-business activity, and from reductions in personal income. The tax revenue discussion summarizes the impacts for those Arizona counties that may experience a water shortage resulting in changes in agricultural production. The results of the county-level assessment on tax revenues for each shortage amount, year, and county are provided in Appendix H. The counties analyzed are Maricopa, Pinal, Pima, Mohave, La Paz, and Yuma. A summary comparison of the effects on tax revenue is provided at the end of this subsection.

Table 4.14-4 presents a comparison of the shortage amounts with the estimated changes in tax revenues and lists the probabilities of occurrence for each alternative. Shortages generated by the alternatives that were not exactly equal to the amounts shown in Table 4.14-4 were counted at the next highest value for the probabilities listed in Table 4.14-4.

Table 4.14-4
Estimated Reduction in Tax Revenues as a Result of Shortages to Agricultural Lands Under the Action Alternatives and the No Action Alternative by Selected Year and Shortages

Shortage Amount (af)	2017						
	Shortage Probabilities for Each Alternative (percent)						Changes in Tax Revenues ($ million)
	NA	BS	CBS	WS	RS	PA	
400,000	-	-	-	2	-	-	(7.7)
500,000	45	15	-	-	-	16	(8.2)
600,000	-	13	-	-		8	(9.7)
800,000	-	3	-	-	18	3	(10.6)
1,000,000	-	-	1	-	16	-	(11.6)
1,200,000	1	-	-	-	2	-	(14.8)
1,800,000	-	-	-	-	-	-	-
2,500,000	-	-	-	-	-	-	-
Shortage Amount (af)	2026						
	Shortage Probabilities for Each Alternative (percent)						Changes in Tax Revenues ($ million)
	NA	BS	CBS	WS	RS	PA	
400,000	-	-	-	12	-	-	(4.6)
500,000	34	15	1	-	-	24	(5.9)
600,000	-	13	-	-	-	11	(6.4)
800,000	7	7	3	-	18	6	(7.4)
1,000,000	6	-	2	-	14	-	(8.5)
1,200,000	1-	-	-	-	5	-	(13.5)
1,800,000	-	-	-	-	-	-	-
2,500,000	-	-	-	-	-	-	-
Shortage Amount (af)	2027						
	Shortage Probabilities for Each Alternative (percent)						Changes in Tax Revenues ($ million)
	NA	BS	CBS	WS	RS	PA	
400,000	-	-	-	-	-	-	-
500,000	38	48	44	37	38	50	(5.5)
600,000	1	-	-	1	-	-	(5.9)
800,000	3	2	2	3	-	-	(7.2)
1,000,000	2	-	2	2	-	1	(8.4)
1,200,000	1	-	1	-	-	-	(12.5)
1,800,000	3	-	-		-	-	(15.6)
2,500,000	-	1	-	3	-	-	(18.9)

Table 4.14-4
Estimated Reduction in Tax Revenues as a Result of Shortages to Agricultural Lands Under the Action Alternatives and the No Action Alternative by Selected Year and Shortages

Shortage Amount (af)	2040						
	Shortage Probabilities for Each Alternative (percent)						Changes in Tax Revenues ($ million)
	NA	BS	CBS	WS	RS	PA	
400,000	-	-	-	-	-	-	-
500,000	37	35	33	34	44	36	(4.6)
600,000	2	-	2	1	-	-	(5.0)
800,000	4	5	3	5	-	4	(6.0)
1,000,000	2	2	2	3	2	1	(7.6)
1,200,000	2	3	7	3	1	4	(9.3)
1,800,000	3	3	2	3	2	3	(14.6)
2,500,000	-	-	-	-	-	-	-
Shortage Amount (af)	2060						
	Shortage Probabilities for Each Alternative (percent)						Changes in Tax Revenues ($ million)
	NA	BS	CBS	WS	RS	PA	
400,000	-	-	-	-	-	-	-
500,000	54	52	50	51	534	52	(4.2)
600,000	1	1	3	2	1	1	(4.6)
800,000	4	6	6	4	4	6	(7.0)
1,000,000	3	1	1	2	1	1	(7.8)
1,200,000	3	3	4	3	4	3	(8.8)
1,800,000	3	3	3	3	3	3	(14.1)
2,500,000	-	-	-	-	-	-	-

Note:
NA = No Action Alternative
WS = Water Supply Alternative
CBS = Conservation Before Shortage Alternative
BS = Basin States Alternative
RS = Reservoir Storage Alternative
PA = Preferred Alternative
- = No Shortage Occurring

Arizona reported a total of $8.477 billion in state taxes collected and $5.943 billion in local government taxes collected for 2001 through 2002 (http://ftp2.census.gov/govs/estimate/02slsstab1a.xls). These values are compared to the tax impacts associated with the action alternatives and the No Action Alternative, discussed in the following paragraphs, as referred to in Table 4.14-4 and in Appendix H.

No Action Alternative. Potential decreases in tax revenue occurring under the No Action Alternative for the period 2008 through 2026 would range from a low of $5.9 million during a 500,000 af shortage in 2026 to a high of $14.8 million during a 1.2 maf shortage in 2017. For the period 2008 through 2026, a shortage of approximately 500,000 af would have the greatest probability of occurring, estimated at 45 percent in 2017 and 34 percent in 2026.

Potential decreases in tax revenue for the period 2027 through 2060 would range from a low of $4.2 million during a 500,000 af shortage in 2060 to a high of $18.9 million during a 2.5 maf shortage in 2027. For the period 2027 through 2060, a shortage of 500,000 af would have the greatest probability of occurring, estimated at between 37 percent in 2040 to 54 percent in 2060. These changes in tax revenues represent less than 0.2 percent total state taxes collected and less than 0.3 percent of local taxes collected.

Basin States Alternative. Potential decreases in tax revenue occurring under the Basin States Alternative for the period 2008 through 2026 would range from a low of $5.9 million during a 500,000 af shortage in 2026 to a high of $10.6 million during an 800,000 af shortage in 2017. For the period 2008 through 2026, a shortage of 500,000 af would have the greatest probability of occurring, estimated at 15 percent.

Potential decreases in tax revenue attributable to a shortage occurring under the Basin States Alternative during the period 2027 through 2060 would range from a low of $4.2 million during a 500,000 af shortage in 2060 to a high of $18.9 million during a 2.5 maf shortage in 2027. For the period 2027 through 2060, a shortage of 500,000 af would have the greatest probability of occurring, estimated at between 35 percent in 2040 to 52 percent in 2060. These changes in tax revenues represent less than 0.3 percent of total state taxes collected and less than 0.4 percent of local taxes collected.

Conservation Before Shortage Alternative. This analysis assumes that the voluntary conservation targets (400 kaf, 500 kaf, and 600 kaf at Lake Mead elevations 1,075 feet msl, 1,050 feet msl, and 1,025 feet msl, respectively) would be met and therefore only the potential impacts of involuntary shortages were analyzed. Potential decreases in tax revenue due to an involuntary shortage occurring under the Conservation Before Shortage Alternative during the period 2008 through 2026 would range from a low of $5.9 million during a 500,000 af shortage in 2026 to a high of $11.6 million during a 1 maf shortage in 2017. For the period 2008 through 2026, a shortage of 800,000 af would have the greatest probability of occurring, estimated at only three percent.

Potential decreases in tax revenue attributable to a shortage occurring under the Conservation Before Shortage Alternative during the period 2027 through 2060 would range from a low of $4.2 million during a 500,000 af shortage in 2060 to a high of $1.6 million during a 1.8 maf shortage in 2040. For the period 2027 through 2060, a shortage of 500,000 af would have the greatest probability of occurring, estimated at between 33 percent in 2040 to 50 percent in 2060. These changes in tax revenues represent less than 0.2 percent of total state taxes collected and less than 0.3 percent of local taxes collected.

Water Supply Alternative. Potential decreases in tax revenue occurring under the Water Supply Alternative during the period 2008 through 2026 would range from a low of $4.6 million during a 400,000 af shortage in 2026 to a high of $7.7 million during a 400,000 af shortage in 2017. For the period 2008 to 2026, only shortages of 400,000 af would occur, ranging from two percent in 2017 to 12 percent in 2026. This lack of shortages is a result of this alternative's strategy to provide full water deliveries until no water remains in Lake Mead, a reservoir draw down situation which has a low probability of occurring during the interim period.

Potential decreases in tax revenue attributable to a shortage occurring under the Water Supply Alternative during the period 2027 through 2060 would range from a low of $4.2 million during a 500,000 af shortage in 2060 to a high of $18.9 million during a 2.5 maf shortage in 2060. For the period 2027 through 2060, a shortage of 500,000 af would have the greatest probability of occurring, estimated at between 37 percent in 2027 to 51 percent in 2060. These changes in tax revenues represent less than 0.3 percent of total state taxes collected and less than 0.4 percent of local taxes collected.

Reservoir Storage Alternative. Potential decreases in tax revenue attributable to a shortage occurring under the Reservoir Storage Alternative during the period 2008 through 2026 would range from a low of $7.4 million during an 800,000 af shortage in 2026 to a high of $14.8 million during a 1.2 maf shortage in 2017. For the period 2008 through 2026, a shortage of 800,000 would have the greatest probability of occurring, estimated at 18 percent in 2017 and 2026.

Potential decreases in tax revenue attributable to a shortage occurring under the Reservoir Storage Alternative during the period 2027 through 2060 would range from a low of $4.2 million during a 500,000 af shortage in 2060 to a high of $14.6 million during a 1.8 maf shortage in 2040. For the period 2027 through 2060, a shortage of 500,000 af would have the greatest probability of occurring, estimated at between 38 percent in 2027 to 53 percent in 2060. These changes in tax revenues represent less than 0.2 percent of total state taxes collected and less than 0.3 percent of local taxes collected.

Preferred Alternative. Potential decreases in tax revenue attributable to a shortage occurring under the Preferred Alternative during the period 2008 through 2026 would range from a low of $5.9 million during 500,000 af shortage in 2026 to a high of $10.6 million during an 800,000 af shortage in 2017. For the period 2008 through 2026, a shortage of 500,000 af would have the greatest probability of occurring, estimated at 16 percent in 2017 and 24 percent in 2026.

Potential decreases in tax revenue attributable to a shortage occurring under the Preferred Alternative during the 2027 through 2060 would range from a low of $4.2 million during a 500,000 in 2060 to a high of $14.6 million during a 1.8 maf shortage in 2040. For the period 2027 through 2060, a shortage of 500,000 af would have the greatest probability of occurring, estimated at between 36 percent in 2040 to 52 percent in 2060. These changes in tax revenues represent less than 0.2 percent of total state taxes collected and less than 0.3 percent of local taxes collected.

4.14.2.3 Changes in Agricultural Production in California and Resulting Changes in Employment and Income in California

The results of the water allocation modeling indicate that although a portion of the shortages may be shared by California, agricultural users and production would only be affected by a very large shortage. However, agricultural production in California would not be adversely affected because any shortage amount would be very small. None of the alternatives are expected to result in a substantial change in California’s agricultural production.

4.14.2.4 Changes in Agricultural Production in Nevada and Resulting Changes in Employment and Income in Nevada

The results of the water allocation modeling indicate that although a portion of the shortages may be shared by Nevada, agricultural users would not be affected in the event a shortage occurs. There are very few agricultural users that receive part of Nevada’s Colorado River water allocation. None of the alternatives are expected to result in a change in Nevada’s agricultural production.

Shortages occurring in Nevada are expected to be limited to the M&I sector. No changes in employment and income as a result of changes in agricultural production in Nevada are expected under any of the alternatives.

4.14.3 Potential Impacts to Municipal and Industrial Water Users

This section provides the results of the assessment of potential changes in M&I water use and resulting socioeconomic effects. The analysis is a qualitative discussion supported by the assessment of the shortage probabilities and volumes described in Section 4.4, Tables 4.4-5 through 4.4-8, Table 4.4-15, and in Appendix G.

For the period 2008 through 2060 the probability of a shortage occurring is highest for shortages ranging from 400,000 to 800,000 af and the probabilities of shortages occurring greater than 800,000 af are very similar among all the alternatives, including the No Action Alternative. Accordingly, the focus of the M&I analysis is to describe the effects of shortages that range from 400,000 af to 800,000 af.

For the period 2008 through 2026, the shortages under the No Action Alternative, the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives, and the Preferred Alternative would have the highest probability of occurring. In 2017, a 500,000 af shortage would have a 45 percent chance of occurring under the No Action Alternative compared to a 16 percent chance under the Preferred Alternative; the alternative with the highest probability of a shortage occurring among the action alternatives. Conversely, a 600,000 af shortage would have a greater likelihood of occurring under the Basin States, Conservation Before Shortage, and Reservoir Storage Alternatives as compared to the No Action Alternative and the Water Supply Alternative.

For the period 2027 through 2060, the probability of a shortage occurring under each alternative is highest at the 500,000 af shortage level. When compared to the No Action Alternative, shortages of 500,000 af in 2060 have a greater probability of occurring under all the action alternatives. Conversely, in 2027 and in 2040 shortages of 500,000 af have a similar probability of occurring under all the alternatives.

4.14.3.1 Changes in Municipal and Industrial Water Uses In Arizona

This section describes the potential socioeconomic effects that would result from changes in deliveries to M&I users in Arizona. The analysis is based on an analysis of shortage amounts in the range of 400,000 af to 800,000 af.

Arizona's Drought Management Plan serves as an umbrella that provides direction to Arizona state agencies and guidance to regional and local agencies regarding responses to drought conditions (Arizona Drought Task Force 2004). Shortages to the Arizona M&I sector would be addressed through the state's and each local jurisdiction's drought responses and plans. These responses include supply-side and demand-side actions. Supply-side actions may include groundwater recharge, water purchase agreements, and alternative water supplies such as brackish water and reclaimed water. Demand-side strategies focus on implementing different stages of water conservation measures as a drought progresses. Shortages to the Arizona M&I sector would be addressed through each entity's supply-side and demand-side drought response actions and programs.

In 2017, Arizona M&I shortages would range from approximately 9,200 af during a 400,000 af shortage to 176,000 af during an 800,000 af shortage. In 2026, Arizona M&I shortages would range from approximately 99,000 af during a 400,000 af shortage to 176,000 af during an 800,000 af shortage. Implementing statewide and local demand-side and supply-side strategies are expected to minimize adverse socioeconomic effects occurring during the maximum M&I shortage.

4.14.3.2 Changes in Municipal and Industrial Water Uses In California

The section provides the results of the analysis of changes of potential socioeconomic effects as a result of changes in deliveries to M&I users. The conclusions are based on information provided in Section 4.4 of this Final EIS. In summary, deliveries to MWD are not anticipated to be adversely affected for Lower Basin shortages up to 1.8 maf because of California's higher Colorado River water supply priority relative to Arizona's and Nevada's Colorado River water supply priorities. In addition, shortages of 1.8 maf or greater have a low probability of occurring. MWD has or is working on putting in place storage and transfer programs that are expected to provide full supplies when needed even when Colorado River surplus supplies are not available. Examples of MWD actions include agreements with irrigation districts and individual landowners to reduce water use by fallowing lands, funding water efficiency improvements, and banking and exchange programs.

MWD is not expected to experience a substantial reduction in deliveries to M&I users during a shortage because of the priority of California's water rights in combination with the availability of alternative water supplies. The action alternatives are not expected to result in a substantial change in economic activities dependent on M&I deliveries.

4.14.3.3 Changes in Municipal and Industrial Water Uses in Nevada

This section describes the potential socioeconomic effects that would result from changes in deliveries to M&I users in Nevada. The analysis is based on a comparison of the action alternatives to the No Action Alternative.

Shortages to the M&I sector of Southern Nevada would mostly be borne by the SNWA, which has prepared a drought plan (SNWA 2005) to address water shortages. That plan includes two levels; a drought watch, and a drought alert and calls for landscape watering restrictions to private lawns, community use recreational turf areas, and golf courses. The plan also includes restrictions on surface, building, equipment, and vehicle washing.

Between 2008 and 2027, action alternatives would result in shortage allocations that are both less than or greater than those under the No Action Alternative. Although the largest differential would occur under the Water Supply Alternative in 2027, where the maximum shortage would equal approximately 279,000 af as compared to 60,548 af under the No Action Alternative, this shortage amount is the result of the unlikely event that Lake Mead elevation would fall below the SNWA intake. Under the Preferred Alternative, maximum shortages would decrease by 15,000 af in 2017 and increase to approximately 45,000 af in 2026. For each shortage scenario, the probability of shortages in southern Nevada would not be substantially different than under the No Action Alternative, with the exception of the 500,000 af shortage. The probability of a 500,000 af shortage occurring under any of the action alternatives would be substantially lower when compared to the No Action Alternative (Tables 4.4-5 and 4.4-6). In addition, with Nevada's drought plan in place, shortages to the M&I sector (under the No Action Alternative or under either of the action alternatives) would be managed. Socioeconomic effects on southern Nevada's M&I sector would vary depending on the size of the shortage, but the probability of larger shortages (greater than 600 kaf) which have the potential for more impacts, is not substantially different between the No Action Alternative and the Preferred Alternative.

4.14.4 Potential Impacts to Recreation

This section describes the changes in reservoir-related and river-related economic activity attributable to implementing the action alternatives. The assessment is based, in part, on the conclusions provided in Section 4.3 and Section 4.12.

4.14.4.1 Change in Economic Activity as a Result of Changes in Recreation Occurring at Lake Powell

The following qualitative assessment of changes in recreation-related economic activity is based on a comparison of Lake Powell elevations modeled for the No Action Alternative and for each action alternative.

As shown in Figure 4.14-2, at the 90th percentile there are no differences in Lake Powell end-of-September elevations between the alternatives. This suggests that at higher lake elevations there would be no differences in recreation opportunities and associated economic activity among the alternatives.

At the 50th percentile, end-of-September reservoir elevations under the Reservoir Storage Alternative would be nearly the same as those under the No Action Alternative. This suggests that recreation opportunities and resulting economic activity would not change. Reservoir elevations would be lower under the Conservation Before Shortage, Basin States, and Water Supply Alternatives, and the Preferred Alternative when compared to the No Action Alternative, with the Water Supply Alternative showing the lowest 50th percentile elevations. Because the reservoir would have substantial storage under all alternatives at the 50th percentile, these lower elevations are not expected to result in substantial change in recreation opportunities at Lake Powell and would not result in a substantial change in recreation-related economic activity.

The greatest differences in Lake Powell elevations would occur at the 10th percentile. Lake Powell elevations would be higher under the Reservoir Storage Alternative when compared to the No Action Alternative. These higher elevations would benefit recreation opportunities at Lake Powell and resulting economic activity. Reservoir levels would be nearly the same under the Basin States and Conservation Before Shortage Alternatives, the Preferred Alternative, and the No Action Alternative. This suggests that recreation-related economic activity would be the same among these four alternatives. Reservoir elevations would be lowest under the Water Supply Alternative and would result in the greatest adverse effect on recreation opportunities and associated reduction in economic activity.

4.14.4.2 Change in Economic Activity as a Result of Changes in Recreation Occurring in the Colorado River Downstream of Lake Powell

Recreation opportunities and use would not be adversely affected on the Colorado River reach downstream of Lake Powell because flows would not drop below safe boating thresholds for all of the alternatives. There would be no resulting changes in recreation-related economic activity among the alternatives because recreation use is not expected to change.

4.14.4.3 Change in Economic Activity as a Result of Changes in Recreation Occurring at Lake Mead

The following qualitative assessment of changes in recreation-related economic activity is based on a comparison of Lake Mead elevations modeled for the No Action Alternative and each action alternative.

As illustrated in Figure 4.14-3, at the 90th percentile there are essentially no differences in Lake Mead end-of-July elevations among the alternatives. This suggests that at the higher lake elevations there would no differences in recreation opportunities and associated economic activity.

At the 50th percentile, end-of-July reservoir elevations under the Reservoir Storage Alternative would be higher when compared to the No Action Alternative. This suggests that recreation opportunities and resulting economic activity would be greater under the Reservoir Storage Alternative. Reservoir levels for the Basin States and Conservation Before Shortage Alternatives, the Preferred Alternative, and the No Action Alternative would be nearly the same. No substantial differences in economic activity would occur under the Conservation Before Shortage, Basin States, and Water Supply alternatives, and the Preferred Alternative.

The greatest differences in Lake Mead elevations would occur at the 10th percentile. Lake Mead elevations under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative would be slightly higher during the interim period when compared to the No Action Alternative. This suggests that there would be only a small, if any, increase in economic activity when compared to the No Action Alternative. The Reservoir Storage Alternative would result in the greatest increase in Lake Mead elevations compared to the No Action Alternative. These higher elevations would benefit recreation opportunities and resulting economic activity.

4.14.4.4 Changes in Economic Activity as a Result of Changes in Recreation Occurring in the Colorado River Downstream of Lake Mead

Recreation opportunities and use would not be adversely affected on the reach of the Colorado River downstream of Lake Mead because daily and hourly releases from Hoover Dam, Davis Dam, Parker Dam, and Imperial Dam would remain within historical ranges. As a result, there would be no change in recreation-related economic activity among the alternatives because recreation opportunities and use are not expected to change.

4.14.5 Potential Impacts of Multi-Year Shortages

An analysis was conducted to estimate the magnitude and probability of shortages occurring during two or more consecutive years (Section 4.4 and Appendix P). The analysis suggests that during the interim period, there is a high probability that multi-year shortages for volumes greater than or equal to 400,000 af may occur. The No Action Alternative has the highest probability of multi-year shortages and the Water Supply Alternative has the lowest probability (zero percent) during the interim period. Of the five action alternatives, the Reservoir Storage Alternative has the highest probability of multi-year shortages. After the end of the interim period, the probability of a multi-year shortages occurring would be very similar among all the alternatives.

A multi-year shortage could result in a higher probability of a permanent loss in employment, income, and tax revenue if the same agricultural operations or M&I uses experience a shortage over consecutive years. Because it is not known how a multi-year shortage would be allocated over a specific water delivery area, the potential magnitude of longer-term socioeconomic effects cannot be estimated. However, as indicated in the multi-year shortage graphs provided in Section 4.4 and in Appendix P, the probabilities of multi-year shortages occurring would typically be less than under the No Action Alternative. This suggests that the probability of longer-term adverse socioeconomic effects occurring under the action alternatives would be less when compared to the No Action Alternative.

4.14.6 Potential Impacts of a Voluntary Conservation Program

An assessment was performed of the positive and negative impacts of implementing a voluntary conservation program (Appendix H) as postulated in the Conservation Before Shortage Alternative. The compensation to farmers under a voluntary fallowing program could potentially offset some of the adverse socioeconomic effects of reducing agricultural production. The degree to which these payments would offset the adverse socioeconomic effects of fallowing agricultural lands would depend on the payment schemes and amounts associated with a particular program. Instituting a voluntary fallowing program could result in positive economic effects. However, as suggested by the results of the two scenarios described in Appendix H, estimating the socioeconomic effects of implementing a program with a reasonable degree of certainty is difficult without additional detail regarding payment amounts, geographic location, and timing. There are many variables that need to be considered and these will vary widely by region, programs size, length of program, and participating entities.

4.14.7 Summary

4.14.7.1 Employment, Income, and Tax Revenues

Although a loss in employment and income could potentially occur under any of the action alternatives, the probability of any shortage occurring would be greater under the No Action Alternative. This suggests that the potential loss in employment, income, and tax revenues estimated for the No Action Alternative would be reduced under each of the action alternatives. The probabilities of any shortage amount occurring would be similar under all the action alternatives during the interim period with the exception of the Water Supply Alternative. When compared to the other action alternatives, the probabilities of any shortage amount occurring would be lower under the Water Supply Alternative. This indicates that, with the exception of the Water Supply Alternative, the potential losses in employment, income, and tax revenues would be similar among the action alternatives during the interim period. However, none of the changes in employment and income are considered substantial when compared to total employment and income generated within the study area.

For the period 2027 through 2060, the change in employment and income would be similar between the No Action Alternative and the action alternatives. The greatest difference would be in 2027 in which the probabilities would be slightly higher when compared to those under the No Action Alternative. However, by 2040, the probabilities of shortages occurring under all of the alternatives are very similar.

4.14.7.2 Municipal and Industrial Water Uses
Adverse effects on employment and income in Arizona and Nevada during shortages would be minimized as a result of drought plans being in place. No adverse effects are expected in California because of priority of apportionment and the availability of alternative water supplies.

4.14.7.3 Recreation
Recreation opportunities and associated economic activity at Lake Powell are not expected to be substantially different under the No Action Alternative, the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative. Recreation opportunities and associated economic activity could potentially be adversely affected under the Water Supply Alternative due to the potentially lower Lake Powell elevations that may occur under this alternative. Conversely, recreation opportunities and associated economic activity would benefit under the Reservoir Storage Alternative as a result of potentially higher Lake Powell elevations under this alternative.

Recreation opportunities and associated economic activity at Lake Mead are not expected to be substantially different under the No Action Alternative, the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative. Recreation opportunities and associated economic activity could potentially benefit under the Reservoir Storage Alternative due to the potentially higher Lake Mead elevations that may occur under this alternative.

Because daily and hourly flows in the Lake Powell to Lake Mead reach and in the Colorado River reaches downstream of Lake Mead would likely remain within ranges suitable for boating, there would be no change in river-related economic activity.

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4.15 Environmental Justice

This section describes the methods of analysis, and potential effects on environmental justice communities at the county level. The twelve environmental justice counties that were identified in Section 3.15 are: Coconino, La Paz, Mohave, Pima, Pinal, and Yuma counties in Arizona; Imperial, Los Angeles, Orange, Riverside, and San Bernardino counties in California; and San Juan County in Utah.

4.15.1 Methodology

The twelve environmental justice counties were examined by resource to identify whether any of the alternatives are likely to have disproportionate and adverse human health or environmental impacts.

4.15.2 Hydrology, Water Deliveries, and Socioeconomics

Potential water shortages will not impact water deliveries in Utah (Section 4.4) and would only rarely affect water deliveries in California (Table 4.4-21 and Table 4.4-22). Six of the eight Arizona counties are environmental justice communities. Two of the three counties served by the CAP are environmental justice communities (Pinal and Pima). Under all alternatives, a Lower Basin shortage would cause the reduction of water deliveries first to the CAP and other post-1968 Colorado River contractors in Arizona. While some would consider this a disproportionate impact on these Arizona counties as compared to other Colorado River contractors, this water entitlement priority is mandated under the CRBPA, and would occur under all of the action alternatives as well as under the No Action Alternative.

As an example of the magnitude of potential socioeconomic impacts, in 2026 a 500,000 af shortage has a 34 percent chance of occurring under the No Action Alternative. This would potentially result in a loss of about 561 jobs in Arizona (Table 4.14-3). In comparison, under the Preferred Alternative, the probability of occurrence is approximately 24 percent and would result in a loss of the same number of jobs. Under the Basin States Alternative, the probability of this shortage volume in 2026 is approximately 15 percent. Under the Conservation Before Shortage and the Water Supply alternative, there would be a one percent and zero percent probability of this occurrence, respectively. Under the Reservoir Storage Alternative, there is a zero percent probability of this shortage volume in 2026. The biggest difference in the probability of shortage occurs in 2017 with an 18 percent probability of occurrence of an 800,000 af shortage under the Reservoir Storage Alternative and a zero percent probability of occurrence under the No Action Alternative. Even so, this effect is projected to only result in the loss of approximately 860 jobs in Arizona. The loss in the number of jobs is so small compared to the total number of jobs in the environmental justice counties that the effects of the alternatives are negligible.

Accordingly, there is no substantive difference among the alternatives with respect to environmental justice impacts from water deliveries and socioeconomics.

4.15.3 Water Quality

Potential changes to water quality were evaluated for salinity, temperature, metals, and perchlorate. Effects on these parameters would be minor and would not disproportionately affect any environmental justice communities in the study area. For example, in Imperial County, California, the predicted salinity values would range from 732 mg/L to 783 mg/L. All values are below the 879 mg/L numeric criterion established by the Colorado River Basin Salinity Control Forum (Section 4.5).

4.15.4 Air Quality

Potential changes to fugitive dust emissions due to exposed shoreline are minor at Lake Powell and there would be no disproportionate effect on the health of residents of San Juan County compared to the other counties. Likewise, there would be no significant difference among alternatives at Lake Mead or downstream. Therefore, the proposed federal action would not result in any disproportionate effects to environmental justice communities.

4.15.5 Visual Resources

Potential impacts to visual resources were considered for attraction features, calcium carbonate rings, and sediment deltas. While some of these features are located within San Juan County, Utah, (e.g., Rainbow Bridge) an environmental justice community, effects are not disproportionate or unique to any environmental justice community.

4.15.6 Biological Resources

Potential impacts to biological resources would not disproportionately impact any environmental justice community identified within the study area. Potential impacts to vegetation, wildlife, and fish due to the action alternatives would be minor.

Scoping and subsequent consultation did not result in the identification of any environmental justice community for whom indigenous fish, vegetation, or wildlife constituted a significant portion of their diet. There will be no difference in rates or patterns of subsistence consumption by environmental justice communities, including Indian tribes, in comparison to the general population in the study area.

4.15.7 Cultural Resources

Potential impacts or access to cultural resources are not expected to be unique to the environmental justice communities identified in the study area. Reclamation and the cooperating agencies are committed to compliance with all laws and regulations associated with historic properties, sacred sites, and cultural resources. Consultations are ongoing with concerned Indian tribes.

4.15.8 Indian Trust Assets

Reclamation has concluded that the proposed federal action will have no significant impacts on ITAs. Reclamation is committed to protecting and maintaining ITAs and rights reserved by or granted to Indian tribes or individual Indians by treaties, statutes, and executive orders.

4.15.9 Electrical Power Resources

Changes to electrical power production among the alternatives have the potential to affect environmental justice communities disproportionately through possible minor increases in electricity rates resulting from decreased electrical power generation under some of the action alternatives. However, these changes in electrical power production are generally very minor (less than one percent) and the facilities potentially affected produce less than four percent of the total power produced in the region. Therefore no substantial environmental justice effects are anticipated.

4.15.10 Recreation

Potential recreational impacts are primarily associated with reduced reservoir elevations affecting access or necessitating capital alterations to shoreline facilities around Lake Powell and Lake Mead. Individuals and businesses within San Juan County, Utah, which is greater than 50 percent minority, could be affected by these recreational impacts. However, the effect would not be disproportionate to the recreational impacts experienced by other counties adjacent to Lake Powell and Lake Mead.

4.15.11 Transportation

Potential transportation impacts are associated with ferry services on Lake Powell and on the Colorado River downstream of Davis Dam. At Lake Powell, both San Juan County and Kane County would be equally affected by any disruption to the ferry service due to low reservoir elevations. San Juan County would not be disproportionately affected. Downstream of Davis Dam, the ferry service across the river serves two non-environmental justice counties.

4.15.12 Summary

After evaluating each resource, it is concluded that the environmental justice communities identified in the study area would not be disproportionately affected by any of the anticipated environmental impacts stemming from the proposed federal action. Nor would the proposed federal action result in adverse disproportionate impacts on human health within these environmental justice communities.

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4.16 Indirect Effects of Intentionally Created Surplus Mechanism

Indirect effects are reasonably foreseeable environmental impacts which are caused by the proposed federal action, but may occur later in time or farther removed in distance. This section describes the potential indirect effects from Reclamation's proposed creation of the ICS mechanism as part of the proposed federal action. Potential cumulative effects of other related non-ICS projects are described in Chapter 5.

Several Colorado River water users have expressed preliminary interest in proposing ICS projects in the future, but the projects are not sufficiently formulated to include in this indirect effect analysis. The types of proposed projects that are being contemplated include: (1) fallowing, (2) tail-water recovery systems, (3) seepage interception, (4) ground-water desalination, (5) canal lining, (6) crop rotation, (7) importation of non-system water, (8) integrated information systems, and (9) scientific irrigation scheduling. Such future ICS proposals will be proposed and considered for approval in accordance with the operational guidelines to be adopted in the ROD[1].

SNWA proposes three ICS projects which were specifically formulated to utilize the ICS mechanism. It is anticipated that creation of ICS and subsequent delivery of water from Lake Mead for these currently proposed projects will be approved as part of the ROD. While the proposed SNWA ICS projects are not federal projects, they will rely on Reclamation's approval for creation, accounting, and delivery of water from Lake Mead. The effects of these projects within the geographic scope of the proposed federal action have been included in the modeling assumptions and are therefore included in the various resource analyses in the Final EIS. The localized impacts of these ICS projects (outside the geographic scope of the proposed federal action) are described here as indirect effects of Reclamation's establishment of the ICS mechanism.

The currently proposed ICS projects addressed in this section include:

- SNWA Virgin River and Muddy River Tributary Conservation;
- SNWA Coyote Spring Well and Moapa Transmission System Project; and
- Lower Colorado River Drop 2 Storage Reservoir Project.

Each of these currently proposed projects is described below.

[1] Reclamation has included draft guidelines in the Final EIS (Appendix S) that discuss the administration of ICS.

4.16.1 ICS Projects Directly Related to Creation of ICS Mechanism

4.16.1.1 SNWA Virgin River and Muddy River Tributary Conservation

As part of an ongoing initiative to protect southern Nevada from drought and augment future water supplies, SNWA proposed a project in 2004 to develop surface flows from the Virgin River and Muddy River for which it holds water rights. The SNWA currently holds water right Permit 58591 (priority date 1989) and Permit 57643 (priority date 1993) for a total not to exceed annual diversion from the Virgin River of 190 kaf, and also owns pre-BCPA water rights in the form of shares which were purchased from irrigation companies on the Virgin River and Muddy River.

SNWA would utilize pre-BCPA Virgin River and Muddy River water rights by retiring the rights from their current use and allowing them to flow into Lake Mead for recovery for municipal and industrial purposes, also known as Tributary Conservation ICS. Tributary Conservation is a form of ICS where water rights on Colorado River tributaries within the Lower Basin states that have been used for a significant period of years and were perfected prior to June 25, 1929 (the effective date of the BCPA) could be retired and allowed to flow into the Colorado River mainstream. Under the proposed federal action, the Lower Basin state that provides such Tributary Conservation could then recover the amount of water contributed through Tributary Conservation for municipal or industrial purposes only.

Pre-BCPA water rights on the Virgin River have a priority date of pre-1905 and were decreed by the Nevada Supreme Court in 1927. The decree allocated 17,785 afy to the Bunkerville and Mesquite Irrigation Companies. SNWA currently owns shares in the Bunkerville Irrigation Company representing approximately 3,700 afy of surface water rights, but does not currently own any shares in the Mesquite Irrigation Company. On the Muddy River, water rights were decreed in 1920 and that decree allocated the entire flow of the Muddy River. On the lower Muddy River, the entire flow is diverted by the Muddy Valley Irrigation Company for agricultural use. SNWA currently owns shares in the Muddy Valley Irrigation Company representing approximately 7,000 afy of pre-BCPA surface water rights. On the upper Muddy River, SNWA leases approximately 1,000 afy from the Church of Jesus Christ of Latter-Day Saints (LDS Church). The LDS Church lease is for a term of 20 years, with an option to renew the lease for an additional 20 years.

SNWA has been purchasing pre-BCPA water rights on the Virgin River and Muddy River since 1997 in an effort to reduce SNWA's dependence on the Colorado River and to develop additional water supplies for Southern Nevada. SNWA's purchase and retirement of pre-BCPA water rights will allow for assured flows within the entire Muddy River and the portion of the Virgin River downstream of the Bunkerville and Mesquite Irrigation Companies by using flows that were historically consumptively used off channel by agriculture for the creation of Tributary Conservation ICS.

4.16.1.2 SNWA Coyote Spring Well and Moapa Transmission System Project

This project involves the development of groundwater production and conveyance facilities for groundwater from Coyote Spring Valley in Clark County, Nevada. The purpose of the Coyote Spring Well and Moapa Transmission System Project is to develop and convey SNWA's existing 9,000 afy of Coyote Spring Valley water rights in an efficient and practical manner to locations where such water can be placed to a beneficial use by SNWA and/or Moapa Valley Water District. This project would increase diversification of SNWA's current water resources to include non-Colorado River water resources.

SNWA applied to BLM for a Right of Way for the project facilities in November 2002. The application required BLM to prepare an EA which was initiated in July 2003. The Final EA and FONSI for the project were issued in June 2007.

4.16.1.3 Lower Colorado River Drop 2 Storage Reservoir Project

The lower Colorado River Drop 2 Storage Reservoir Project is one of many potential actions that will be taken to maximize beneficial use of Colorado River water in the United States. Reclamation issued a draft EA on November 30, 2006 for public review. The specific objectives of the proposed Drop 2 Storage Reservoir Project include:

- providing additional storage capacity to reduce non-storable flows of the Colorado River below Parker Dam; and
- providing additional operational flexibility in the lower Colorado River system for the Imperial Irrigation District, Coachella Valley Water District, and other Colorado River system users.

The Drop 2 Storage Reservoir Project has three primary physical components: 1) the reservoir itself; 2) an inlet canal; and 3) an outlet canal:

- **Reservoir.** Two 4,000 af capacity reservoir cells would be formed by excavating below the existing ground surface. The approximate depth of the reservoir would be 20 feet. The reservoir would occupy approximately 621 acres.
- **Inlet Canal.** The inlet canal would be from five to seven miles in length depending on alignment. Inlet canal capacity would be 1,700 cfs.
- **Outlet Canal.** The outlet canal would be approximately 3,500 feet in length, connecting the reservoir to the AAC near Drop 2 Reservoir Project. Outlet canal capacity would be 1,700 cfs.

The Drop 2 Storage Reservoir Project operations would be relatively simple: a new inlet canal would convey water from the existing Coachella Canal Turnout on the AAC to a new storage reservoir, and as needed, water would be returned to the AAC via a new outlet canal. Both the inlet and outlet canals would be designed to use gravity flow.

Recent legislation passed by Congress in late 2006[2] requires that the Secretary proceed "without delay" with the "construction, operation and maintenance" of the Drop 2 Storage Reservoir Project. Reclamation published a Final EA on the project and made it available to the public on June 20, 2007. Construction is scheduled to begin in 2008.

4.16.2 Impacts by Resource

4.16.2.1 Hydrologic Resources and Water Delivery

The SNWA Virgin River and Muddy River Tributary Conservation are projected to result in up to 30,000 af of additional water being delivered to Lake Mead annually from the Virgin River and the Muddy River. Approximately one-third of this amount is expected to come from the Virgin River and two-thirds from the Muddy River. This is consistent with the flow volumes that were analyzed in the Final EIS and the additional flow volumes from the Virgin River and Muddy River analyzed in the LCR MSCP for effects to Lake Mead.

The retired agricultural water rights will be conveyed to Lake Mead via the Overton Arm in one of two fashions. Water will be diverted from the Colorado River through its historic point of diversion, flow through irrigation company ditches, and return to the mainstream Colorado River further downstream if the flow is necessary in the irrigation company ditches to avoid impacts to the irrigation company's operations or wildlife. This is the proposed operation for waters thus far acquired in the Bunkerville Irrigation Company and Muddy Valley Irrigation Company. Alternatively, if the water is not associated with an irrigation company or not required for the purposes described above, it will not be diverted and instead will remain in the channel and allowed to flow to the mainstream Colorado River. Additional information on the hydrology of the Lower Virgin River and Muddy River is provided in Appendix R.

The effects to lower Virgin River and Muddy River hydrology are detailed in Appendix R. In the Virgin River, the 10,000 afy of Tributary Conservation represents less than 7 percent of the historic annual flow in the Virgin River at Halfway Wash. Given the relative magnitudes of flow, and the complex geology and underflow that occur in the floodplains along the entire Virgin River, it is questionable whether there would be any noticeable change in surface flows on the Virgin River from this project. Upper Muddy River surface water flow is measured at the Moapa and Glendale gages, which average

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[2] The full text of the legislation, contained in Public Law 109-432 provides:
: "SEC. 396. REGULATED STORAGE WATER FACILITY.
(a) CONSTRUCTION, OPERATION, AND MAINTENANCE OF FACILITY.—
Notwithstanding any other provision of law, upon the date of enactment of this Act, the Secretary shall, without delay, pursuant to the Act of January 1, 1927 (44 Stat. 1010, chapter 47) (commonly known as the ''River and Harbor Act of 1927''), as amended, design and provide for the construction, operation, and maintenance of a regulated water storage facility (including all incidental works that are reasonably necessary to operate the storage facility) to provide additional storage capacity to reduce nonstorable flows on the Colorado River below Parker Dam.
(b) LOCATION OF FACILITY.—
The storage facility (including all incidental works) described in subsection (a) shall be located at or near the All American Canal."

approximately 30,000 afy. The current leased SNWA water rights in the upper Muddy River (1,000 afy) represent approximately 3 percent of the gages' flow, well within a typical gage margin of error of 10 percent and virtually undetectable. In the lower Muddy River, the surface flows are measured at the Overton Gage which averages approximately 9,000 afy. This gage reflects surface water flows reaching Lake Mead. While there have been no studies confirming irrigation system losses to the alluvium, it is believed that there is water bypassing the Overton Gage as underflow. Because of irrigation system losses and substantial underflow bypassing the gage, simply subtracting the Moapa-Glendale Gage readings from the Overton Gage readings will not provide an accurate accounting of the volume of Tributary Conservation flow reaching Lake Mead. Like the Virgin River and upper Muddy River, the complex geology, gaging accuracies and historic use of this water will make it difficult to see a marked increase in the Overton Gage from Tributary Conservation flows. Due to all the factors mentioned above, 20,000 afy of Tributary Conservation is not likely to result in a noticeable change to flows on the Muddy River from the current conditions. Additional information on the effects to river hydrology is provided in Appendix R.

The hydrologic impacts on Lake Mead from additional inflows from the Virgin River and Muddy River, and additional water deliveries to SNWA, were included in the modeling assumptions and are described in Chapter 4.3 of the Final EIS. Impacts of the Virgin River and Muddy River tributary conservation projects are described in this section.

The development of Coyote Spring Well and the Moapa Transmission System would similarly result in increased flows into Lake Mead. The project would develop and convey SNWA's existing 9,000 afy of Coyote Spring Valley water rights for delivery into the mainstream of the Colorado River. These hydrologic effects were also included in the modeling conducted for this EIS. For the reasons described above, the positive effect on river flow would be subtle, if noticeable at all.

The Drop 2 Storage Reservoir Project would result in a reduction in the non-storable flows that are delivered to Mexico. The Drop 2 Storage Reservoir Project was included in the hydrologic modeling for Lake Mead and the Colorado River conducted for this EIS, and any resulting impacts are included in the analysis in Sections 4.3 and 4.4. The EA for the Drop 2 Storage Reservoir Project included a specific analysis of the hydrologic impacts of the project on smaller (non-flood release) flows in the limitrophe division of the Colorado River. The EA concluded decreases in surface water flows passing Morelos Diversion Dam would not conflict with 1944 Treaty delivery obligations, or substantially alter the existing drainage pattern or flows of the limitrophe reach. The slight decrease in flows could potentially adversely affect groundwater levels, but the change does not represent a significant impact to groundwater supplies.

4.16.2.2 Water Quality

No significant impacts on water quality in the Virgin River and the Muddy River are anticipated from the SNWA Tributary Conservation. For the reasons described immediately above, the changes in river flow, while positive, would be within a typical gage margin of error of ten percent and virtually undetectable. Potential water quality impacts of the Drop 2 Storage Reservoir Project on the Colorado River were included in the modeling assumptions, and are included in the analysis in Section 4.5. The localized short-term and long-term water quality impacts of the Drop 2 Storage Reservoir Project were considered in the Reclamation EA and determined not to be significant, with implementation of mitigation measures, such as construction of sediment traps (e.g., hay bales, silt fences, straw wattles) and temporary desilting basins for onsite erosion control.

4.16.2.3 Air Quality

Any effect from SNWA's development of pre-BCPA water rights on the Virgin River and the Muddy River, the development of the Coyote Spring Well and the Moapa Transmission System, and the Drop 2 Storage Reservoir Project on Lake Mead was taken into account in the modeling performed for this project, and any impacts of wind blown dust from exposed reservoir shoreline is included in the analysis in Section 4.6. SNWA's Virgin River and Muddy River Tributary Conservation project has the potential to contribute to air quality concerns through the retirement of agricultural lands. However, this concern is mitigated by the gradual implementation of the full project. Moreover, some of the water rights that SNWA purchased may have already been regularly fallowed or out of production at the time they were acquired by SNWA. The air quality effects of the Coyote Spring Well and the Moapa Transmission System were considered in the BLM EA and determined not to be significant because construction emissions would cease at the completion of construction and will be mitigated by implementation of an approved dust control plan. Air emissions from the Drop 2 Storage Reservoir Project were estimated in the Reclamation EA for the project and determined not to be significant. Project air emissions from both construction and operation and maintenance activities would remain below all emission significance thresholds would produce no significant air quality impacts.

4.16.2.4 Visual Resources

The potential impact of SNWA's development of pre-BCPA water rights on the Virgin River and the Muddy River, the development of the Coyote Spring Well and the Moapa Transmission System, and the Drop 2 Storage Reservoir Project related to the exposure of the calcium carbonate ring around Lake Mead was included in the modeling for Lake Mead elevations, as described in Section 4.7. SNWA's Virgin River and Muddy River Tributary Conservation would not result in visual impacts because, as described above, the increased flows in the two rivers would likely not be noticeable. Visual impacts from the Coyote Spring Well and the Moapa Transmission System were considered in the BLM EA and determined not to be significant because SNWA will mitigate visual effects by restoring the pipeline right-of-way and using best management practices to reduce the line and form contrast of the regulating tank by application of color, reduction of height, reduction of size, and addition of architectural features. Construction emissions from the Drop 2 Storage Reservoir Project were considered in the Reclamation EA and determined not to be significant. The location for the Drop 2 Storage Reservoir Project is a former working farm and the location has no visually unique characteristics. As this site is presently void of any significant visual feature, and as the nearby open space areas would remain unchanged from existing conditions, construction and operation under the Drop 2

Storage Reservoir River Project would not degrade the existing visual character or quality of the site and its surroundings.

4.16.2.5 Biological Resources

In general, increased flow from the SNWA Virgin River and Muddy River Tributary Conservation is expected to have a beneficial, albeit minor, effect on any marsh or riparian habitat along the Muddy River or within the Mormon Mesa area on the Virgin River. No effect is anticipated on the Virgin River above the Bunkerville Irrigation Company service area, as acquisition of surface water rights will take place below this area.

Drought has been identified as one type of event that could create conditions that can impact sensitive fish species on the Lower Virgin River and the Muddy River. The assured flows in the Virgin River and the Muddy River proposed by the SNWA Tributary Conservation Program are expected to have a beneficial effect on fish and bird species because they may help lessen the effects of drought (Bio-West Inc. 2007). While drought tends to decrease river flows, the Tributary Conservation flows are expected to act as an assured baseflow for sensitive fish and bird species on the Muddy River and below the Bunkerville Irrigation Company service area on the Virgin River. Potential effects to species within Lake Mead from increased flows from the Virgin River and the Muddy River are described in Section 4.8 and were addressed in the LCR MSCP. More detailed information on the existing biological resources along the Virgin River and the Muddy River and potential project impacts is provided in Appendix R. The Coyote Spring Well and the Moapa Transmission System would have similar, but proportionately smaller benefits to biological resources. Other biological impacts from the Coyote Spring Well and the Moapa Transmission System were considered in the BLM EA and determined not to be significant because any impacts to species will be mitigated through the Clark County Multiple Species Habitat Conservation Program and conservation measures implemented through the Biological Opinion for the project. Restoration of the right-of-way will minimize impacts to vegetation.

The Drop 2 Storage Reservoir Project will reduce the amount of non-storable flows that arrive at Morelos Diversion Dam, resulting in reduced frequency of a portion of these flows in the limitrophe reach of the Colorado River. These and other impacts to biological resources from the Drop 2 Storage Reservoir Project were described in the Reclamation EA for the project and determined not to be significant. Because the habitat where the storage reservoir would be constructed is already relatively disturbed, the development would not result in a significant adverse effect on vegetation and wildlife habitat.

Reductions in non-storable flows to Morelos Diversion Dam would not significantly affect riparian communities and associated wildlife of the limitrophe. Based on results of groundwater modeling, the potential impacts on marsh habitats from potential changes in minimum groundwater levels are considered not significant. Potential impacts on occupied southwestern willow flycatcher habitat are considered not significant. The implementation of the proposed compensation and the conservation of habitat will fully mitigate impacts to the flat-tailed horned lizard.

4.16.2.6 Cultural Resources

SNWA's Virgin River and Muddy River Tributary Conservation would not result in impacts to cultural resources because, as described above, the increased flows in the two rivers would not cause effects outside their normal channels. Further, because the surface water rights acquired are not appurtenant to specific land parcels, there would be no way to associate the water rights acquisition to specific land use changes. Cultural resource impacts from the Coyote Spring Well and the Moapa Transmission System were considered in the BLM EA and determined not to be significant because no impacts to historic properties or paleontological resources are proposed and impacts to one cultural resource site has been mitigated by implementation of an archeological site treatment plan. Reclamation considered cultural resources for the Drop 2 Storage Reservoir Project as part of its EA. Mitigation or avoidance will be implemented for the four historic properties which may be either directly or indirectly affected by the proposed project. There would be no significant residual impacts to cultural resources.

4.16.2.7 Indian Trust Assets

SNWA's Virgin River and Muddy River Tributary Conservation would not result in impacts to ITAs because, as described above, the increased flows in the two rivers would not cause effects outside their normal channels. Further, because the surface water rights acquired are not appurtenant to specific land parcels, there would be no way to associate the water rights acquisition to specific land use changes. No ITAs were identified by BLM in the area affected by the Coyote Spring Well and the Moapa Transmission System. No Indian tribes, groups, or individuals have identified any specific ITAs during the public notification or scoping process. Therefore, no impacts to ITAs are anticipated from implementation of the project. Reclamation considered ITAs for the Drop 2 Storage Reservoir Project as part of its EA and determined that none would be affected. The Drop 2 Storage Reservoir Project would augment Reclamation's ability to meet its obligations to Colorado River water users, including the Quechan Tribe.

4.16.2.8 Electrical Power

SNWA's development of pre-BCPA water rights on the Virgin River and the Muddy River, the development of the Coyote Spring Well and the Moapa Transmission System, and the Drop 2 Storage Reservoir Project would result in limited impacts to power production. These projects were included in the hydrologic modeling for the EIS, and the potential impacts of these changes on power production are included in Section 4.11. None of the projects would have significant effects on electrical power resources in the local project areas.

4.16.2.9 Recreation

SNWA's Virgin River and Muddy River Tributary Conservation would not result in impacts to recreational activities because the increased flows in the two rivers would be small. Potential impacts to recreational activities from the Coyote Spring Well and the Moapa Transmission System were considered in the BLM EA and determined not to be significant. Reclamation considered potential recreation impacts for the Drop 2 Storage

Reservoir Project as part of its EA and determined that the Drop 2 Storage Reservoir Project would have impacts during the construction period through temporary closure of BLM trails, and some access roads to recreation areas. These temporary closures were determined not to be a significant impact on recreation.

4.16.2.10 Transportation

SNWA's Virgin River and Muddy River Tributary Conservation would not result in impacts to transportation because the two rivers are not used for transportation. Potential impacts to transportation from the Coyote Spring Well and the Moapa Transmission System were considered in the BLM EA and determined not to be significant because there are currently low levels of traffic in the vicinity and construction traffic impacts would cease at the end of construction activity. Reclamation considered potential transportation impacts for the Drop 2 Storage Reservoir Project as part of its EA and determined that the Drop 2 Storage Reservoir Project would have temporary, insignificant impacts to area roadways during its construction period. Impacts would be mitigated by implementation of traffic management plan and other measures. The outlet canal would be installed as a pipe underneath Interstate 8 (I-8). This construction has the potential to require temporary closure of some travel lanes of I-8. During the Drop 2 Storage Reservoir Project construction Reclamation will direct the contractor to maintain at least one eastbound travel lane and one westbound travel lane on I-8 (or the functional equivalent using detours).

4.16.2.11 Socioeconomics

SNWA has been purchasing pre-BCPA water rights on the Virgin River and the Muddy River since 1997, in an effort to reduce SNWA's dependence on the Colorado River and to develop additional water supplies for Southern Nevada. As of July 1, 2007, SNWA has acquired water rights from Virgin River and Muddy River sources that will yield an average annual water supply of approximately 11,700 af. SNWA anticipates acquiring a total of approximately 30,000 afy of pre-BCPA water rights from entities with rights on the Virgin River and the Muddy River. Water rights historically used for agriculture along these two rivers are being voluntarily sold or leased to willing buyers, including buyers not associated with SNWA. Sometimes the water rights are leased back for agricultural use with a provision that at the end of the lease term, the water rights will be retired and allowed to return to the river system. Socioeconomic impacts on the local communities are reduced by the gradual nature of the acquisition program. The gradual conversion of these agricultural water rights to other uses is ongoing and will continue regardless of the establishment of the ICS mechanism, and this particular project. The Coyote Spring Well, the Moapa Transmission System, and the Drop 2 Storage Reservoir Project will result in short-term economic benefits from the creation of jobs and purchases of materials, supplies, and services. These effects were considered in the two EA's for these projects. The Drop 2 Storage Reservoir Project would have no effect on agricultural production and related revenues within Imperial County.

4.16.2.12 Environmental Justice

SNWA's Virgin River and Muddy River Tributary Conservation would not result in disproportionately high and adverse human health and environmental impacts to low-income or minority populations. The acquisition of surface water rights is from willing sellers and provides an economic benefit to the sellers. No environmental justice impacts were identified in the BLM EA for the Coyote Spring Well and the Moapa Transmission System. Reclamation considered environmental justice impacts for the Drop 2 Storage Reservoir Project as part of its EA and determined there would be no disproportionate impacts to low-income or minority populations.

Chapter Five

5.1 Federal Statutes and Policies

In compliance with NEPA, this Final EIS is intended to provide decision makers and the public with information regarding compliance with other environmental laws, rules, and regulations that are applicable to the proposed federal action as well as the environmental impacts of the proposed federal action, as presented below.

5.1.1 Endangered Species Act of 1973, as Amended (16 U.S.C. Sections (§§) 1531-1544)

Section 7 of the ESA requires federal agencies to consult with FWS to ensure that undertaking, funding, permitting, or authorizing an action is not likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, as defined under the law.

Adoption of the proposed federal action by the Secretary is a discretionary federal action and it is, therefore, subject to compliance with ESA. Reclamation has prepared a biological assessment to address the potential effects of the proposed federal action on listed species and has initiated formal consultation with FWS (Appendix R). It is anticipated that consultation will be completed prior to Reclamation's execution of a Record of Decision.

5.1.2 Fish and Wildlife Coordination Act of 1934, as Amended (16 U.S.C. §§ 661-667d)

The Fish and Wildlife Coordination Act of 1934, as amended, requires consultation and coordination with federal and state wildlife agencies to ensure that fish and wildlife are given equal consideration when developing water resources projects. This Act applies "whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified…" and requires that the responsible federal agency "shall consult with the United States Fish and Wildlife Service, Department of the Interior, and with the head of the agency exercising administration over the wildlife resources of the particular State wherein the impoundment, diversion, or other control facility is to be constructed". The proposed federal action is not a construction project. Nevertheless, FWS is a cooperating agency and has been involved in the preparation of the Draft EIS and the Final EIS. In addition, FWS reviewed and provided comments on the Draft EIS and the Final EIS. The close coordination with FWS on this project meets the intent and provisions of the Fish and Wildlife Coordination Act.

5.1.3 National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd)

The National Wildlife Refuge System Administration Act of 1966 provides for the administration and management of the national wildlife refuge system, including wildlife refuges, areas for the protection and conservation of fish and wildlife threatened with extinction, wildlife ranges, game ranges, wildlife management areas and waterfowl production areas. The study area includes the following four national wildlife refuges on the Colorado River downstream of Hoover Dam: Havasu NWR, Bill Williams NWR, Cibola NWR, and Imperial NWR. Only minor changes in Colorado River flow through these refuges would occur under the action alternatives. No adverse impacts to refuges would result from the proposed federal action; thus, it would be consistent with the National Wildlife Refuge System Administration Act.

5.1.4 Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§ 1271-1287)

The Wild and Scenic Rivers Act of 1968 establishes a National Wild and Scenic Rivers System for the protection of rivers with important scenic, recreational, fish and wildlife, and other values. Rivers are classified as wild, scenic or recreational. The Congressional policy behind the National Wild and Scenic Rivers System is not to halt use of a river; instead, the goal is to preserve the character of a river. Uses compatible with the management goals of a particular river are allowed; however, development must ensure the river's free flow and protect its "outstandingly remarkable resources." The Wild and Scenic Rivers Act of 1968 designates specific rivers for inclusion in the National Wild and Scenic Rivers System and prescribes the methods and standards by which additional rivers may be added. There are no designated wild and scenic rivers within the study area.

However, pursuant to Section 5(d) of the Wild and Scenic Rivers Act, NPS has compiled and maintains a Nationwide Rivers Inventory (NRI), a register of river segments that potentially qualify as national wild, scenic, or recreational river areas. The NRI is a listing of more than 3,400 free-flowing river segments in the United States that are believed to possess one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance. Under a 1979 Presidential directive, and related Council on Environmental Quality procedures, all federal agencies must seek to avoid or mitigate actions that would adversely affect one or more NRI segments. Within the study area, NPS has identified four river segments (with segment lengths provided in parentheses) on the NRI:

- Colorado River from Paria Riffle (RM 1) to 237-Mile Rapid in Grand Canyon National Park (236 miles);
- Colorado River from Glen Canyon Dam to Lake Mead (278 miles);
- Colorado River from upper end of Lake Havasu (Blankenship Bend) to Interstate Highway 40 bridge crossing in Topock (11 miles); and
- Colorado River from gaging station below Cibola Lake to Martinez Lake (Fishers Landing) (31 miles).

The relatively minor changes in flow associated with the proposed federal action would not adversely affect the values for which these Colorado River segments were identified.

5.1.5 Migratory Bird Treaty Act of 1918 (16 U.S.C. §§ 703-712)

The Migratory Bird Treaty Act of 1918 protects migratory birds by limiting the hunting, capturing, selling, purchasing, transporting, importing, exporting, killing, or possession of these birds or their nests or eggs. The specific migratory birds covered are identified in separate agreements between the United States and Great Britain, Mexico, and Japan. No significant adverse impacts to migratory birds would result from the proposed federal action; thus, it would be consistent with the Migratory Bird Treaty Act.

5.1.6 Migratory Bird Conservation Act of 1929 (16 U.S.C. § 715)

The Migratory Bird Conservation Act of 1929 protects migratory birds by creating the Migratory Bird Conservation Commission. This commission's purpose is to consider and approve the purchase, rental, or other acquisition of any areas of land or water that may be recommended by the Secretary for the purpose of establishing sanctuaries for migratory birds. No significant adverse impacts on migratory birds would result from the proposed federal action; thus, it would be consistent with the Migratory Bird Conservation Act.

5.1.7 Bald Eagle Protection Act of 1940 (16 U.S.C. § 668)

The Bald Eagle Protection Act of 1940 imposes criminal and civil penalties on anyone in the United States or within its jurisdiction who, unless excepted, takes, possesses, sells, purchases, barters, offers to sell or purchase or barter, transports, exports or imports at any time or in any manner a bald or golden eagle, alive or dead; or any part, nest or egg of these eagles; or violates any permit or regulations issued under the Bald Eagle Protection Act. No adverse impacts to bald eagles would result from the proposed federal action; thus, it would be consistent with the Bald Eagle Protection Act.

5.1.8 Clean Air Act of 1963, as Amended (42 U.S.C. § 7506)

The primary objective of the Clean Air Act of 1963, as amended, is to establish federal standards for air pollutants from stationary and mobile sources and to work with the states to regulate polluting emissions. The Clean Air Act is designed to improve air quality in areas of the country that do not meet federal standards and to prevent significant deterioration in areas where air quality exceeds those standards. The proposed federal action would not result in any emissions from stationary or mobile sources or violate air quality standards. Therefore the proposed federal action is consistent with the Clean Air Act.

5.1.9 Federal Water Pollution Control Act (Clean Water Act) of 1972, as Amended (33 U.S.C. Chapter 26)

Section 404 of the Clean Water Act of 1972, as amended, identifies conditions under which a permit is required for construction projects that result in the discharge of fill or dredged materials into waters of the United States. Section 402 of the Clean Water Act requires a permit for the discharge of pollutants into waters of the United States. No construction activities are associated with implementation of the proposed federal action. Therefore, it is consistent with the Clean Water Act.

5.1.10 River and Harbors Act of 1899 (33 U.S.C. §§ 401-403)

The River and Harbors Act of 1899 protects the public's right to free navigation in navigable waters of the United States as described by the USACE Section 10/404 implementing regulations at 33 C.F.R. pt. 329. The River and Harbors Act also prohibits unauthorized construction in navigable waters of the United States. No construction activities are associated with implementation of the proposed federal action. Therefore, it is consistent with the River and Harbors Act.

5.1.11 National Historic Preservation Act of 1966, as Amended (16 U.S.C. § 470)

Federally funded undertakings that have the potential to impact historic properties are subject to Section 106 of the NHPA and its implementing regulations under 36 C.F.R. pt. 800. Under the National Historic Preservation Act of 1966, as amended, federal agencies are responsible for the identification, management, and nomination to the NRHP of cultural resources; if a proposed undertaking would affect historic properties, the agency must afford the Advisory Council on Historic Preservation the opportunity to comment. Reclamation's compliance with the National Historic Preservation Act, as amended, is described in Section 4.9.

5.1.12 Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. §§ 3001-3013)

Native American Graves Protection and Repatriation Act of 1990 assigns ownership to Indians of human burials and associated grave goods, which are excavated or discovered on federal or Tribal lands. Implementation of the proposed federal action has no potential to disturb Indian human remains or associated funerary objects; however, Reclamation and the other Department agencies with compliance responsibilities under this Act or its implementing regulations are committed to compliance with the inadvertent discovery process in pertinent laws and regulations.

5.1.13 Archaeological Resources Protection Act of 1979 (16 U.S.C. § 470)

The Archaeological Resources Protection Act (ARPA) of 1979 provides for the protection of archaeological resources on public and Indian lands. Protection of archaeological resources, under the guidelines of ARPA, includes consideration of excavation and removal of resources, enforcement of ARPA, and confidentiality of information concerning the nature and location of archaeological resources. It also provides substantial criminal and civil penalties for those who violate the terms of ARPA. Should any data recovery be proposed as a result of cultural resources compliance and consultation, Reclamation or its contractors shall seek the appropriate ARPA permits.

5.1.14 Farmland Protection Policy Act of 1981 (7 U.S.C. §§ 4201-4209)

The purpose of the Farmland Protection Policy Act of 1981 is to minimize the extent to which federal programs contribute to the unnecessary conversion of farmland to nonagricultural uses. The proposed federal action will not permanently convert any farmland, prime or otherwise. The Farmland Protection Policy Act also stipulates that federal programs be compatible with state, local, and private efforts to protect farmland. While there is a potential for increased temporary land following during droughts under some of the action alternatives, the proposed federal action would not likely result in the conversion of farmland to nonagricultural uses. Any impact from the storage and delivery mechanism would not result in the permanent conversion of any prime farmland. Therefore, the proposed federal action is consistent with the Farmland Protection Policy Act.

5.1.15 Executive Order No. 11988, Floodplain Management, May 24, 1977

This executive order requires avoiding or minimizing harm associated with the occupancy or modification of a floodplain. The proposed federal action would not involve modifications or occupancy of any floodplain, therefore the proposed federal action is consistent with Exec. Order No. 11988.

5.1.16 Executive Order No. 11990, Protection of Wetlands, May 24, 1977

This executive order provides for protection of wetlands through avoidance or minimization of adverse impacts. The proposed federal action would not involve modifications of or construction within jurisdictional wetlands, therefore, the proposed federal action is consistent with Exec. Order No. 11990. Minor changes in river flow and its potential effect on backwaters and marsh habitat is discussed in Section 4.8.

5.1.17 Executive Order No. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, February 11, 1994

This executive order directs agencies to identify and address, as appropriate, disproportionately high and adverse human health and environmental impacts of their programs, policies, and activities on minority and low-income populations. An analysis of the effects of the proposed federal action on minority and low-income populations is included in Section 4.15 of this Final EIS. No significant disproportionate impacts on minority or low income populations were identified.

5.1.18 Executive Order No. 13007, Indian Sacred Sites, May 24, 1996

This executive order requires that all Executive Branch agencies that have responsibility for the management of federal lands will, where practicable, permitted by law, and not clearly inconsistent with essential agency functions, provide access to Indian sacred sites for ceremonial use by Indian religious practitioners, and will avoid adversely impacting the integrity of these sites. When possible, federal agencies must also maintain the confidentiality of sacred sites. Implementation of the proposed federal action would not conflict with the requirements of Exec. Order No. 13007.

5.1.19 Executive Order No. 12114, Environmental Impacts Abroad of Major Federal Actions, January 4, 1979

The 1944 Treaty between the United States and Mexico (including its implementing Minutes) establishes the obligations of the United States regarding the delivery of Colorado River water to Mexico. In addition, Section 397 of Public Law 109-432 states: "The Treaty between the United States of America and Mexico relating to the utilization of waters of the Colorado and Tijuana Rivers and of the Rio Grande, and supplementary protocol signed November 14, 1944, signed at Washington February 3, 1944 (59 Stat. 1219) is the exclusive authority for identifying, considering, analyzing, or addressing impacts occurring outside the boundary of the United States of works constructed, acquired, or used within the territorial limits of the United States."

Exec. Order No. 12114 provides among other things that: (1) federal agencies involved in actions with potential significant environmental impacts outside of the United States must provide information to federal decision makers so that the potential effects may be analyzed with other pertinent considerations of national policy; (2) activities involving foreign governments be coordinated through the Department of State; and (3) pertinent information may be withheld from other agencies and nations when necessary to avoid adverse impacts to foreign relations and ensure appropriate reflection of diplomatic factors. Section 1 of Exec. Order No. 12114 provides that it is the United States' "exclusive and complete determination of the procedural and other actions to be taken by the federal agencies to further the purpose of the National Environmental Policy Act, with respect to the environment outside the United States, its territories and possessions."

Reclamation has complied with Exec. Order No. 12114 and Public Law 109-432 by informing the Department of State of the proposed federal action and by providing technical support to the USIBWC for its consultation with Mexico. This Final EIS incorporates appropriate information regarding potential hydrologic and water quality impacts to Mexico at the border with Mexico that have been prepared after coordination with the USIBWC, as well as with representatives of the Department of State.

5.1.20 Secretarial Order No. 3206, American Indian Tribal Rights, Federal-Tribal Trust Responsibility, and the Endangered Species Act, June 7, 1997

This Secretarial Order directs that the Department and it's sub-bureaus carry out their responsibilities under ESA in a manner "that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the Departments, and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation." Implementation of the proposed federal action will be undertaken consistent with the requirements of this Secretarial Order.

5.2 Cumulative Impacts

The CEQ's regulations (40 C.F.R. pt. 1500 through 1508) implementing the procedural provisions of NEPA defines cumulative impacts as the following:

> "…the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 C.F.R. pt. 1508.7)."

Cumulative impacts refer to two or more individual impacts that, when considered together, are significant or that compound or increase other environmental impacts. Cumulative impacts can be categorized as additive and interactive. An additive impact results from additions from one kind of source either through time or space. An interactive impact results from more than one kind of source.

Generally, other actions that could result in cumulative impacts when considered in tandem with the effects of the proposed federal action (as identified in Chapter 4) have been incorporated into modeling of future system conditions. Such actions include future increases in consumptive use of Colorado River water in the Upper Division states, intrastate water transfers in the Lower Division states (e.g., QSA water transfers), implementation of the LCR MSCP, and various requirements and constraints applied to the operation of the Colorado River system.

This section addresses the cumulative impacts of the proposed federal action combined with other regional water supply or closely related projects in the region. Closely related projects that could result in significant cumulative impacts are briefly described below.

5.2.1 SNWA Clark, Lincoln, and White Pine Counties Groundwater Development Project

This project includes groundwater production, conveyance and treatment facilities, and power conveyance facilities located in central and eastern Nevada. The project as proposed would develop and convey up to 167 kafy of groundwater from Clark, Lincoln, and White Pine Counties to the Las Vegas Valley for use in the SNWA service area to supplement the SNWA water supplies. This project will assist SNWA in meeting southern Nevada's projected future water demands and increase the diversification of SNWA's current water resources to include non-Colorado River groundwater resources.

SNWA applied to BLM for the Rights of Way for the pipelines and other facilities. BLM is the lead federal agency preparing SNWA's groundwater EIS to analyze the environmental issues associated with SNWA's request for Rights of Way. It is not currently anticipated that this project will be completed prior to 2014. Water from this project will be fully consumptively used in southern Nevada.

5.2.2 SNWA Lake Mead Intake No. 3 Project

SNWA presently operates two water intakes at Saddle Island on the west shore of Lake Mead, approximately five miles northwest of Hoover Dam and approximately 20 miles east of the center of Las Vegas, within the LMNRA. Drought has caused declining Lake Mead elevations during recent years. Long-term water supply modeling indicates that the lake elevation is expected to decline even further in future years, even under normal hydrologic conditions in the Colorado River Basin, until the system recovers from the recent drought conditions.

SNWA proposes to construct a third deep-water intake, Intake No. 3, in Lake Mead, and other associated project components to protect the existing water system capacity against the potential loss of pumping capability of Intake No. 1 should the lake elevations fall below 1,050 feet msl. An EA is being prepared by NPS, lead federal agency, to grant SNWA's application for an expansion of an existing Right of Way associated with the construction of the proposed Intake No. 3 facilities. The major project components would include a new intake structure and intake tunnel beneath the lake and beneath Saddle Island; Intake Pumping Station No. 3 (IPS-3) on Saddle Island, the caverns or forebays beneath Saddle Island and shafts around IPS-3 for construction and connections; a conveyance pipeline from IPS-3 connecting with Alfred Merritt Smith Water Treatment Facility; and a tunnel interconnecting the Intake No. 3 tunnel with the existing Intake No. 2 tunnel beneath Saddle Island.

The Intake No. 3 project would:

- preserve water delivery system capacity;
- provide reliable water delivery system back-up capability; and

- provide operational flexibility for accessing the best available water quality for the public water supply.

The construction of the Intake No. 3 would allow SNWA to maintain full system capacity at Lake Mead elevations as low as 1,000 feet msl. The Intake No. 3 project does not propose any change or increase in the quantity of Colorado River water authorized for diversion and use by the SNWA. The project is a modification of the location from which SNWA's existing contractual rights to water are withdrawn from the Colorado River at Lake Mead, giving SNWA the flexibility to take water from different elevations and locations in Lake Mead depending on seasonal lake conditions and lake elevations.

5.2.3 Systems Conveyance and Operations Program

Reclamation and NPS prepared an EIS as joint lead federal agencies to analyze the potential impacts associated with the construction, operation, and maintenance of the SCOP. The Clean Water Coalition (CWC) is comprised of the four agencies currently responsible for wastewater treatment in Las Vegas Valley: the City of Las Vegas, the City of Henderson, the Clark County Water Reclamation District, and the City of North Las Vegas. The CWC proposes to implement the SCOP, which would include optimization of the treatment plants, increased treatment (as needed), and a pipeline to discharge the highly treated effluent into Lake Mead, while minimizing impacts to water quality and other natural resources. The SCOP would provide an alternate discharge point for the effluent, which is currently discharged to Lake Mead through the Las Vegas Wash. The purpose of the project is to maintain water-quality standards and NPS's recreational and resource values by operating a system that would allow for flexible management of wastewater flow from Las Vegas Valley to Lake Mead. The quantity of effluent treated and discharged from Las Vegas Valley will increase as the population of Las Vegas Valley increases. Wastewater facilities must accommodate the additional flows while continuing to meet current or future water quality standards for the Las Vegas Wash, Las Vegas Bay, and Lake Mead.

The SCOP EIS analyzed the potential environmental impacts associated with three pipeline alternatives, a Process Improvements Alternative (no pipeline), the No Action Alternative (no pipeline); and the Boulder Islands North (pipeline) alternative, which was identified as the preferred alternative.

5.2.4 Lower Colorado River Multi-Species Conservation Program

This program was developed to address potential effects to listed and other selected special status species (covered species) from identified ongoing and future anticipated federal discretionary actions and non-federal activities on the lower Colorado River (covered actions). The development and implementation of shortage criteria on the lower Colorado River was one of the federal covered actions included in the LCR MSCP and covered under the LCR MSCP BO (FWS 2005). The LCR MSCP BO covered the effects of covered actions for a reduction of Lake Mead reservoir elevations to 950 feet msl and flow reductions of up to 0.845 maf from Hoover Dam to Davis Dam, 0.860 maf from Davis Dam to Parker Dam, and 1.574 maf from Parker Dam to Imperial Dam. The LCR MSCP identified, and it is mitigating for, impacts to the covered species and their habitats from the flow reduction conditions described above. These impacts included the potential loss of up to:

- 2,008 acres of cottonwood-willow habitats;
- 133 acres of marsh habitat; and
- 399 acres of backwater habitat.

To address these impacts, the LCR MSCP will:

- restore 5,940 acres of cottonwood-willow habitat;
- restore 512 acres of marsh habitat;
- restore 360 acres of backwater habitat;
- stock 660,000 razorback sucker over the term of the LCR MSCP; and
- stock 620,000 bonytail over the term of the LCR MSCP.

In addition, these habitats will be actively managed to provide habitat values greater than those of the impacted habitats. While the LCR MSCP is geared toward special status species, it is important to understand that all species that use the habitats impacted by the LCR MSCP covered activities benefit by the conservation actions currently being carried out under the LCR MSCP. The LCR MSCP EIS evaluated the impacts of implementing the Habitat Conservation Plan and the issuance of a Section 10(a)(1)(B) permit by FWS. The LCR MSCP documents (Reclamation 2004a-e) are incorporated by reference into this Final EIS.

5.2.5 All-American Canal Lining Project

Imperial Irrigation District obtains water from the 82-mile long AAC, which diverts water from the Colorado River at Imperial Dam. This water conservation project is proceeding according to Sections 395 and 397 of Public Law 109-432. This project includes construction of a new, parallel canal from one mile west of Pilot Knob to Drop 3, a distance of 23 miles. The centerline of the new canal would be offset from the old centerline of the original canal by a distance of 300 to 600 feet, depending on terrain, ease of construction, and location of existing structures. Operation and maintenance roads would be 20 feet wide to match existing canal roads (Reclamation 1994c,d).

Excavation of 25 million cubic yards of earth is required. Excess material will be placed in waste banks along the new canal. An estimated 530 acres of new right-of-way will be required, all of which is under federal control. Other land disturbances will include a 10-acre concrete batch plant and three, 5-acre staging areas, all of which are on previously disturbed lands. Power lines would be relocated as required. Actual construction will last approximately three years. The canal would be in service year-round, as it is at the present (Reclamation 1994c,d).

Environmental impacts were identified in the following areas: groundwater quantity and quality in Mexico, biological resources (wetlands along the canal and along the impacted reach of the Colorado River, terrestrial plant communities and associated wildlife, and special status species), canal fisheries, cultural resources, hydroelectric power, and recreation (Reclamation 1994c,d). The AAC Lining Project will employ compensation measures to reduce potential air quality impacts. A variety of mitigation measures have been incorporated into the project, including establishing 43 acres of honey mesquite and cottonwood/willow and one acre of marsh, restoring shelter for juvenile fish by constructing artificial reefs in the canal, replacing and protecting habitat for special status species and to help maintain the fishery for recreational fishing, and avoiding cultural resources sites where feasible.

The Final EIS/EIR for the AAC Lining Project was filed with EPA on April 14, 1994 and noticed in the *Federal Register* on April 19, 1994. A ROD was prepared and signed by the Lower Colorado Region's Regional Director on July 29, 1994. On January 12, 2006 Reclamation determined that the EIS and ROD continued to meet the requirements of NEPA. Funding for the AAC Lining Project was authorized by the California legislature in September 2003. Final designs for the AAC Lining Project were completed in January 2006 (Reclamation 2006) and construction began in Summer 2007.

5.2.6 Long-Term Experimental Plan for the Operation of Glen Canyon Dam and Other Associated Management Activities

The Upper Colorado Region of Reclamation has filed a NOI to prepare an EIS regarding experimental actions to benefit resources downstream of Glen Canyon Dam in the GCNRA and Grand Canyon National Park (71 Fed. Reg. 74556). The purpose of this Long-Term Experimental Plan is to increase understanding of the ecosystem downstream of Glen Canyon Dam and to improve and protect important downstream resources. The NEPA process would analyze the implications and impacts of each of the alternatives on all of the purposes and benefits of Glen Canyon Dam as well as on downstream resources. The Long-Term Experimental Plan would implement a structured, long-term program of experimentation (including dam operations, modifications to Glen Canyon Dam intake structures, and other non-flow management actions, such as removal of non-native fish species) and monitoring in Colorado River downstream of Glen Canyon Dam.

The Long-Term Experimental Plan is intended to ensure a continued, structured application of adaptive management in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and GCNRA were established, including, but not limited to, natural and cultural resources and visitor use, consistent with applicable federal law.

The Long-Term Experimental Plan will build on a decade of scientific experimentation and monitoring that has taken place as part of the Glen Canyon Dam Adaptive Management Program, and will build on the knowledge gained by experiments, operations, and management actions taken under that program. Accordingly, Reclamation intends to tier from earlier NEPA compliance documents prepared as part of the Department's Glen Canyon Adaptive Management Program efforts (40 C.F.R. pt. 1500.4(i), 1502.20, and 1508.20(b)), such as the 2002 EA prepared on adaptive management experimental actions at Glen Canyon Dam (Reclamation 2002).

The anticipated implementation of a Long-Term Experimental Plan for the operation of Glen Canyon Dam is not anticipated to contribute to cumulative adverse effects to the resources described below.

5.2.7 Cumulative Impacts by Resource

5.2.7.1 Hydrologic Resources and Water Delivery

Water from SNWA Clark, Lincoln, and White Pine Counties groundwater development projects will be fully consumptively used in southern Nevada and will increase return flows to Lake Mead. This increase was modeled as part of the hydrologic analysis in this Final EIS. Similarly, water conserved under the AAC lining project, and planned changes in point of delivery (a covered action under the LCR MSCP), were also accounted for in the hydrologic modeling for this Final EIS. The SCOP and SNWA Lake Mead Intake No. 3 project would not result in any cumulative effects because these projects would not alter water system operations. The Long-Term Experimental Plan would implement a structured, long-term program of experimentation (including dam operations, modifications to Glen Canyon Dam intake structures, and other non-flow management actions such as removal of non-native fish species) and monitoring in Colorado River downstream of Glen Canyon Dam. It is not expected to result in cumulative adverse impacts to hydrologic resources or water delivery.

5.2.7.2 Water Quality

For the reasons described immediately above, the potential cumulative impacts on water quality from SNWA groundwater development projects, AAC lining project, and planned changes in point of delivery were included in the modeling assumptions, and are included in the analyses presented in Section 4.5 of this Final EIS. The Long-Term Experimental Plan for Glen Canyon Dam could result in some alteration of water quality parameters, particularly temperature, in the Colorado River reach between Glen Canyon Dam and Lake Mead. Because the outcome of the planning process is not known, it would be speculative to address potential cumulative effects at this time.

The SCOP has the potential to affect water quality in Lake Mead. However, the SCOP is intended to accommodate Lake Mead's lowering elevations since the amount of mixing and dilution available in the inner Las Vegas Bay would decrease as Lake Mead elevations decrease. The SCOP also intends to provide flexibility to avoid possible impacts to source-water quality at SNWA's intake structure. As a result of these project planning criteria, no significant cumulative impacts are anticipated.

5.2.7.3 Air Quality

Changed operations due to the AAC lining project and changed points of diversion envisioned under the LCR MSCP have the potential to change storage elevations and exposed shoreline at Lake Mead. Potential effects from these operations were taken into account in the modeling performed for this EIS, and potential impacts of wind-blown dust from exposed reservoir shoreline is already included in the analyses presented in Section 4.6. The slight increase in return flow credits from the northern Nevada groundwater projects would have no cumulative effect on air quality. The LCR MSCP may result in minor reductions in fugitive dust emissions through the creation of habitat on lands that currently may be less vegetated and therefore potentially produce more fugitive dust.

5.2.7.4 Visual Resources

Potential cumulative impacts related to the exposure of the calcium carbonate ring around Lake Mead was included in the modeling for this EIS, as described above.

Implementation of the LCR MSCP will result in the creation of new habitat areas, which viewers may perceive as attractive. The proposed federal action would not affect the creation of this habitat.

5.2.7.5 Biological Resources

As noted above, the potential cumulative impacts on Lake Mead storage and releases from the increased return flows from SNWA groundwater development projects, AAC lining project, and other planned changes in point of diversion were accounted for in the hydrologic modeling for this Final EIS and are reflected in the biological impact analysis presented in Section 4.8. The LCR MSCP will result in substantial habitat creation along the lower Colorado River. This habitat creation will provide benefits to biological resources. No adverse cumulative effects to biological resources are anticipated from the SCOP or SNWA Lake Mead Intake No. 3 project. The Long-Term Experimental Plan has the potential to affect biological resources in the reach of the Colorado River between Lake Powell and Lake Mead, especially from potential flow and non-flow actions and temperature changes. It would be speculative to address potential cumulative effects associated with the ongoing Long-Term Experimental Plan process at this time because the outcome of the planning process is not known.

5.2.7.6 Cultural Resources

The proposed federal action’s effects on cultural resources result from hydrologic changes in reservoir elevations and river flows. Projects with potential for cumulative impacts were included in the hydrologic modeling; such as, cumulative impacts on cultural resources are already addressed in Section 4.9. The conservation projects to be implemented under the LCR MSCP have the potential to impact cultural resources through construction activities, as do the AAC lining, SCOP, and SNWA Lake Mead Intake No. 3 projects. Each of these projects will comply with Section 106 of the NHPA; significant adverse cumulative impacts are not anticipated.

5.2.7.7 Indian Trust Assets

The proposed federal action would not result in any substantive effects on ITAs. Therefore, it would not contribute to any cumulative effects.

5.2.7.8 Electrical Power

Effects on electrical power production related to the proposed federal action are described in Section 4.11. The hydrologic effects of the related projects discussed above were included in the modeling assumptions, have been included in the analyses. The SNWA Lake Mead Intake No. 3 project and SCOP would not have cumulative impacts related to electrical power production. The Long-Term Experimental Plan has the potential to affect power production at Glen Canyon Dam. It would be speculative to address potential cumulative effects associated with the ongoing Long-Term Experimental Plan process at this time because the outcome of the planning process is not known.

5.2.7.9 Recreation

Effects on recreation activities related to the proposed federal action are described in Section 4.12. To the extent these recreation impacts are dependent on reservoir elevations, the effects of the projects listed above are included in the analyses. The LCR MSCP, SCOP, SNWA Lake Mead Intake No. 3, and AAC lining projects would not contribute to any cumulative effects on recreation. The Long-Term Experimental Plan for Glen Canyon Dam could result in some alteration of flow and water quality parameters, particularly temperature, in the Colorado River reach between Glen Canyon Dam and Lake Mead. This could result in recreational fishing and boating impacts. It would be speculative to address potential cumulative effects associated with the ongoing Long-Term Experimental Plan process at this time because the outcome of the planning process is not known.

5.2.7.10 Transportation

Effects on transportation related to the proposed federal action are described in Section 4.13. To the extent these transportation impacts are dependent on reservoir elevations, the effects of the projects listed above are included in the analyses. The LCR MSCP, SCOP, SNWA Lake Mead Intake No. 3 project, and the Long-Term Experimental Plan would not contribute to any cumulative effects on transportation. The AAC lining project would have temporary and localized impacts on transportation during construction. These impacts would be at a significant distance from the Colorado River corridor, and no cumulative impacts are anticipated.

5.2.7.11 Socioeconomics

Effects on socioeconomics related to the proposed federal action are described in Section 4.14, and occur in the service areas of Colorado River water users, primarily in Arizona. The projects listed above would not contribute to any cumulative effects on socioeconomic conditions. The AAC lining, SCOP, SNWA Lake Mead Intake No. 3, and implementation of the LCR MSCP conservation projects will result in short-term economic benefits from creation of jobs for these construction projects. However, these temporary effects would not contribute to any cumulative effects associated with the proposed federal action.

5.2.7.12 Environmental Justice

The proposed federal action would not result in any substantive effects on environmental justice communities. Therefore, it would not contribute to any cumulative effects.

5.3 Relationship Between Short-term Uses of the Environment and Long-term Productivity

For purposes of this required regulatory assessment, Reclamation considers the interim period of the proposed federal action (through 2026) short-term, especially when compared with the longer modeling period of through 2060 or even longer durations. Within this time-frame, Reclamation would implement water management practices that would result in an increased predictability of water operations, particularly under drought and low reservoir conditions. This predictability is expected to have a stabilizing effect on the use of water in the region by ensuring that all parties have a better understanding of how the system would operate and, therefore, what management actions water users may need to undertake under such conditions, thus ensuring long-term productivity.

The trade-off between short-term uses of the environment and long-term productivity is such that Reclamation, and state and local water managers and users will gain valuable experience operating under shortage conditions, thus ultimately resulting in enhanced long-term productivity throughout the region. Adoption of the proposed federal action would contribute to the long-term predictability of water use through highly defined water operations.

5.4 Irreversible and Irretrievable Commitments of Resources

Irreversible commitments are decisions impacting non-renewable resources such as soils, wetlands, and waterfowl habitat or commitments that cannot be reversed. Such decisions are considered irreversible because their implementation would impact a resource to the point that renewal can occur only over an extremely long period of time or at great expense or because they would cause the resource to be destroyed, become extinct, or removed. The term “irreversible” describes the loss of future options and applies to the impacts of using nonrenewable resources or resources that are renewable only over a long period of time. Irretrievable commitments are those that are lost for a period of time.

Implementation of the proposed federal action would not result in irreversible or irretrievable commitment of resources. Managing water supplies in a more structured way will help conserve resources. In addition, the proposed guidelines are intentionally interim in order to provide opportunities for gaining valuable operation experience under a wide range of reservoir conditions.

Chapter Six

6.1 Introduction

This chapter describes Reclamation's public involvement program and coordination with specific federal, state and local agencies, NGOs, and the general public for the preparation of this EIS. In addition, this chapter describes Reclamation's government-to-government consultation with Indian tribes and with Mexico.

6.2 General Public Involvement Activities

The public involvement program leading to this Final EIS included project scoping, consultation, and coordination with interested stakeholders and the public. Reclamation developed and implemented a robust public involvement plan to satisfy the public participation requirements set forth in NEPA and also to establish a consistent and constant level of engagement with interested parties and stakeholders. The multi-faceted approach consisted of informational materials, formal consultations, general and stakeholder outreach, and media relations.

A variety of informational materials to educate and inform audiences about the study and related issues were employed. Fact sheets were produced and distributed that provided general project updates and also targeted specific issues or processes throughout the period of preparing this EIS. A website was established and maintained for this EIS, and contained project documents, press releases, fact sheets, points of contact, and the project schedule. An electronic mailing list was used to notify interested parties of website postings, project meetings, and documents. A project phone line and email account were maintained live during the entire period of preparing this EIS for interested parties to express opinions, ask questions, and submit comments.

Briefing packets were developed for the media, periodic media briefings with direct access to project staff were offered, and one-on-one interviews with various news outlets and journals were held.

Reclamation discussed the development of the proposed federal action with various agencies and organizations at: (1) agency/organization regular meetings; (2) public conferences and events sponsored by the agencies/organizations; and (3) meetings sponsored by Reclamation. The entities included the Basin States' water resource departments, water agencies within these states, contractors and associations for federal hydroelectric power, and NGOs. Reclamation also consulted with Indian tribes and Mexico. The coordination activities with each agency, entity or group are summarized below in this chapter. Table 6.9-1 in Section 6.9 lists the agencies and organizations that were invited to such meetings by letter, met with Reclamation and/or invited Reclamation to their meetings or events. Entities participating in these meetings and the meeting dates are listed in Appendix I. Public conferences and events that Reclamation attended and presented information on the proposed federal action are also listed in Appendix I.

A synopsis of the NEPA-related outreach efforts for this EIS follows:

In a May 2, 2005 letter to the Governors of the Colorado River Basin States issued to complete the 2005 AOP mid-year review, the Secretary directed Reclamation to develop additional strategies to improve coordinated management of the reservoirs in the Colorado River system. Pursuant to that direction, Reclamation conducted a public consultation workshop on May 26, 2005 in Henderson, Nevada; issued a *Federal Register* notice on June 15, 2005 soliciting public comments (70 Fed. Reg. 34794); and conducted public meetings on July 26 and July 28, 2005, in Henderson, Nevada, and Salt Lake City, Utah, respectively. Reclamation received a broad range of comments and suggestions from the public, and based in part on these comments, Reclamation determined that a process consistent with NEPA would be the appropriate method to use for the development of Lower Basin shortage guidelines and management strategies for coordinated operations of Lake Powell and Lake Mead under low reservoir conditions.

On September 30, 2005 Reclamation published a NOI (70 Fed. Reg. 57322) to prepare an EIS. The NOI also initiated a public scoping process for soliciting input on the scope of specific shortage guidelines and coordinated reservoir management strategies, and the issues and alternatives to be considered and analyzed in the EIS. As part of this process, Reclamation conducted public scoping meetings on November 1, 2, 3, and 8, 2005. The meetings took place in Salt Lake City, Utah; Denver, Colorado; Phoenix, Arizona; and Henderson, Nevada, respectively. Reclamation also consulted with representatives from the Basin States, Tribal representatives, NGOs, and other interested parties. A 62-day public comment period was noticed by the NOI which started on September 30, 2005 and ended on November 30, 2005. A total of 1,153 written comment letters were received during the scoping process. The comment letters were submitted by a wide-range of interested parties that included businesses; federal, state and local agencies; Indian tribes; special interest groups; and individuals.

Reclamation prepared and published a Scoping Summary Report on the development of Lower Basin shortage guidelines and management strategies for coordinated operations of Lake Powell and Lake Mead. A NOA was published on March 31, 2006 (71 Fed. Reg. 16341). This Scoping Summary Report provided a summary of the comments received and the issues raised during the scoping process and provided a summary of the proposed scope of the environmental analysis to be included in the EIS.

On February 28, 2007, Reclamation published a NOA (72 Fed. Reg. 9026) for the Draft EIS which commenced a 61-day public review period that ended on April 30, 2007. As part of this review process, Reclamation conducted three public hearings, on April 3, 4, and 5, 2007. The hearings took place in Henderson, Nevada; Phoenix, Arizona; and Salt Lake City, Utah, respectively, to invite public input on the Draft EIS. Additionally, a Modeling Workshop was held on March 6, 2007 in Henderson, Nevada to provide the public with information on the modeling performed in the Draft EIS to analyze the potential impacts of hydrologic resources and water deliveries. A total of 78 written comment letters were received in response to the Draft EIS public review period and two individuals provided oral comments during the public hearings. The comment letters were submitted by a wide-range of interested parties that included businesses; federal, state and local agencies; Indian tribes; special interest groups; and individuals. Volume IV of this Final EIS contains reproductions of letters received from the public and transcripts of the three public hearings held in connection with the public review of the Draft EIS and Reclamation's responses to the comments received.

6.3 Cooperating Agency Involvement

In compliance with NEPA and its implementing regulations, Reclamation worked with five cooperating agencies in the preparation of this EIS. The primary role of the cooperating agencies was in the development of alternatives considered in this EIS. Specific contributions of the cooperating agencies are summarized here.

6.3.1 Bureau of Indian Affairs

The BIA is a cooperating agency in recognition of its administration of the federal trust responsibility to Indian tribes. The BIA staff provided updated lists of Tribal governmental representatives, assisted in government-to-government consultations, and assisted in the preparation of ITA analyses. The BIA also assisted Reclamation with the Tribal consultations (Section 6.4) and generally served in an advisory capacity to Reclamation and the Indian tribes.

6.3.2 Fish and Wildlife Service

The FWS is a cooperating agency in recognition of its jurisdiction by law and special expertise with respect to the ESA and biological resources within the study area, and its administration of several wildlife refuges in the study area.

Under Section 7(a)(2) of the ESA, each federal agency must, in consultation with either the Secretary of Commerce through the National Marine Fisheries Service or the Secretary of the Interior through the FWS, insure that any proposed discretionary action authorized, funded or carried out by that agency is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat. To assist agencies in complying with the requirements of Section 7(a)(2), ESA's implementing regulations set out a detailed consultation process for determining the biological impacts of a proposed discretionary activity. The consultation process is described in regulations promulgated at 50 C.F.R. pt. 402.

Adoption of the proposed federal action by the Secretary is a discretionary federal action and it is, therefore, subject to compliance with ESA. Reclamation prepared a Draft BA (Appendix R) to address the potential effects of the proposed federal action on listed species. Formal consultation was initiated in September 2007 with the intent of completing a BO prior to the ROD in December 2007.

6.3.3 National Park Service

The NPS is a cooperating agency in recognition of its administration of park units along the Colorado River. The NPS staff participated in developing the Reservoir Storage Alternative (along with Western), and in providing data on visual resources and recreation. NPS staff at GCNRA, Grand Canyon National Park, and the LMNRA, assisted in the preparation of this EIS.

6.3.4 Western Area Power Administration

Western is a cooperating agency in recognition of its role in marketing and transmitting electricity from various Reclamation-operated powerplants located within the study area. Western customers include municipalities, cooperatives, public utility and irrigation districts, federal and state agencies, investor-owned utilities (only one of which purchases firm power from Western), marketers, and Indian tribes located throughout the Colorado River Basin. The wholesalers, in turn, provide retail electric service to millions of consumers within the seven Colorado River Basin states. Western participated in developing the Reservoir Storage Alternative (along with the NPS), and in preparing the hydroelectric power analyses contained in this EIS.

6.3.5 United States Section of the International Boundary and Water Commission

The USIBWC is a cooperating agency in recognition of its administration of the 1944 Treaty obligations with Mexico. As such, USIBWC staff participated in numerous meetings with Reclamation's project evaluation team and participated in internal document reviews as sections of the EIS were prepared. These activities facilitated close coordination with the USIBWC in developing information needed for this EIS and in Reclamation's participation in support of USIBWC's consultations with Mexico as discussed further below. USIBWC's input on this EIS was coordinated through the Commissioner of the USIBWC, as well as USIBWC staff located in their offices in El Paso, Texas; Yuma, Arizona; and San Ysidro, California.

6.4 Tribal Consultation

For purposes of this NEPA process, Reclamation, assisted by BIA, conducted government-to-government consultations with Tribal entities having entitlements to or contracts for Colorado River water, and those that may be affected by or have interests in the proposed federal action. The correspondence concerning consultation efforts is provided in Appendix I. Representatives of various Indian tribes also attended the scoping meetings in November 2005 and the public hearings in April 2007, and some provided Reclamation with written and oral comments on the proposed federal action and its potential effects on resources of Tribal concern, including ITAs. Table 6.9-1 lists the federally-recognized Indian tribes that participated in this NEPA process.

6.5 State and Local Water and Power Agency Coordination

Since the June 15, 2005 *Federal Register* notice announcing Reclamation's interest in soliciting comments on the development of management strategies for Lake Powell and Lake Mead, including Lower Basin shortage guidelines, Reclamation has had various discussions with state and local water agencies regarding the proposed federal action. These meetings are listed in Appendix I by entity and date. However, the Basin States have been continuously engaged in drought mitigation discussions since 2004, at the request of the Secretary, to develop recommendations on how to lessen the impacts of droughts. Reclamation provided the Basin States technical support during these discussions by modeling various strategies, including protection of key elevations of Lake Powell and Lake Mead.

As a result of these ongoing discussions, the Basin States provided Reclamation with projections of future depletions of Colorado River water anticipated in each state. The Upper Colorado River Commission compiled Upper Basin depletions, and the Lower Division states compiled their respective depletions. These projections were used as input to Reclamation's operational modeling analysis, as discussed in this EIS.

In 2004, the Basin States began formulation of a proposal for management strategies for Lake Powell and Lake Mead, and Lower Basin shortage guidelines. The Basin States submitted their "Seven Basin States' Preliminary Proposal Regarding Colorado River Interim Operations" in a letter addressed to the Secretary dated February 3, 2006. A copy of this proposal is included in Appendix J. Reclamation subsequently conducted several consultations with representatives from the Basin States and several water agencies and worked with them to formulate an alternative (Basin States Alternative) that reflected the contents of the Seven Basin States' proposal. In response to the Draft EIS public review, the Basin States revised and submitted a final multi-agreement proposal on April 30, 2007 (Appendix J). That proposal has been analyzed herein.

6.6 Non-Governmental Organizations Coordination

Reclamation contacted and coordinated the preparation of this EIS with multiple recreational and environmental groups. A consortium of environmental NGOs that included the Defenders of Wildlife, Environmental Defense, National Wildlife Federation, The Nature Conservancy, Pacific Institute, Sierra Club, Sonoran Institute, and Rivers Foundation of the Americas, developed what became the Conservation Before Shortage Alternative analyzed in this EIS.

This consortium of environmental NGOs developed and submitted its first proposal, "Conservation Before Shortage", on July 18, 2005. After publication of the Summary Scoping Report, this consortium of environmental NGOs modified elements of its proposal. The final proposal of this consortium, "Conservation Before Shortage II," was submitted to Reclamation on July 7, 2006. A copy of this proposal is included in Appendix K. From 2005 through 2006, Reclamation met with representatives of the consortium of environmental NGOs and worked with them to formulate what became the Conservation Before Shortage Alternative, as analyzed herein. These meetings are listed in Appendix I by entity and date.

6.7 Other Consultations

In compliance with the NHPA, Reclamation has initiated the process of consultation with SHPOs in Arizona, California, Nevada, and Utah. Consultations regarding eligibility of cultural resources to the National Registry and effect of the proposed federal action are ongoing. In addition, consultations are underway with THPOs (e.g., Navajo Nation THPO, Hualapai Indian Tribe THPO). Indian tribes with concerns under Exec. Order No. 13007 and the Native American Graves Protection and Repatriation Act are also being consulted.

6.8 Consultation with the Government of Mexico Agencies

The USIBWC has engaged in consultation with agencies of Mexico regarding the proposed federal action. Reclamation has assisted USIBWC in conducting this consultation by providing information on the proposed federal action and by participating in briefings with the Mexican Section of the IBWC, the Mexico National Water Commission, and Mexico Secretariat of Foreign Relations. Consistent with these consultations, Section 397 of Public Law 109-432 directs Reclamation to utilize these treaty-related processes to identify potential impacts beyond the borders of the United States. Accordingly, meetings with representatives of Mexico were conducted, during which representatives of Mexico provided their views, input, and concerns regarding the potential effects of the proposed federal action. These meetings are listed in Appendix I by entity and date.

Exec. Order No. 12114 instructs federal agencies to investigate the effects of proposed federal actions in other countries. This Final EIS documents the hydrologic and water quality effects of the proposed federal action on water deliveries to Mexico.

The modeling assumptions used in this Final EIS are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico.

6.9 Summary of Coordination and Consultation Contacts

Table 6.9-1 lists those Indian tribes, agencies, organizations, interest groups, and representatives of Mexico that Reclamation notified, consulted and coordinated with regarding the proposed federal action. Consultations are ongoing with most of these entities. These entities, meeting dates and related correspondence are listed and/or provided in Appendix I.

Table 6.9-1
Consultation and Coordination Regarding the EIS

Federal Agencies
National Oceanographic and Atmospheric Administration
Bureau of Indian Affairs – Cooperating Agency
United States Fish And Wildlife Service – Cooperating Agency
National Park Service – Cooperating Agency
United States Department of State
United States Environmental Protection Agency
United States Section of the International Boundary and Water Commission – Cooperating Agency
Western Area Power Administration – Cooperating Agency
State and Local Water and Power Organizations and Agencies
Arizona Department of Water Resources
California Department of Water Resources
Central Arizona Water Conservation District

Table 6.9-1
Consultation and Coordination Regarding the EIS

Coachella Valley Water District
Colorado Department of Natural Resources
Colorado River Board of California
Colorado River Commission of Nevada
Colorado River Energy Distributors Association
Colorado River Water Conservation District
Colorado Water Conservation Board
Imperial Irrigation District
Las Vegas Valley Water District
Metropolitan Water District of Southern California
Nevada Department of Justice
New Mexico Interstate Stream Commission
Office of the State Engineer, Wyoming
Palo Verde Irrigation District
Parker Valley Natural Resources Conservation District
San Diego County Water Authority
Southern Nevada Water Authority
Upper Colorado River Commission
Utah Attorney General's Office
Utah Division of Water Resources
Wyoming Water Association
Environmental and Recreational Organizations (NGOs)
Center for Biodiversity
Defenders of Wildlife
Environmental Defense
Glen Canyon Action Network
Grand Canyon River Guides
High County Citizen's Alliance
Living Rivers
National Wildlife Federation
The Nature Conservancy
Pacific Institute
Sierra Club
Sonoran Institute
Southwest Rivers
Utah Water & Sierra Club Southwest Water Committee
American Indian Tribe, Community, Pueblo[1]
Ak-Chin Indian Community of the Maricopa Indian Reservation
Chemehuevi Indian Tribe of the Chemehuevi Reservation, California
Cocopah Tribe of Arizona

Table 6.9-1
Consultation and Coordination Regarding the EIS

Colorado River Indian Tribes of the Colorado River Indian Reservation, Arizona and California
Fort McDowell Yavapai Nation
Fort Mojave Indian Tribe of Arizona, California, and Nevada
Gila River Indian Community
Havasupai Indian Tribe of the Havasupai Reservation
Hopi Tribe of Arizona
Hualapai Indian Tribe of the Hualapai Indian Reservation
Jicarilla Apache Nation
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation
Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony
Moapa Band of Paiute Indians of the Moapa River Indian Reservation
Navajo Nation, Arizona, New Mexico, and Utah
Paiute Indian Tribe of Utah
Pascua Yaqui Tribe of Arizona
Pueblo of Acoma
Pueblo of Cochiti
Pueblo of Jemez
Pueblo of Laguna
Pueblo of Nambe
Pueblo of Pojoaque
Pueblo of San Felipe
Pueblo of San Juan
Pueblo of Sandia
Pueblo of Santa Ana
Pueblo of Santa Clara
Pueblo of Tesuque
Pueblo of Zia
Quechan Tribe of the Fort Yuma Indian Reservation, California and Arizona
Salt River Pima-Maricopa Indian Community of the Salt River Reservation
San Carlos Apache Tribe of the San Carlos Reservation
San Juan Southern Paiute Tribe of Arizona
Southern Ute Indian Tribe of the Southern Ute Reservation
Tohono O'odham Nation of Arizona
Tonto Apache Tribe of Arizona
Ute Indian Tribe of the Uintah and Ouray Reservation
Ute Mountain Tribe of the Ute Mountain Reservation, Colorado, New Mexico, and Utah
White Mountain Apache Tribe of the Fort Apache Reservation
Yavapai-Apache Nation of the Camp Verde Indian Reservation
Yavapai-Prescott Tribe of the Yavapai Reservation
Zuni Tribe of the Zuni Reservation

Table 6.9-1
Consultation and Coordination Regarding the EIS

Government of Mexico Agencies
International Boundary and Water Commission, Mexican Section
National Water Commission
Secretariat of Foreign Relations

1 *Source of Names: Bureau of Indian Affairs, Tribal Leaders Directory. Accessed on-line, December 2006 at http://library.doi.gov/internet/native.html.*

6.10 Federal Register Notices

Several *Federal Register* notices have been issued to inform the public about the formulation of interim operational guidelines and the preparation and availability of the Draft EIS and this Final EIS. Table 6.10-1 lists the *Federal Register* notices; their full text is provided in Appendix L. In addition to the notices issued, additional notices are planned to announce the publication and availability of the Final EIS and Secretary's ROD based on the Final EIS.

Table 6.10-1
Federal Register Notices Regarding the Proposed Federal Action

Notice	Title
70 Fed. Reg. 34794 (June 15, 2005)	Notice to solicit comments and hold public meetings on the development of management strategies for Lake Powell and Lake Mead, including Lower Basin shortage guidelines, under low reservoir conditions.
70 Fed. Reg. 57322 (September 30, 2005)	Notice of intent to prepare an environmental impact statement (EIS) and notice to solicit comments and hold public scoping meetings on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead.
71 Fed. Reg. 16341 (March 31, 2006)	Notice of public availability of a Scoping Summary Report on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead, particularly under low reservoir conditions.
72 Fed. Reg. 9026 (February 28, 2007)	Notice of availability and notice of public hearings for the Draft EIS for the Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead.

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Index

Index

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

Y

Z

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Acronyms

Acronyms

1944 Treaty	The February 3, 1944 Treaty between the United States and Mexico Relating to the Utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande
602(a) storage	Section 602(a) of the Colorado River Basin Project Act of 1968
I-8	Interstate Highway 8 (Interstate 8)
°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	microgram per liter
µg/m^3	microgram per cubic meter of air
§	Section
§§	Sections
AAC	All-American Canal
AAQS	Ambient Air Quality Standards
af	acre-feet
afy	acre-feet per year
ACHP	Advisory Council on Historic Preservation
ADWR	Arizona Department of Water Resources
AGC	Automatic Generation Control
AMO	Atlantic Multidecadal Oscillation
AMP	Adaptive Management Program
AMWG	Adaptive Management Work Group
AOP	Annual Operating Plan for Colorado River Reservoirs
APE	area of potential effect
ARPA	Archaeological Resources Protection Act
AWBA	Arizona Water Banking Authority
AWSA	Arizona Water Settlement Act
BA	Biological Assessment
Basin Fund	Upper Colorado River Basin Fund
Basin States	Colorado River Basin States
BBAMP	Boulder Basin Adaptive Management Plan
BCP	Boulder Canyon Project
BCPA	Boulder Canyon Project Act of 1928
BHBF	beach/habitat-building flow
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BMI	Basic Management, Inc.
BO	Biological Opinion
CADSWES	Center for Advanced Decision Support for Water and Environmental Systems
CA PLAN	California's Colorado River Water Use Plan
CalEPA	California Environmental Protection Agency
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CEQ	Council on Environmental Quality
C.F.R.	Code of Federal Regulations
cfs	cubic feet per second
Commission	Upper Colorado River Commission
Compact	Colorado River Compact of 1922
Consolidated Decree	Entered by the United States Supreme Court on March 27, 2006 in the case of *Arizona v. California*, 547 U.S. 150 (2006)
Cr(VI)	hexavalent chromium

CRBPA	Colorado River Basin Project Act of 1968
CRIR	Colorado River Indian Reservation
CRIT	Colorado River Indian Tribes of the Colorado River Indian Reservation, Arizona and California
CRSP	Colorado River Storage Project
CRSPA	Colorado River Storage Project Act of 1956
CRSS	Colorado River Simulation System
CVWD	Coachella Valley Water District
CWA	Clean Water Act of 1972, as amended
CWC	Clean Water Coalition
Dam Fund	Colorado River Dam Fund
DBP	disinfection by-product
Decree	The 1964 United States Supreme Court Decree in the case of *Arizona v. California*
Department	Department of the Interior
Development Fund	Lower Colorado River Basin Development Fund
Draft EIS	Draft Environmental Impact Statement
DTSC	California Environmental Protection Agency Department of Toxic Substances Control
EA	Environmental Assessment
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ENSO	El Nino Southern Oscillation
EOM	end-of-month
EOCY	end-of-calendar year
ESA	Endangered Species Act of 1973, as amended
Exec. Order	Executive Order
Fed. Reg.	Federal Register
feet msl	feet above mean sea level
Final EIS	Final Environmental Impact Statement
FONSI	Finding of No Significant Impact
Forum	Colorado River Basin Salinity Control Forum
FWS	United States Fish and Wildlife Service
GCDAMP	Glen Canyon Dam Adoptive Management Program
GCM	General Circulation Model
GCNRA	Glen Canyon National Recreation Area
GEMSS	Generalized Environmental Modeling System for Surfacewater
GWh	gigawatt-hour
HRR	Hualapai River Runners
HVID	Harquahala Valley Irrigation District
IBWC	International Boundary and Water Commission
ICS	Intentionally Created Surplus
ICUA	Intentionally Created Unused Apportionment
IID	Imperial Irrigation District
Indian	American Indian
IPCC	Intergovernmental Panel on Climate Change
IPS-3	Intake Pumping Station No. 3
ISG	Interim Surplus Guidelines

ISM	Indexed Sequential Method
ITA	Indian Trust Asset
kaf	thousand acre-feet
kafy	thousand acre-feet per year
kW	kilowatt
kWh	kilowatt-hour
LC	Lower Colorado (Reclamation's Lower Colorado Region)
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
LDS Church	Church of Jesus Christ of Latter-Day Saints
LMNRA	Lake Mead National Recreation Area
Lower Basin	Colorado River Lower Basin – Arizona, California, Nevada, New Mexico, and Utah, within and from which waters drain naturally into the Colorado River Basin below Lee Ferry Compact Point, Arizona
Lower Division states	Colorado River Lower Division states - Arizona, California, and Nevada
LROC	Long-Range Operating Criteria (Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968)
M&I	municipal and industrial
maf	million acre-feet
mafy	million acre-feet per year
MCL	Maximum Contaminant Level
Mexico	United Mexican States
mg/L	milligram per liter
MLFF	Modified Low Fluctuating Flows
msl	mean sea level
MW	megawatt
MWD	Metropolitan Water District of Southern California
MWh	megawatt-hour
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act of 1990
NASS	National Agricultural Statistics Service
NAU	Northern Arizona University
NDEP	Nevada Division of Environmental Protection
NDOW	Nevada Department of Wildlife
NEPA	National Environmental Policy Act of 1969, as amended
NERC	North American Electric Reliability Council
NGO	non-governmental organization
NGS	Navajo Generating Station
NHPA	National Historic Preservation Act of 1966, as amended
NIB	Northerly International Boundary
NNAD	Navajo Nation Archaeological Department
NOA	Notice of Availability
NOAA	National Oceanic & Atmospheric Administration
NOI	Notice of Intent
NPS	National Park Service
NRA	National Recreation Area
NRC	National Research Council

NRHP	National Register of Historic Places
NRI	Nationwide Rivers Inventory
NWPCC	Northwest Power and Conservation Council
NWR	National Wildlife Refuge
O&M	operation and maintenance
P-DP	Parker-Davis Project
PDO	Pacific Decadal Oscillation
PG&E	Pacific Gas and Electric
PM	particulate matter
PM2.5	particulate matter (dust particles) less than 2.5 micrometers in diameter
PM10	particulate matter (dust particles) of ten micrometers or less in diameter
ppb	parts per billion
ppm	parts per million
PPR	Present Perfected Rights
PSD	Prevention of Significant Deterioration
pt.	part
PUP	Priority Use Projects
PV 2008 $	Present Value in 2008 dollars
PVID	Palo Verde Irrigation District
QSA	Quantification Settlement Agreement
Reclamation	Bureau of Reclamation
RM	river mile
ROD	Record of Decision
SCOP FEIS	Systems Conveyance and Operations Program Final Environmental Impact Statement
SCP	Colorado River Basin Salinity Control Program
SDCWA	San Diego County Water Authority
Secretary	Secretary of the Department of the Interior
SHPO	State Historic Preservation Officer
SIA	Secretarial Implementation Agreement
SIB	Southerly International Boundary
SIRA	Storage and Interstate Release Agreement
SLCA/IP	Salt Lake City Area Integrated Projects
SNWA	Southern Nevada Water Authority
SRA	State Recreation Area
SRP	Salt River Project
TCP	Traditional Cultural Property
TDS	total dissolved solids
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
Upper Basin	Colorado River Upper Basin – Arizona, Colorado, New Mexico, Utah, and Wyoming, within and from which waters drain naturally into the Colorado River Basin above Lee Ferry Compact Point, Arizona
Upper Division states	Colorado River Upper Division states - Colorado, New Mexico, Utah, and Wyoming
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

USIBWC United States Section of the International Boundary and Water Commission

USU Utah State University

Water Control Manual Water Control Manual for Flood Control, Hoover Dam and Lake Mead, Colorado River, Nevada and Arizona, dated December 1982, published by the United States Army Corps of Engineers

WECC Western Electricity Coordinating Council

Western Western Area Power Administration

Workgroup Arizona Department of Water Resources Director's Shortage Sharing Workgroup

ZCRE Zuni Cultural Resource Enterprise

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Glossary

Glossary

A

acre-foot (af)	Volume of water (43,560 cubic feet) that would cover one acre to a depth of one foot.
adaptive management	A method for examining alternative strategies for meeting measurable biological goals and objectives, and then if necessary, adjusting future conservation management actions according to what is learned.
affected environment	Existing biological, physical, social, and economic conditions of an area that are subject to change, both directly and indirectly, as the result of a proposed human action.
algae	Simple plants containing chlorophyll; most live submerged in water.
allocation, allotment	Refers to a distribution of water through which specific persons or legal entities are assigned individual rights to consume pro-rata shares of a specific quantity of water under legal entitlements. For example, a specific quantity of Colorado River water is distributed for use within each Lower Division state through an apportionment. Water available for consumptive use in that state is further distributed among water users in that state through the allocation. An allocation does not establish an entitlement; the entitlement is normally established by a written contract with the United States government. *See also* Lower Division states.
alluvium	Sedimentary material transported and deposited by the action of flowing water.
ambient	Surrounding natural conditions (or environment) in a given place and time.
amphibian	Vertebrate animal that has a life stage in water and a life stage on land (e.g., salamanders, frogs, toads).
annual flow-weighted average concentration	A weighted average of monthly total dissolved solids (TDS) concentrations for a year, where the weight for each month is based on the relative flow for each month.
Annual Operating Plan for Colorado River Reservoirs (AOP)	The AOP describes how Reclamation will manage Colorado River resources over a 12-month period, consistent with the Long-Range Operating Criteria and the *Arizona v. California* 1964 Supreme Court Decree. The AOP is prepared annually by Reclamation in cooperation with the Basin States, appropriate federal agencies, Indian tribes, state and local agencies, and the general public, including governmental interests as required by federal law. As part of the AOP process, the Secretary of the Department of the Interior (Secretary) makes annual determinations regarding the availability of Colorado River water for deliveries to the Lower Division states of the Colorado River Basin. *See also* Lower Division states.
apportionment	Refers to the distribution of water available to each Lower Division state in Normal, Surplus or Shortage condition years, as set forth, respectively, in Articles II(B)(1), II(B)(2), and II(B)(3) of the 1964 Supreme Court Decree in the case of *Arizona v. California*.
appropriative rights	The right to divert a specified quantity of water at a specified point of diversion for reasonable and beneficial uses at a specified place of use for a specified manner of use. Appropriative rights are generally “first-in-time, first-in-right”; that is, one appropriative right has priority over appropriative rights established later.

B

backwater	A relatively small, generally shallow area of a river with little or no current.
banked groundwater	Water that has been stored temporarily in a groundwater aquifer. Banked groundwater can be recovered for use at a later time.
base load	Minimum load in a power system over a given period of time.
Basin States	In accordance with the Colorado River Compact of 1922, the Colorado River Basin is comprised of those parts of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming, within and from which waters drain naturally into the Colorado River. These seven states are referred to as the Basin States. *See also* Colorado River Compact of 1922.
Biological Assessment (BA)	To facilitate compliance with Section 7(a)(2) of the Endangered Species Act (ESA), federal agencies must prepare a BA pursuant to Section 7(c)(1) of ESA that identifies the likely effects of the proposed federal action on threatened and endangered species. *See also* Endangered Species Act.
Biological Opinion (BO)	Document stating the United States Fish and Wildlife Service (FWS) and/or the National Marine Fisheries Service opinion as to whether a federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.
bypass flows	Saline agricultural return flows from the Wellton-Mohawk Irrigation and Drainage District that are routed to the Cienega de Santa Clara in Mexico in order to ensure compliance with the salinity provisions of Minute 242 of the 1944 Treaty.

C

candidate species	Plant or animal species not yet officially listed as threatened or endangered under the ESA, but which is undergoing status review by the United States Fish and Wildlife Service.
catch	At a recreational fishery, refers to the number of fish captured, whether they are kept or released.
channel (watercourse)	An open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. River, creek, run, branch, and tributary are some of the terms used to describe natural channels. Natural channels may be single or braided. Canal and floodway are some of the terms used to describe artificial channels.
Cladophora	Filamentous green alga important to the food chain in the Colorado River downstream of Glen Canyon Dam.
Colorado River Basin	All of the drainage area of the Colorado River system and all other territory within the United States to which the waters of the Colorado River system shall be beneficially applied.
Colorado River Basin Project Act of 1968 (CRBPA)	This Act authorized construction of a number of water development projects, including the Central Arizona Project (CAP), and required the Secretary to develop the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs, or Long-Range Operating Criteria (LROC).
Colorado River Basin Salinity Control Forum	The organization dedicated to controlling Colorado River salinity, consists of representatives of the seven Basin States.

Colorado River Compact of 1922	The agreement concerning the apportionment of the use of the waters of the Colorado River Basin, dated November 24, 1922, executed by Commissioners for the States of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming, approved by Herbert Hoover, representative of the United States, and proclaimed effective by the President of the United States, June 25, 1929.
Colorado River Simulation System (CRSS)	An operational model of the Colorado River Basin based on a monthly time step.
Colorado River system	The portion of the Colorado River and its tributaries within the United States as defined in the Colorado River Compact of 1922.
Compact	The Colorado River Compact of 1922.
Compact Point	Lee Ferry, Arizona, the reference point designated by the Colorado River Compact of 1922 as dividing the Colorado River Basin into two sub-basins, the Upper Basin and the Lower Basin. *See also* Lee Ferry Compact Point.
Consolidated Decree	Entered by the United States Supreme Court on March 27, 2006 in the case of *Arizona v. California*, 547 U.S. 150 (2006). In 1963 the Supreme Court reached a Decision in the case of *Arizona v. California.* The 1964 Supreme Court Decree in the case of *Arizona v. California* implemented the 1963 Decision. This 1964 Supreme Court Decree was supplemented over time after its adoption and the Supreme Court entered a Consolidated Decree in 2006 which incorporates all applicable provisions of the earlier-issued Decisions and Decrees.
consumptive use	For purposes of this Environmental Impact Statement (EIS), diversions of water from mainstream Colorado River, including water withdrawn from the mainstream through underground pumping, minus any measured and unmeasured return flows.
Contractors	Those who hold entitlements to Colorado River water are referred to as Contractors. Contractors consist of the federal government, states, Indian tribes, and various public and private entities that are recognized under the Consolidated Decree, hold a Section 5 Contract with the Secretary, or have a Secretarial Reservation of water. *See also* Consolidated Decree.
conveyance loss	Water that is lost in transit from a pipe, canal, conduit, or ditch by leakage or evaporation. If the water is lost due to leakage, it may be considered return flow if it percolates to an aquifer and is available for reuse. If the water evaporates, it is considered consumptive use.
Cooperating Agency	With respect to the National Environmental Policy Act of 1969, as amended, (NEPA) process, an agency that has jurisdiction by law or special expertise concerning an aspect of a proposed federal action, and that is requested by the lead agency to participate in the preparation of an Environmental Impact Statement.
coordinated operation	As applied to hydroelectric power resources, the operation of a group of hydroelectric powerplants to obtain optimal power benefits with due consideration for all other uses. Generally, the operation of two or more interconnected electrical systems to achieve greater reliability and economy.
covered species	Those species addressed in the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) for which conservation measures would be implemented and for which authorization for "take" is being requested under Section 10 of the ESA. *See also* take.
criteria	Standards used for making a determination.
critical habitat	Specific areas with physical or biological features essential to the conservation of a listed species and which may require special management considerations or protection. These areas have been legally designated via *Federal Register* notices.

cubic foot per second (cfs)	A measure of water flow equal to one cubic foot of water passing a point on the stream in one second of time.
cultural resource	Building, site, district, structure, or object significant in history, architecture, archeology, culture, or science.

D

dead pool	Reservoir elevation corresponding to dead storage.
dead storage	Reservoir space from which stored water cannot be evacuated by gravity.
delta	Sediment deposit formed at the mouth of the Colorado River and other rivers where they enter Lake Powell, Lake Mead or the Gulf of California.
depletion	Loss of water from a stream, river, or basin resulting from consumptive use.
deposition	Settlement of material out of the water column and on to the streambed. Occurs when the energy of flowing water is unable to support the load of suspended sediment.
discharge (flow)	Volume of water that passes a given point within a given period of time; expressed in this EIS in cubic feet per second. *See also* cubic foot per second.
dissolved oxygen (DO)	Amount of free oxygen found in water; perhaps the most commonly employed measurement of water quality. Low DO levels adversely affect fish and other aquatic life. The ideal dissolved oxygen for fish life is between 7 milligrams per liter (mg/L) and 9 mg/L; most fish cannot survive when DO falls below 3 mg/L.
diversion(s)	Colorado River water withdrawn from the mainstream, including water diverted from reservoirs or drawn from the mainstream by underground pumping.
domestic use	Refers to the use of water for household, stock, municipal, mining, milling, industrial, and other like purposes, but excludes the generation of electrical power.
draw down	Lowering of a reservoir's elevation; process of depleting reservoir or groundwater storage.

E

ecosystems	Complex system composed of a community of fauna and flora and that system's chemical and physical environments.
electric power system	Physically connected electric generating, transmission, and distribution facilities operated as a unit under one control.
electrical demand	Energy requirement placed upon a utility's generation at a given instant or averaged over any designated period of time.
endangered species	A species or subspecies whose survival is in danger of extinction throughout all or a significant portion of its range.
Endangered Species Act (ESA)	The Endangered Species Act (ESA) of 1973 (16 U.S.C. §§ 1531-1544), as amended, under Section 9, provides for the prohibition of "take" of any fish or wildlife species listed as threatened or endangered under the ESA unless specifically authorized by regulation. *See also* take.
energy	Electric capacity generated and/or delivered over time.

entitlement	Refers to an authorization to beneficially consume Colorado River water pursuant to a decreed right; a contract with the United States through the Secretary; or a Secretarial Reservation of water.
epilimnion	Thermal layering of water in lakes and streams. *See also* stratification.

F

firm energy or power	Non-interruptible energy or power guaranteed by the supplier to be available at all times except for reasons of uncontrollable forces or "continuity of service" contract provisions.
flood	An overflow or inundation that comes from a river or other body of water, and causes or threatens damage. Any relatively high streamflow overtopping the natural or artificial banks in any reach of a river or stream. A relatively high flow as measured by either gage height or discharge quantity.
flood control pool	Reservoir volume above the active conservation and joint-use pool that is reserved for flood runoff and then evacuated as soon as possible to keep that space in readiness for the next flood.
flood control release	The release of water from Lake Mead and the operation of Hoover Dam for flood control purposes pursuant to the reservoir operating criteria specified in the February 8, 1984 Field Working Agreement between the United States Army Corps of Engineers (USACE) and the Bureau of Reclamation (Reclamation), and the USACE regulations contained in 33 C.F.R. pt 208.11.
flow	Volume of water passing a given point per unit of time expressed in cubic foot per second. *See also* cubic foot per second.
forage fish	Generally, small fish that reproduce prolifically and are consumed by predators.
fore bay	Impoundment immediately above a dam or hydroelectric plant intake structure. The term is applicable to all types of hydroelectric developments (storage, run-of-river, and pumped-storage).
fry	Life stage of fish between the egg and fingerling stages.
full pool	Volume of water in a reservoir at maximum design elevation.

G

gaging station	Specific location on a stream where systematic observations of hydrologic data are obtained through mechanical or electrical means.
gigawatt-hour (GWh)	One billion watt-hours of electrical energy.

H

headwater	The source and upper part of a stream.
hydroelectric power	Electrical capacity produced by falling water.
hypolimnetic zone	The deep portion of a lake or reservoir volume generally classified as below the level of the thermocline.
hypolimnion	Thermal layering of water in lakes and streams. *Also see* stratification.

I

Important Farmland	As defined by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (formerly the Soil Conservation Service), Important Farmlands include Prime Farmland, Unique Farmland, Farmland of Statewide Importance, and Farmland of Local Importance. The categorization of farmland is based upon a soil classification system which accounts for the physical and chemical characteristics of the land and the suitability of the land for producing crops. Important Farmlands are afforded special protection due to their importance to agricultural production.
impoundment	Body of water created by a dam.
incidental take	Incidental take is defined under the ESA as take that is “incidental to, and not the purpose of, the carrying out of an otherwise lawful activity” (50 C.F.R. pt. 17.22 and 17.32). *See also* take.
Indian Trust Assets (ITAs)	Indian Trust Assets are ‘legal interests’ in ‘assets’ held in ‘trust’ by the federal government for federally recognized Indian tribes or individual Indians.
inflow	Water flowing into a lake or reservoir from a river and/or its tributaries; or water entering a river from tributaries.
in situ	In archaeology, and as used in this EIS, *in situ* refers to an artifact that has not been moved from its original place of deposit.
Interim Surplus Criteria (ISC)	*See* "Interim Surplus Guidelines".
irrigated area	The gross farm area upon which water is artificially applied for the production of crops, with no reduction for access roads, canals, or farm buildings.
irrigation	The controlled application of water to arable lands to supply water requirements not satisfied by rainfall.

J-K

juvenile	Young fish older than one year but not having reached reproductive age.
kilowatt-hour (kWh)	One thousand watt-hours of electrical energy.

L

land cover type	A classification system to describe vegetation and other habitat types (e.g., cotton-wood willow, honey mesquite type III, marsh).
Las Vegas Valley	The topographic basin containing the City of Las Vegas, the City of North Las Vegas, the City of Henderson, and certain unincorporated townships of Clark County.
Las Vegas Wash	The natural drainage channel for the entire Las Vegas Valley. It is dominated by wastewater flows from the City of Las Vegas, Clark County Sanitation District, and City of Henderson wastewater treatment plants. It terminates in the Las Vegas Bay of Lake Mead.

Law of the River	As applied to the Colorado River, the Secretary is vested with the responsibility to manage the mainstream waters of the Lower Basin pursuant to applicable federal law. This responsibility is carried out consistent with a body of documents referred to as the Law of the River. This collective set of documents comprising numerous operating criteria, regulations, and administrative decisions included in federal and state statues, interstate compacts, court decisions and decrees, an international treaty, and contracts with the Secretary, apportions the Colorado River waters and regulates the use and management of the Colorado River among the seven Basin States and Mexico.
lead agency	A lead agency is an agency initiating and overseeing the preparation of an EIS. For this EIS, Reclamation is the lead agency for compliance with NEPA.
Lee Ferry Compact Point	The Colorado River Compact of 1922 divided the Colorado River Basin into two sub-basins: the Upper Basin, and the Lower Basin. The Lee Ferry Compact Point, identified as the reference point which marks this division between the Upper Basin and the Lower Basin, is located in the mainstream Colorado River in Arizona, one mile below the confluence of the Colorado River with the Paria River.
Lees Ferry Gaging Station	The site of the United States Geological Survey (USGS) stream gage (Lees Ferry Gaging Station) located in Arizona, on the Colorado River upstream of its confluence with the Paria River, downstream of Glen Canyon Dam. Also, the location of Colorado River ferry crossings (1873 to 1928).
limnology	Scientific study of physical characteristics and biology of lakes, ponds, and streams.
load	Amount of electrical power or energy delivered or required at a given point.
Lower Basin (states)	The Colorado River Compact of 1922 divided the Colorado River system into two sub-basins: the Upper Basin, and the Lower Basin, and defined the Lower Basin as including those parts of the states of Arizona, California, Nevada, New Mexico, and Utah, within and from which waters drain naturally into the Colorado River below the Lee Ferry Compact Point in Arizona. *See also* Lee Ferry Compact Point.
Lower Division (states)	The Colorado River Compact of 1922 divided the seven Colorado River Basin states into two groups: Upper Division states, and Lower Division states. The Lower Division states are Arizona, Nevada, and California. *See also* Basin States.

M

magnitude	A number characteristic of a quantity and forming a basis for comparison with similar quantities such as flows.
mean monthly flow	Average flow for the month, usually expressed in cubic feet per second.
mean sea level (msl)	The average height of the surface of the oceans and seas measured throughout all stages of the tidal cycle, determined from hourly readings of tidal height and computed over a long (usually 19-year) period. It is used as a datum plane, i.e., serves as the reference surface, from which elevations and depths are measured.
median	Middle value in a distribution, above and below which lie an equal number of values.
megawatt (MW)	One million watts of electrical power (capacity).
megawatt-hour (MWh)	One million watt-hours of electrical energy.
metalimnion	Thermal layering of water in lakes and streams. *See also* stratification.
milligram per liter (mg/L)	Equivalent to one part per million.

N

National Environmental Policy Act of 1969, as amended (NEPA)	Law requiring federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement, or EIS.
National Register of Historic Places (NRHP)	The nation's official list of cultural resources worthy of preservation. Authorized under the National Historic Preservation Act of 1966, the NRHP is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archeological resources. Properties listed in the NRHP include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archeology, engineering, and culture.
natural flow	The flow of any stream undepleted by human activities.
non-system water	Waters originating from outside the Colorado River system.
Normal Condition	When the Secretary has determined that there is available for annual release 7.5 maf to satisfy consumptive use in the Lower Division states pursuant to Article II(B)(1) of the Consolidated Decree.

O

oligotrophic	A body of water characterized by low dissolved plant nutrient and organic matter, and rich in oxygen at all depths.

P-Q

peak flow	Maximum instantaneous flow in a specified period of time.
peak load	Maximum electrical demand in a stated period of time.
penstock	Conduit pipe used to convey water under pressure to the turbines of a hydroelectric plant.
percentile	A statistical term. A descriptive measure that splits ranked data into 100 parts, or hundredths. For example, the 10^{th} percentile is the value that splits the data in such a way that ten percent of the values are less than or equal to the 10^{th} percentile.
Piscivorous	Habitually feeding on fish.
PM_{10} (PM10)	Particulate matter (PM) (dust particles) standard that includes particles with a diameter of ten micrometers or less.
power	Electrical capacity generated, transferred or used.
Present Perfected Right (PPR)	Many Colorado River water rights originated as 'perfected rights' specified in the 1964 United States Supreme Court Decree in the case of *Arizona v. California*. 'Present perfected rights' (PPRs) are the highest priority Colorado River water rights that the 1964 Decree defines as those perfected rights existing on June 25, 1929 (the effective date of the Boulder Canyon Project Act of 1928).
priority	A ranking with respect to diversion of water relative to other water users.

probability	In this EIS, the relative frequency with which a range of modeled values occurs. For example, the probability of Lake Mead elevation exceeding 1,180 feet msl in June 2005 is equal to the number of modeled elevations greater than 1,180 feet msl in June 2005, divided by the total number of modeled elevations in June 2005.
public involvement	Process of obtaining citizen input into each stage of development of planning documents. Required as a major input into any EIS.

R

ramp rate	The rate of change in instantaneous output from a powerplant. The ramp rate is established to prevent undesirable effects due to rapid changes in loading or, in the case of hydroelectric plants, discharge.
rated head	Water depth for which a hydroelectric generator and turbines were designed.
reach	A specified segment of a river, stream, channel, or other water conveyance facility.
recruitment	Survival of young plants and animals from birth to a life stage less vulnerable to environmental change.
reregulating reservoir	A reservoir for reducing diurnal fluctuations resulting from the operation of an upstream reservoir for power production.
resampling	The digital process of changing the sample rate or dimensions of sampled data (e.g., digital imagery or audio) by temporarily or areally analyzing and sampling the original data.
reserved water	In the case of Indian reservations, rights based on the doctrine of Indian reserved rights, and in the case of federal establishments other than Indian reservations, a federal reservation of water for use on property under federal jurisdiction.
reservoir	A pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water.
return flow	Portion of water previously diverted from a river or stream and subsequently returned to that river or stream, and is available for consumptive use by others.
return flow credit	In the accounting of consumptive use in the Lower Basin, Colorado River water that is returned to the river and is available for consumptive use by others in the year in which it was diverted is credited against a water user's total diversions.
riffle	A stretch of choppy water caused by an underlying rock shoal or sandbar.
riparian	Of, on, or pertaining to the bank of a river, pond, or lake.
river mile (RM)	River miles are numbered along the Colorado River from south to north starting with RM 0.0 at the Southerly International Border (SIB) with Mexico. Dam locations are noted at their respective river miles.
river stage	Water surface elevation of a river above a datum.
RiverWare™	A commercial river system simulation computer program that was configured to simulate operation of the Colorado River for this EIS.
runoff	That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage, or other works of man in or on the stream channels.

S

salinity	A term used to refer to the dissolved minerals in water, also referred to as total dissolved solids (TDS). *See also* total dissolved solids.
Secretary	The Secretary of the Department of the Interior, and duly appointed successors, representatives and others with properly delegated authority.
Section 10(a)(1)(B) permit	Section 10(a)(1)(B) of the ESA authorizes the FWS to issue non-federal entities a permit for the incidental take of endangered and threatened wildlife species. This permit allows the non-federal entity to proceed with an activity that is legal in all other respects, but that results in the “incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.” *See also* take.
sediment	Unconsolidated solid material that comes from weathering of rock and is carried by, suspended in, or deposited by water or wind.
sediment load	Mass of sediment passing through a stream.
seepage	Relatively slow movement of water through a medium, such as sand.
Shortage Condition	When the Secretary has determined that there is available for annual release less than 7.5 maf to satisfy consumptive use in the Lower Division states pursuant to Article II(B)(3) of the Consolidated Decree.
spawn	To lay eggs, especially fish.
spills	Water releases from a dam in excess of powerplant capacity.
spillway	Overflow facility at a dam, usually consisting of a sill at the full-reservoir elevation.
spinning reserves	Available capacity of generating facilities synchronized to the interconnected electric system so that it can be called upon for immediate use in response to system problems or sudden load changes.
stage	Reservoir elevation.
Standards	A means established by authority as a rule for the measure of quality, such as cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water.
storage	Water artificially impounded in surface or underground reservoirs, for future use. Water naturally detained in a drainage basin, such as groundwater, channel storage, and depression storage. The term "drainage basin storage" or simply "basin storage" is sometimes used to refer collectively to the amount of water in natural storage in a drainage basin. *See also* conservation storage and dead storage.
stratification	Thermal layering of water in lakes and streams. Lakes usually have three zones of varying temperature: (1) *epilimnion* – top layer with essentially uniform warmer temperature; (2) *metalimnion* – middle layer of rapid temperature decrease with depth; and (3) *hypolimnion* – bottom layer with essentially uniform colder temperatures.
streamflow	The discharge that occurs in a natural channel. Although the term discharge can be applied to the flow of a canal, the word streamflow uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than runoff, as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.
system storage	The total volume of water available in the Colorado River Basin at a specific point in time.

system water — Waters originating from the Colorado River system.

Surplus Condition — When the Secretary has determined that there is available for annual release more than 7.5 maf to satisfy consumptive use in the Lower Division states pursuant to Article II(B)(2) of the Consolidated Decree.

T

tail water — Water immediately downstream of the outlet from a dam or hydroelectric powerplant.

take — As defined by the ESA, "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 U.S.C. §§ 1531[18]).

thermocline — The zone of maximum change in temperature in a water body, separating upper (epilimnetic) from lower (hypolimnetic) zones.

threatened species — A species or subspecies that is likely to become endangered in the foreseeable future.

total dissolved solid (TDS) — A measure of the inorganic or mineral content of water, commonly expressed in milligrams per liter. *See also* salinity.

traditional cultural property — A site or resource that is eligible for inclusion in the National Register of Historic Places because of its association with cultural practices or beliefs of a living community. *See also* National Register of Historic Places.

tributary — River or stream flowing into a larger river or stream.

Turbidity — Cloudiness of water, measured by how deeply light can penetrate into the water column from the surface.

U-V

Upper Basin (states) — The Colorado River Compact of 1922 divided the Colorado River system into two sub-basins: the Upper Basin, and the Lower Basin, and defined the Upper Basin as including those parts of the states of Arizona, Colorado, New Mexico, Utah, and Wyoming, within and from which waters drain naturally into the Colorado River above the Lee Ferry Compact Point in Arizona. *See also* Lee Ferry Compact Point.

Upper Colorado River Commission — Commission established by the Upper Colorado River Basin Compact of appointed members from the Upper Division states whose purpose is to secure the storage of water for beneficial consumptive use in the Upper Basin.

Upper Division (states) — The Colorado River Compact of 1922 divided the seven Colorado River Basin states into two groups: Upper Division states, and Lower Division states. The Upper Division states are Colorado, New Mexico, Utah, and Wyoming. *See also* Basin States.

W-X

water year	That period of twelve months ending September 30 of each year.
Waters of the United States	In accordance with the Clean Water Act, Waters of the United States include: (1) all waters which may be susceptible to use in interstate or foreign commerce; (2) all interstate waters including interstate wetlands; (3) all other waters such as intrastate lakes, rivers, streams (including intermittent streams), mud flats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce including any such waters; (4) all impoundments of waters otherwise defined as waters of the United States; (5) tributaries of waters identified in this EIS; (6) the territorial seas; and (7) wetlands adjacent to waters (other than waters that are themselves wetlands) identified in this EIS.
watershed	The drainage area upstream of a specified point on a stream.

Y-Z

List of Preparers

List of Preparers

This Final Environmental Impact Statement was prepared by the Bureau of Reclamation, Upper and Lower Colorado Regions. This List of Preparers presents the persons who developed significant background material and various sections, or participated to a significant degree in the preparation of this Final Environmental Impact Statement.

Alan G.K. Solbert
1950-2006

Alan Solbert of Jones & Stokes, a dear friend and colleague, contributed substantially to the completion of this document. The project team as well as many others will miss Alan's leadership, enthusiasm, and friendship. This effort is dedicated to his memory.

BUREAU OF RECLAMATION, LOWER COLORADO REGION

Name	Education	Qualifications	Experience	Project Role
Belew, Stephen	B.S., Civil Engineering	GIS	10	GIS
Blasius, Becky	B.S., Physiology M.S., Entomology	Aquatic ecology	9	Water Quality
Callejo, Russell	M.S., Civil Engineering	Hydrologic modeling and data analysis	5	Hydrologic Resources/Modeling Team
Cunningham, Amber	Economics degree from UNLV	Economics and Colorado River contracts	3	Water Supply/ Modeling Team
Dwyer, Colleen	B.S., Engineering	Writing/Editing	23	Public Outreach
Ellis, Bruce	B.A., Anthropology	NEPA/ESA compliance	30	Quality Control and Quality Assurance
Fulp, Terry	Ph.D., Mathematical and Computer Sciences	Hydrology and water operations	20	Project Manager
Gould, Glen	M.S., Fisheries Management	Ecology of Lower Colorado River	26	Biology
Hvinden, Steve	M.S., B.S., Agricultural Economics	Water entitlements and priorities, water contracts, Indian trust assets	27	Hydrologic Resources/Modeling Team
Jamrog, John	B.S. Forestry	Natural resources management	30	Agriculture
Jerla, Carly	B.S., Civil Engineering, B.S., Engineering Public Policy M.S., Civil Engineering	Water resources engineering - hydrologic modeling	5	Hydrologic Resources/Modeling Team
Kleinman, Alan	B.S., M.S., Ph.D., Economics	Agricultural economics	35	Hydrologic Resources/Modeling Team
Martin, Bill	B.S., Natural Resources, and Business Administration	Outdoor recreation management	10	Recreation
Maus, Shorty	A.S. Leisure Studies	Grabblin', nocturnal foraging	0.01	Post-production
Saint, Debby	B.A., Geography	Environmental specialist, social factors analyst, Lower Colorado Region Native American Affairs Program Manager	33	Indian Trust Assets

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Name	Education	Qualifications	Experience	Project Role
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Simms, Ron	B.A., Anthropology M.S., Geology	Land use, settlements, shortage allocation model	21	GIS
Smith, Ron	B.S., Electrical Engineering	Power generation	23	Electric Power Generation
Watt, Dennis	B.S., Geology	Groundwater	32	Groundwater
Yoder, Nan	B.A., Economics	Project management	10	Project Coordinator, Quality Control and Assurance
<u>Denver Technical Service Center:</u>				
Harpman, David	M.S., Agricultural Economics Ph.D., Natural Resource Economics	Water resource economics, the economics of hydropower, nonmarket valuation and the valuation of instream flow	17	Electric Power Generation
Lichtkoppler, Rich	B.S., Business Administration M.S., Park and Recreation Administration Ph.D., Resource Economics	Natural resource economics, recreation economics, Economic damage assessment, national park planning, environmental justice	22	Sociological

BUREAU OF RECLAMATION, UPPER COLORADO REGION

Name	Education	Qualifications	Experience	Project Role
Barnett, Karen	B.S., Biology	Biology	15	Biology
Berry, Mike	Ph.D., Anthropology M.A., Anthropology B.A., History	Archaeology	30	Cultural Resources
Blair, Jane	B.S., Civil Engineering M.S., Civil Engineering	Hydropower	25	Agency Review
Clayton, Rick	B.S., Economics B.S., Civil Engineering	Hydrology	9	Hydrologic Resources/Modeling Team
Coulam, Nancy	B.A., M.A., Ph.D., Anthropology	Environmental compliance	20	Quality Control and Quality Assurance

BUREAU OF RECLAMATION, UPPER COLORADO REGION

Name	Education	Qualifications	Experience	Project Role
Cutler, Amy	B.S., Civil Engineering M.E., Environmental Civil Engineering	Water quality	8	Water Quality/Modeling
Cutler, Chris	B.S., Civil Engineering M.E., Environmental Civil Engineering	Hydrology	5	Hydrologic Resources/Modeling Team
Gilmore, Andrew	M.S., Civil Engineering	Hydrology	7	Hydrologic Resources/Modeling Team
Kelleher, Jayne		Technical writing	28	Project Coordinator
Liljegren, Fred	B.S., Landscape Architecture	Landscape architecture	32	Recreation
Loring, Mike	M.S., Resource Economics	Economics	21	Socioeconomics, Hydropower
Parry, Brian	J.D.	Water rights and Indian Trust Assets	30	Indian Trust Assets
Miller, Jerry	B.S., Geology/Chemistry	Water quality/modeling	30	Water Quality
Peterson, Randall	B.S., Civil Engineering	Environmental compliance	30	Project Manager
Prairie, Jim	Ph.D., Civil Engineering	Water quality/modeling	6	Hydrologic Resources/Modeling Team
Ryan, Tom	B.A., Psychology B.S., Civil Engineering	Hydrology	18	Hydrologic Resources/Modeling Team

COOPERATING AGENCY REPRESENTATIVES

Name	Education	Qualifications	Experience	Project Role
National Park Service:				
Henderson, Norman	B.S., Biology M.S., Ecology	Park management/recreation	25	Recreation
Western Area Power Administration:				
Loftin, Sam	A.S., Casper College B.S.E.E., (Electrical Engineering)	CRSP hydro resources, forecasting power purchases	27	Electric Power Generation
Palmer, Clayton	M.A., Economics	Natural resource economics, hydroelectric power economics	22	Electric Power Generation
Young, Brian	B.S., Engineering	Hydropower generation & marketing	22	Electric Power Generation

BROWN AND CALDWELL

Name	Education	Specialty Area	Experience	Project Role
Beavers, Kathleen		Project management and administrative coordination	5	Administrative coordinator
Biggs, John	B.S.E., Civil Engineering M.S.E., Civil Engineering	Odor/Air emissions monitoring & control, buried infrastructure assessment, water/wastewater treatment.	4	Hydrological Resources, Quality Control and Quality Assurance
Dow, Sarahann	B.S., Biology M.S., Ph.D., Environmental Engineering	Water chemistry, microbial assessments, and advanced treatment technologies	7	Resource Lead – Water Quality
Duren, Sabre	B.A., Environmental Studies M.S., Environmental Engineering	Watershed water quality and hydrology assessments	5	Visual, Hydrological
Ennis, Renee		Word processing management, document preparation, database maintenance	15	Word Processor Lead
Gain, Jenny	B.S., Civil and Environmental Engineering M.S., Environmental Engineering	Watershed management, water quality monitoring, water supply and conservation, ecosystem restoration	4	Recreation
Herencia, Chris	B.S., Civil Engineering Facilities Management	Storm water management, hydraulic applications, and storm water characterization and monitoring	19	Hydrology

BROWN AND CALDWELL

Name	Education	Specialty Area	Experience	Project Role
Kadaster, Omer	B.S., Civil Engineering M.S., Civil Engineering Registered Professional Civil and Geotechnical Engineer in California	Civil and Environmental Engineering; CERCLA process and compliance	41	Technical Review/Editing
Kremer, Robert	B.S., Business Administration M.A., Environmental Geography Ph. D., Forestry	Ecological assessment/arid land ecology	20	Co-lead, vegetation resources.
Lindburg, Matt	B.S., Agricultural Engineering M.S., Agricultural and Biological Systems Engineering	Project management and water resources planning and engineering for irrigation and hydrogenation facilities	12	Agricultural
Lindenmayer, Laura	B.S., Water Resource Management M.S., Hydrology	Hydrology	1	Hydrologic Resources, Quality Control and Quality Assurance
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Martin, Eric	B.S., Natural Resources	Environmental permitting, groundwater investigations, groundwater and soil remediation, and data management	7	Project Coordinator, Quality Control and Quality Assurance
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Glines, Harlan	B.A., Environmental Studies	NEPA compliance, regulatory compliance, water resource planning	21	Assistant Project Manager
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McConnaha, Willis	B.A., Geology M.S., Fisheries Ph.D., Environmental Science and Resources	Fisheries biology, aquatic ecology, urban and regional planning	28	Biology
McGowan, Dana	B.A., Anthropology Minor in Geology M.A., Anthropology	Historical archaeology, prehistoric archaeology	25	Resource Lead—Indian Trust Assets; Cultural Resources
Norgaard, Ingrid	B.A., Political Science	Public outreach/ education, public involvement/ facilitation, community affairs	8	Resource Lead—Environmental Justice
Oakes, Harry	B.S., Wildlife and Fisheries Biology Minor, Forestry	Restoration ecology, riparian ecology, vegetation management	12	Biology
Rimpo, Tim	B.A., Economics M.S., Economics	Natural resource economics, NEPA/SEPA/CEQA compliance	17	Resource Lead—Transportation
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Solbert, Alan	B.S., Biology and Zoology M.S., Wildlife Sciences and Ecology	Project management, NEPA compliance, environmental impact analysis, flood protection and water resource planning, habitat restoration planning, local government and interagency coordination, land use planning, interagency facilitation, mitigation planning	23	Assistant Project Manager
Stock, Jennifer	B.S., Landscape Architecture	Licensed Landscape Architect open space and recreational planning, Computer Aided Design & Drafting	8	Recreation
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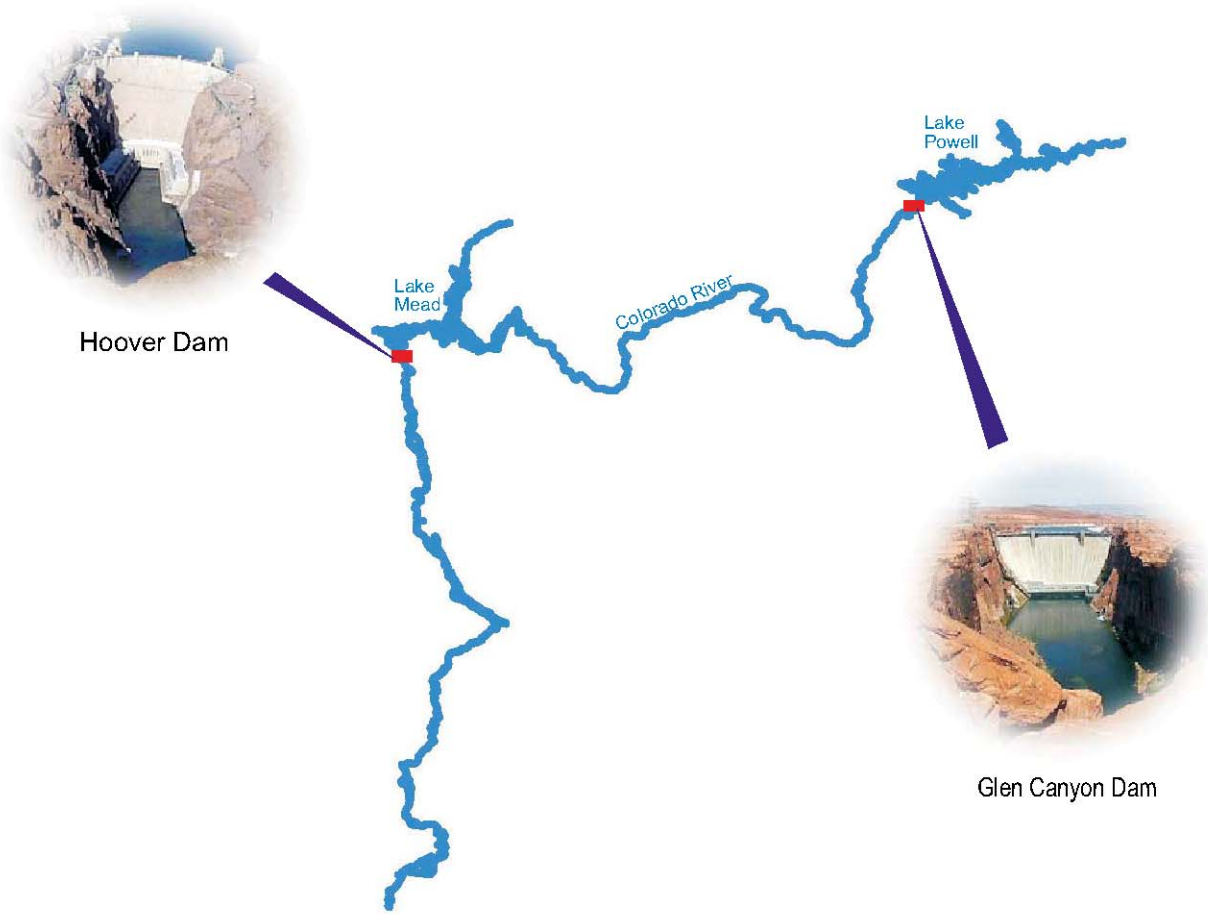
Managing Water in the West

Final

Environmental Impact Statement



Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Volume II – Appendices A through L

U.S. Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions

October 2007

Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Final
Environmental Impact Statement

Volume II
Appendices A through L

U.S. Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions
October 2007

Table of Contents

Volume II - Appendices: Table of Contents

A. CRSS MODEL DOCUMENTATION

B. COLORADO RIVER SYSTEM FACILITIES AND CURRENT RIVER SYSTEM OPERATIONS, FROM LAKE POWELL TO SIB

D. LOWER DIVISION STATES DEPLETION SCHEDULES

F. WATER QUALITY MODELING DOCUMENTATION

G. SHORTAGE ALLOCATION MODEL DOCUMENTATION

H. SOCIOECONOMICS DATA

I. PUBLIC OUTREACH, COORDINATION, AND CONSULTATION EFFORTS

J. SEVEN BASIN STATES' PROPOSALS REGARDING COLORADO RIVER INTERIM OPERATIONS

K. CONSERVATION BEFORE SHORTAGE II PROPOSAL

L. FEDERAL REGISTER NOTICES

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Appendix A

CRSS Model Documentation

This appendix describes the reservoir operating rules and related data used in Reclamation's Colorado River Simulation System (CRSS), as implemented in the RiverWare™ modeling system.

Table of Contents

List of Tables

List of Attachments

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A.1 Background

Long-term policy and planning studies on the Colorado River have typically used computer modeling results from Bureau of Reclamation's (Reclamation) Colorado River Simulation System (CRSS). Developed in the 1980's as a Fortran-based modeling system, CRSS originally ran on a Cyber mainframe computer. CRSS modeled twelve major reservoirs and approximately 115 diversion points throughout the Colorado River Upper Basin and Lower Basin on a monthly time step. A major drawback of the Fortran-based CRSS was that the operating policies or rules were hardwired into the modeling code, making modification of those policies difficult.

Based on the need to initiate surplus and shortage studies for the Lower Basin in the early 1990s, Reclamation developed an annual time step model, CRSSez, implemented in Visual Basic (Bureau of Reclamation 1998). CRSSez primarily modeled the operation of Lake Powell and Lake Mead, representing the reservoirs upstream of Lake Powell as one aggregate reservoir, and the effect of reservoirs downstream of Lake Mead as part of the water demand from Lake Mead. CRSSez was used in the Interim Surplus Criteria Environmental Impact Statement (EIS) process to develop a model, and evaluate a range of alternatives.

In 1994, Reclamation began a collaborative research and development program with the University of Colorado and the Tennessee Valley Authority with the goal of developing a general-purpose modeling tool that could be used for both operations and planning on any river basin. This modeling tool, known as RiverWare™, is now being used by Reclamation's Upper and Lower Colorado Regions for both planning and operations (Fulp 1999). A major advantage of RiverWare™ is that the operational policies or rules are no longer hardwired into the modeling code (Zagona et al. 2001). The user expresses and prioritizes the rules through the RiverWare™ graphical user interface, and RiverWare™ then interprets the rules when a simulation is performed. Multiple rule sets can be used to perform different simulations using the same model and this provides the capability for efficient "what-if" analysis with respect to different policies.

Reclamation replaced the original CRSS model with a new model implemented in RiverWare™ in 1996. The new model has the same spatial and temporal resolution, uses the same basic input data (hydrology and consumptive use schedules), and uses the same physical process algorithms as the original CRSS. A rule set was also developed to mimic the policies contained in the original model. Comparison simulations were made between the original CRSS and the new model and rule set, with typical differences of less than 0.5 percent (Reclamation 1996).

Since 1996, enhancements to CRSS have consisted of developing new rule sets to reflect current operational policy as well as investigating and improving, where necessary, the physical process methodologies. A team of Reclamation engineers from the Upper and Lower Colorado Regions has been established for these purposes and continues to assess the need to further enhance CRSS to reflect new operational policies.

In 2005 a policy-screening model, CRSS-Lite was developed to replace CRSSez (Reclamation 2005). CRSS-Lite was developed in RiverWare™ and preserves the complexity and accuracy of CRSS with a significantly shorter model execution time, an advantage over CRSSez. CRSS-Lite was used extensively to evaluate and compare a multitude of operational strategies and alternatives in this EIS.

A.2 Description of the Model

In summary, twelve Upper Basin and Lower Basin reservoirs are modeled: Fontenelle, Flaming Gorge, Starvation, Taylor Park, Blue Mesa, Morrow Point, Crystal, Navajo, Powell, Mead, Mohave, and Havasu in CRSS. Critical to this EIS was the allocation of shortages, which required breaking out several of the approximately 115 modeled diversions (demands and return flows) throughout the basin that had been aggregated in the original CRSS. The hydrologic "natural" inflows (flows corrected for upstream regulation and consumptive uses and losses) at 29 inflow points throughout the basin were also used from the standard CRSS hydrology data set covering the period 1906–2005.

A.3 Initial Reservoir Conditions

The first year considered for the interim period of the proposed federal action is 2008. Since the initial modeling was performed in 2006, some projection of Colorado River system conditions was need. In order to establish the reservoir starting conditions for CRSS modeling, Reclamation's 24-Month Study model is used to project the reservoir storage conditions as of end-of-calendar year 2007. This process inputs the storage conditions at the time the modeling is performed and adds to that several assumptions including estimates of snow pack and run-off for the intervening period (the period between when the model is run and December 31, 2007).

The hydrologic modeling that was performed and used in the analyses for the Draft EIS was undertaken in the fall of 2006 and used the August 2006 24-Month Study. For the Final EIS, more current estimates of inflow to Lake Powell in 2007 were available and these differed somewhat from the original assumptions that were used in the modeling for the Draft EIS. The lower inflow projections reflected the effects of the continued drought in the Colorado River Basin (which began in 2000). In order to provide the most current information available for the Final EIS, the alternatives were remodeled using the latest available inflow projections. Using this latest inflow forecast in the June 2007 24-Month Study provides different starting conditions for Lake Powell and Lake Mead from those used in the Draft EIS and shows that the projected Lake Powell and Lake Mead elevations for January 1, 2008 would be approximately 20 feet and one foot lower, respectively, than the starting elevations that were used in the Draft EIS.

Table A-1 provides the initial conditions for the Upper Basin and Lower Basin reservoirs that were used in the CRSS simulations for the Draft EIS and the Final EIS. Since the simulation begins in January 2008, these values reflect the end-of-calendar year 2007 reservoir elevations, as projected by the August 2006 24-Month Study and June 2007 24-Month Study, respectively.

Table A-1
Initial Reservoir Conditions
(End-of-Calendar Year 2007 Forecast)

Reservoir	Draft EIS Initial Conditions[1]		Final EIS Initial Conditions[2]	
	Elevation (feet msl)	Storage (af)	Elevation (feet msl)	Storage (af)
Fontenelle	6,486.29	203,787	6,481.89	177,000
Flaming Gorge	6,029.67	3,336,300	6,023.89	3,119,000
Starvation	5,734.92	255,000	5,734.92	255,000
Taylor Park	9,308.32	67,260	9,306.45	64,000
Blue Mesa	7,489.99	581,270	7,490.00	581,000
Morrow Point	7,153.73	112,000	7,153.73	112,000
Crystal	6,753.04	16,970	6,753.04	17,000
Navajo	6,080.33	1,629,760	6,070.99	1,494,000
Powell	3,614.80	13,219,550	3,596.77	11,445,000
Mead	1,116.53	13,023,940	1,114.85	12,864,000
Mohave	638.71	1,582,960	638.71	1,583,000
Havasu	445.80	539,520	445.80	539,000
Total Storage Volume	NA	34,568,317	NA	32,250,000

1 Projected initial conditions based on August 2006 24-Month Study.
2 Projected initial conditions based on June 2007 24-Month Study.
msl: mean sea level
af: acre-foot

A.4 Reservoirs Upstream of Lake Powell

The reservoirs upstream of Lake Powell are operated to meet monthly storage targets (or “rule curves”) and downstream demands. The basic procedure is that given the inflow for the current month, the release will be either the release necessary to meet the target storage, or the release necessary to meet demands downstream of the reservoir, whichever is greater. The rule curves are input for each reservoir, but are modified during the simulation for Flaming Gorge, Blue Mesa, and Navajo to simulate operations based on the imperfect inflow forecasts that are encountered in actual reservoir operations. Furthermore, each reservoir is constrained to operate within user-supplied minimum and maximum releases (mean monthly release in cubic feet per second [cfs]) as specified in Table A-2.

Table A-2
Release Constraints for Reservoirs Upstream of Lake Powell

Reservoir	Minimum Release (cfs)	Maximum Release (cfs)
Fontenelle	500	18,700
Flaming Gorge	800	4,900
Starvation	100	5,000
Taylor Park	50	5,000
Blue Mesa	270	5,000
Morrow Point	300	5,000
Crystal	300	4,200
Navajo	300	5,900

For Flaming Gorge, Blue Mesa, and Navajo, the target storage is computed by using an inflow forecast for the period January through July, again to mimic the imperfect forecasts seen in actual operations. The inflow forecast (for the current month through July) is computed as a weighted average of the long-term average natural inflow and the natural inflow assumed for the year being modeled. The weights used are listed in Table A-3.

Table A-3
Weights for Inflow Forecast for Reservoirs Upstream of Lake Powell

Month	Natural Inflow Weight	Average Natural Inflow Weight
January	0.3	0.7
February	0.4	0.6
March	0.5	0.5
April	0.7	0.3
May	0.7	0.3
June	0.7	0.3
July	0.6	0.4

The long-term, average natural inflows into the Flaming Gorge, Blue Mesa and Navajo reservoirs are listed in Table A-4 (in thousand acre-feet [kaf]).

Table A-4
Average Natural Inflows for Reservoirs Upstream of Lake Powell (kaf)

Reservoir	Jan	Feb	Mar	Apr	May	Jun	Jul
Flaming Gorge	23.3	20.9	33.8	87.9	250.4	327.8	157.5
Blue Mesa	34.0	39.5	94.6	176.0	339.8	561.6	346.8
Navajo	18.8	24.6	69.3	176.9	297.3	284.7	120.1

Based on the inflow forecast, the rule computes the volume necessary to release from the current month through July, assuming the reservoir will fill in July:

> Release needed for the current month = (current contents - live capacity + predicted remaining inflow) divided by the number of months remaining until the end of July

The target storage for the current month is then computed, adjusting the storage at the end of the previous month for any gains or losses upstream of the reservoir:

> Target storage = previous storage - release needed + gains – losses

A.5 Lake Powell Operation

The operation of Lake Powell depends on a rule curve consisting of a forecast-driven operation from January through July that attempts to fill the reservoir to July target storage, and an operation from August through December that attempts to draw down the reservoir to December target storage. The July and December targets are 23.822 million acre-feet (maf) (500,000 af of space) and 21.900 maf (2.422 kaf of space), respectively. Another rule simulates the occurrence of Beach/Habitat-Building Flows (BHBFs or spike flows). Two other higher priority rules ensure that the minimum objective release of 8.23 million acre-feet per year (mafy) is met and that equalization of Lake Powell and Lake Mead is accomplished when necessary. Release constraints that reflect the 1996 Record of Decision on the Operation of Glen Canyon Dam are also part of the Lake Powell rule set.

Sections A.5.1 through A.5.6 that follow describe modeling assumptions for Lake Powell operation that are common to all six alternatives. A summary comparison of the Lake Powell operational strategy for each alternative is provided in Attachment A to this Appendix (Table Att. A-1).

A.5.1 Lake Powell Inflow Forecast

The unregulated Lake Powell inflow forecast from the current month through July is computed as

> unregulated Lake Powell inflow = natural flow into Lake Powell - estimated Upper Basin depletions + the forecast error
>
> where: the forecast error is computed using equations derived from an analysis of past Colorado River forecasts and runoff data for the period 1947 to 1983.

An analysis of these data reveals two strongly established patterns: (1) high runoff years are under-forecast, and low runoff years are over-forecast; and (2) the error in the current month's seasonal forecast is strongly correlated with the error in the preceding month's forecast (Reclamation 1985). A regression model was developed to aid in determining the error to be incorporated into the seasonal forecast for each month from January to June. The error is the sum of a deterministic component and a random component. The deterministic component is computed from the regression equation. The random component is computed by multiplying the standard error of the regression equation by a random mean deviation selected from a standard normal distribution.

The forecast error equation has the following form (all runoff units are maf):

$$E_i = a_i X_i + b_i E_{(i-1)} + c_i + Z_r d_i$$

where:

i = month,

E_i = error in the forecast for month "i,"

X_i = natural runoff into Lake Powell from month "i" through July,

a_i = linear regression coefficient for Xi,

$E_{(i-1)}$ = previous month's forecast error,

b_i = linear regression coefficient for E(i-1),

c_i = constant term in regression equation for month "i,"

Z_r = randomly determined deviation, and

d_i = standard error of estimate for regression equation for month "i."

Table A-5 summarizes the regression equation coefficients for each month.

Table A-5
Lake Powell Inflow Forecast Regression Equation Coefficients

Month	a_i	b_i	c_i	d_i
January	0.70	0.00	-8.195	1.270
February	0.00	0.80	-0.278	0.977
March	0.00	0.90	0.237	0.794
April	0.00	0.76	0.027	0.631
May	0.00	0.85	0.132	0.377
June	0.24	0.79	0.150	0.460

The magnitude of the June forecast error is constrained to not exceed 50 percent of the May forecast error and the July forecast error is equal to 25 percent of the June forecast error.

A.5.2 January through July Operation

To accomplish the operation from January through July, the unregulated forecast is first adjusted to account for potential reservoir regulation upstream of Lake Powell. This potential regulation is currently computed as just the sum of the available space (live capacity – previous month’s storage) in Fontenelle, Flaming Gorge, Blue Mesa, and Navajo reservoirs. Using the regulated forecast inflow, the total volume of water necessary to release from the current month through July is computed as

total volume to release = end of previous month’s storage – July target storage + forecast regulated inflow – loss due to evaporation – loss due to bank storage

The release for the current month is then computed by multiplying the total volume to release by a fraction for the current month, where the fraction reflects a user-supplied preferred weighting pattern. The weights and resulting fractions used for this study are listed in Table A-6.

Table A-6
Lake Powell January through July Operation Weights and Resulting Fractions

Month	Weights	Fractions
January	0.170	0.170
February	0.160	0.193
March	0.130	0.194
April	0.100	0.185
May	0.100	0.227
June	0.160	0.471
July	0.180	1.000

The fraction is computed as current month's weight divided by the sum of the current and remaining month's weights for the season.

During the operation from January through July, the computed release is constrained to be at least as great as the total volume divided by the number of months remaining. This constraint ensures that sufficient water is released early during high forecast years. Lake Powell’s operational release during January through July is further constrained in each month to be within a minimum and maximum range (currently set to 6,500 and 25,000 cfs, respectively).

An additional constraint is placed on computed monthly release during spill avoidance. If the calculated average flow for a given month is in excess of 1.0 maf, then it is held to a maximum of 1.0 maf each month.

A.5.3 August through December Operation

Conceptually, the computation for the operation from August through December is identical to the computation made for the operation from January through July. The regulated inflow forecast is simply the natural inflow, adjusted for Upper Basin depletions, and potential reservoir regulation with no forecast error added. The potential reservoir regulation is again computed as the sum of the available space in Fontenelle, Flaming Gorge, Blue Mesa, and Navajo reservoirs, where the space is the target storage in December for each reservoir minus the end of the previous month’s storage. User-supplied weights are also used to compute the current month release from the total volume to release. The weights and resulting fractions are listed in Table A-7.

Table A-7
Lake Powell August through December Operation Weights and Resulting Fractions

Month	Weights	Fractions
August	0.266	0.266
September	0.200	0.272
October	0.156	0.292
November	0.156	0.413
December	0.222	1.000

Two additional constraints are placed on the computed monthly release to ensure a smooth operation. In July, the release is constrained to be at least 1.0 maf if Lake Powell's storage is greater than 23.0 maf. From July through December, the release is constrained to not exceed 1.5 maf, as long as a 1.5 maf release results in storage at Lake Powell less than 23.822 maf. Lake Powell's operational release during August through December is further constrained in each month to be within a minimum and maximum range (currently set to 6,500 and 25,000 cfs, respectively).

A.5.4 602(a) Storage Requirement

The 602(a) storage requirement refers to the quantity of water required to be in storage in the Upper Basin so as to assure future deliveries to the Lower Basin without impairing annual consumptive uses in the Upper Basin (Bureau of Reclamation 1985). The current implementation of that storage requirement duplicates the original CRSS calculation. It computes a storage amount necessary in the Upper Basin to meet the minimum objective release and Upper Basin depletions over the next "n" years, assuming the inflow over that period would follow that seen in the most "critical period on record." The critical period in the Colorado River basin occurred in 1953 through 1964, a length of 12 years. Inflows from these years are used in the calculation of 602(a) storage.

At the beginning of each calendar year, a value for 602(a) storage is computed by the following formula:

602a = {(UBDepletion + UBEvap)* (1 – percentShort/ 100) + minObjRel – criticalPeriodInflow} * 12 + minPowerPoolStorage

where:

602a	=	the 602(a) storage requirement
UBDepletion	=	the average over the next 12 years of the Upper Basin scheduled depletions
UBEvap	=	the average annual evaporation loss in the Upper Basin (currently set to 560 kaf)
percentShort	=	the percent shortage that will be applied to Upper Basin depletions during the critical period (currently set to zero)
minObjRel	=	the minimum objective release to the Lower Basin (currently set to 8.23 maf)
criticalPeriodInflow	=	average annual natural inflow into the Upper Basin during the critical period (1953–1964) (currently set to 12.18 maf)
minPowerPoolStorage	=	the amount of minimum power pool to be preserved in Upper Basin reservoirs (currently set to 5.179 maf)

All parameter values currently used were as found in the original CRSS data files converted from the Cyber mainframe in 1994.

Additionally, since 2004, the Interim 602(a) Storage Guideline (69 Fed. Reg. 28945) has been included in CRSS. This guideline necessitates that for the 602(a) storage requirement to be met, Lake Powell storage must be greater than 14.85 maf (elevation 3,630 feet msl) on September 30. This interim guideline provides guidance to the Secretary in making a determination of the quantity of water considered necessary as of September 30 of each year to assist in implementation of and as required by Article II(1) of the 1970 Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs (Long-Range Operating Criteria or LROC) pursuant to the Colorado River Basin Project Act of September 30, 1968. The interim guideline specifies that:

1. through the year 2016, 602(a) storage requirements determined in accordance with Article II(1) of the LROC shall utilize a value of not less than 14.85 maf (elevation 3,630 feet msl) for Lake Powell. Accordingly, when projected September 30 Lake Powell storage is less than 14.85 maf (elevation 3,630 feet msl), the objective will be to maintain a minimum annual release of water from Lake Powell of 8.23 maf, consistent with Article II(2) of the LROC;

2. under the current area-capacity relationship at Lake Powell, a reservoir elevation of 3,630 feet msl corresponds to 14.85 maf of storage. In the event that a sediment survey is performed at Lake Powell and a revised area-capacity relationship is determined before 2016, the revised water storage volume that correlates with the

reservoir elevation of 3,630 feet msl at Lake Powell shall be used in Section V(1) of this Interim 602(a) Storage Guideline; and

3. the Interim 602(a) Storage Guideline shall be utilized in the operation of the Colorado River from 2005 through 2016. This guideline will first be implemented in the development of the 2005 Colorado River Annual Operating Plan (AOP) and for all subsequent AOPs through 2016.

In the modeling for the Final EIS, the Interim 602(a) Storage Guideline is in effect through 2016. In the CRSS simulation, following the 602(a) storage computation described above, a subsequent rule checks to see if Lake Powell elevation is above 3,630 feet msl on September 30. The 602(a) requirement is not met if projected September 30 elevation of Lake Powell is below 3,630 feet msl, through 2016.

A.5.5 Predicting End-of-Water Year Volumes of Lake Powell and Lake Mead

Lake Powell end-of-water year (EOWY) volume is predicted each month by taking the end of the previous month's storage, adding the estimated inflow, subtracting the estimated release, and subtracting the estimate of evaporation and change in bank storage. All estimated values are for the period from the current month through September. The estimated inflow is just the regulated inflow forecast previously discussed, where the forecast error is included through July. The estimated release is based on the operation from January through July and the operation for August and September. The estimated evaporation and bank storage losses are based on an initial estimate of the EOWY volume.

Similarly, the Lake Mead EOWY volume is predicted each month by taking the end of previous month's volume, adding the estimated Lake Powell release, subtracting the estimated Lake Mead release, adding the average gain between Lake Powell and Lake Mead, subtracting the Southern Nevada depletion, and subtracting the estimate of evaporation and change in bank storage. Again, all values are for the period from the current month through September. Lake Mead's release is estimated as the sum of the depletions downstream of Lake Mead and the reservoir regulation requirements (including evaporation losses) for Lake Mohave and Lake Havasu minus the gains below Lake Mead.

The changes in volume of water storage in Lake Powell and Lake Mead are calculated by the model using relationship curves that are programmed into the model. These relationship curves correlate the water surface elevation to live capacity, total capacity, and surface area for each respective reservoir. Tables which present the corresponding values for the range of operational elevations at Lake Powell and Lake Mead are provided in Attachment B to this appendix (Table Att. B-1 and Table Att. B-2, respectively).

A.5.6 Beach/Habitat-Building Flows

Under the current rule that implements BHBFs, a BHBF is triggered for the current month if the following conditions are met:

- in January, if the unregulated inflow forecast for January through July (the natural flow – Upper Basin depletions plus forecast error) is greater than the “January trigger volume” (currently set to 13.0 maf); and

- in January through July, if the current month’s Lake Powell release is greater than the “release trigger” (currently set to 1.5 maf) or if the release volume for the current month through July equally distributed over those months would result in a release greater than the release trigger.

Once a BHBF has been triggered, if Lake Powell would have had to spill in that month anyway, the total outflow from Lake Powell is not increased; rather the volume for the BHBF (currently set to 200 kaf) is taken from the total outflow already determined by the operational rule. If Lake Powell was not going to spill in that month, then the total outflow from Lake Powell is increased (i.e., the volume for the BHBF is taken from Lake Powell’s storage). Under the case where the BHBF is triggered even though the current month’s release is less than the release trigger, the rule re-sets Lake Powell’s outflow for that month to the trigger release amount (1.5 maf).

Under all circumstances, only one BHBF is made per calendar year in the model.

A.5.7 Minimum Objective Release

A minimum objective release is required from Lake Powell only under the No Action Alternative, as discussed below. The minimum release required under the action alternatives varies by alternative and Lake Powell volume. These releases are described in Section A.5.9.

A.5.7.1 No Action Alternative

Under the No Action Alternative, a higher priority rule ensures that the previously described Lake Powell operation will satisfy a minimum objective release to the Lower Basin, currently equal to 8.23 maf over each water year (October through September). Similar to the weighting and release fraction scheme used for the operational rule, a preferred release pattern for each month to meet the minimum objective release is supplied and a fraction is computed. The release pattern (in kaf) and resulting fractions are listed in Table A-8.

Table A-8
Lake Powell Release Pattern and Resulting Fractions
No Action Alternative

Month	8,230 kaf	
	Release (kaf)	Fraction
October	600	0.073
November	600	0.079
December	800	0.114
January	800	0.128
February	600	0.110
March	600	0.124
April	600	0.142
May	600	0.165
June	650	0.215
July	850	0.357
August	900	0.588
September	630	1.000
Total	8,230	-----

The fraction is computed as current month's release divided by the sum of the current and remaining months' releases through September.

Each month the rule computes the volume of water remaining to meet the minimum objective release for the current water year (accounting for the water released previously in the water year) and multiplies that volume by the release fraction. The release determined by the operational rule must then be at least as great as this resulting minimum objective release for the month.

A.5.8 Equalization of Lake Powell and Lake Mead

A.5.8.1 No Action Alternative

Under the No Action Alternative, the equalization of storage between Lake Powell and Lake Mead is implemented in a rule that accurately models the past and current operations of equalization at Glen Canyon Dam. The rule first determines if equalization needs to occur, and if so, determines how much water to release from Lake Powell to accomplish it. The rule is in effect from January through September of each year. The rule states that equalization needs to occur if two criteria are met: (1) if the storage in the Upper Basin meets the 602(a) storage requirement; and (2) if the projected EOWY storage in Lake Powell is greater than that in Lake Mead.

The storage in the Upper Basin is computed for each month (January through September) and consists of the predicted EOWY storage in Lake Powell, plus the sum of the end of previous month's storage for Flaming Gorge, Blue Mesa, and Navajo reservoirs. That storage is then compared to the computed value of 602(a) storage, described above, to determine if the 602(a) storage requirement is met each month. The method of estimating the EOWY storage is described above.

The release for equalization is computed by taking half of the difference between the predicted EOWY volumes of Lake Powell and Lake Mead and dividing by the number of months remaining through September. Evaporation and bank storage losses at Lake Powell and Lake Mead are included in the calculation, resulting in an iterative procedure to arrive at the computed equalization release. The iteration stops when the forecast EOWY volumes of Lake Powell and Lake Mead are within a user-specified tolerance. That tolerance is currently set to 250,000 af.

The computed equalization release for each month is constrained in three ways: (1) if the additional release due to equalization would cause the total Upper Basin storage to drop below the 602(a) storage requirement, then the amount of the equalization release can be adjusted downward but cannot be reduced below 8.23 maf; (2) the equalization release is reduced if it would cause Lake Mead volumes to exceed its exclusive flood control space; and (3) the equalization release is constrained to be not greater than 25,000 cfs, the maximum normal release as per the Glen Canyon Operating Criteria.

A.5.8.2 Basin States Alternative

Under the Basin States Alternative, the equalization of storage between Lake Powell and Lake Mead is implemented in a rule that first determines if equalization needs to occur, and if so, then determines how much water to release from Lake Powell to accomplish it. The rule is in effect from January through September of each year. The rule states that equalization needs to occur if two criteria are met: (1) if the EOWY elevation of Lake Powell is predicted to be equal to or higher than the Equalization Level (see Table A-9); and (2) if the EOWY storage in Lake Powell is greater than EOWY storage in Lake Mead. The Basin States Alternative substitutes the 602(a) Storage and Interim 602(a) Storage Guideline with the Equalization Level for each year 2008 through 2026.

In years when Lake Powell EOWY elevation is projected to be equal to or above the Equalization Level and the EOWY volume of Lake Powell is projected to be above the EOWY volume of Lake Mead, a volume of water greater than 8.23 maf is scheduled for annual release from Lake Powell to the extent necessary to equalize storage in the two reservoirs. Otherwise, if Lake Powell EOWY volume is not higher than Lake Mead EOWY volume, the annual release volume from Lake Powell is scheduled at 8.23 maf.

The release for equalization is computed by taking half of the difference between the predicted EOWY volumes of Lake Powell and Lake Mead and dividing by the number of months remaining through September. Evaporation and bank storage losses at Lake Powell and Lake Mead are included in the calculation, resulting in an iterative procedure to arrive at the computed equalization release. The iteration stops when the forecast EOWY volumes of Lake Powell and Lake Mead are within a user-specified tolerance. That tolerance is currently set to 250,000 af.

Table A-9
Lake Powell Equalization Elevation
Basin States Alternative

Year	Equalization Elevation (feet msl)
2008	3,636
2009	3,639
2010	3,642
2011	3,643
2012	3,645
2013	3,646
2014	3,648
2015	3,649
2016	3,651
2017	3,652
2018	3,654
2019	3,655
2020	3,657
2021	3,659
2022	3,660
2023	3,662
2024	3,663
2025	3,664
2026	3,666

The computed equalization release for each month is constrained in three ways: (1) if the additional release due to equalization would cause the Lake Powell EOWY elevation to drop below the Equalization Line, then the amount of the equalization release is reduced to prevent this from happening; (2) the equalization release is reduced if it would cause Lake Mead volumes to exceed its exclusive flood control space; and (3) the equalization release is constrained to be not greater than 25,000 cfs, the maximum normal release as per the Glen Canyon Operating Criteria.

A.5.8.3 Conservation Before Shortage Alternative
The equalization method for Lake Powell under the Conservation Before Shortage Alternative is identical to that of the Basin States Alternative.

A.5.8.4 Water Supply Alternative
The equalization criteria for Lake Powell under the Water Supply Alternative are identical to those of the No Action Alternative.

A.5.8.5 Reservoir Storage Alternative
The equalization criteria for Lake Powell under the Reservoir Storage Alternative are identical to those of the No Action Alternative.

A.5.8.6 Preferred Alternative

The equalization method for Lake Powell under the Preferred Alternative is identical to that of the Basin States and Conservation Before Shortage Alternatives.

A.5.9 Water Year Releases When Equalization Does Not Apply

A.5.9.1 No Action Alternative

Under the No Action Alternative, Lake Powell water releases are constrained by the minimum objective release as described in Section A.5.7.

A.5.9.2 Basin States Alternative

Under the Basin States Alternative, when the EOWY level of Lake Powell is below the Equalization Level (see Table A-9), a higher priority rule ensures that the Lake Powell operation will satisfy a water year release to the Lower Basin, between 7.00 maf and 9.50 maf, depending on elevations in Lake Powell and Lake Mead. Similar to the weighting and release fraction scheme used for the operational rule in the No Action Alternative, a preferred release pattern for each month to meet the water year release is supplied and a fraction is computed. The fraction is computed as current month’s release divided by the sum of the current and remaining months’ releases through September. Each month the rule computes the volume of water remaining to meet the release for the current water year (accounting for the water released previously in the water year) and multiplies that volume by the release fraction. The release determined by the operational rule must then be at least as great as this resulting release for the month.

Specific release patterns (in kaf) and resulting fractions for the Basin States Alternative are provided in Table A-10.

Table A-10
Lake Powell Release Patterns and Resulting Fractions
Basin States Alternative

Total Release	7,000 kaf		7,480 kaf		8,230 kaf		9,000 kaf		9,500 kaf	
Month	Release (kaf)	Fraction	Release (kaf)	Fraction	Release (kaf)	Fraction	Release (kaf)	Fraction	Release (kaf)	Fraction
October	480	0.069	480	0.064	600	0.073	600	0.067	600	0.063
November	500	0.077	500	0.071	600	0.079	600	0.071	600	0.067
December	600	0.100	600	0.092	800	0.114	800	0.103	800	0.096
January	600	0.111	800	0.136	800	0.128	800	0.114	850	0.113
February	600	0.124	600	0.118	600	0.110	650	0.105	650	0.098
March	500	0.118	600	0.133	600	0.124	650	0.117	650	0.108
April	500	0.134	500	0.128	600	0.142	600	0.122	650	0.121
May	500	0.155	600	0.176	600	0.165	650	0.151	800	0.170
June	600	0.221	600	0.214	650	0.215	800	0.219	900	0.231
July	800	0.377	800	0.364	850	0.357	1,000	0.351	1,050	0.350
August	800	0.606	800	0.571	900	0.588	1,050	0.568	1,100	0.564
September	520	1.000	600	1.000	630	1.000	800	1.000	850	1.000
Total	7,000	-----	7,480	-----	8,230	-----	9,000	-----	9,500	-----

In years when Lake Powell EOWY elevation is projected to be lower than the Equalization Level and equal to or above 3,575 feet msl, and the projected Lake Mead EOWY elevation is equal to or above 1,075 feet msl, then the annual release volume is scheduled to be 8.23 maf. If the projected Lake Mead EOWY elevation is below 1,075 feet msl, however, then a volume of water is scheduled for annual release from Lake Powell to the extent necessary to balance storage in the two reservoirs, constrained by being no more than 9.00 maf and no less than 7.00 maf.

In years when Lake Powell EOWY elevation is projected to be lower than 3,575 feet msl and at or above 3,525 feet msl, and the projected Lake Mead EOWY elevation is equal to or above 1,025 feet msl, then the annual release volume is scheduled at 7.48 maf. However, if Lake Powell EOWY elevation is projected to be lower than 3,575 feet msl and at or above 3,525 feet msl, but the projected Lake Mead EOWY elevation is below 1,025 feet msl, then the annual release volume is scheduled at 8.23 maf.

In years when Lake Powell EOWY elevation is projected to be below 3,525 feet msl, then a volume of water is scheduled for annual release from Lake Powell to the extent necessary to balance storage in the two reservoirs, constrained by being no more than 9.50 maf and no less than 7.00 maf.

A.5.9.3 Conservation Before Shortage Alternative

Water year releases for Lake Powell under the Conservation Before Shortage Alternative are identical to those of the Basin States Alternative.

A.5.9.4 Water Supply Alternative

Under the Water Supply Alternative, when projected EOWY storage in the Upper Basin is less than the 602(a) storage requirement, a higher priority rule ensures that the Lake Powell operation will satisfy a water year release to the Lower Basin between 7.00 maf and 9.50 maf, depending on projected EOWY elevations in Lake Powell and Lake Mead. Similar to the weighting and release fraction scheme used for the operational rule, a preferred release pattern for each month to meet the water year release is supplied and a fraction is computed. The fraction is computed as current month's release divided by the sum of the current and remaining months' releases through September. Each month the rule computes the volume of water remaining to meet the release for the current water year (accounting for the water released previously in the water year) and multiplies that volume by the release fraction. The release determined by the operational rule must then be at least as great as this resulting release for the month.

Specific release patterns (in kaf) and resulting fractions for the Water Supply Alternative are provided in Table A-11.

In years when the Lake Powell EOWY volume is projected to be below the 602(a) storage requirement and equal to or above 3,575 feet msl, and the projected Lake Mead EOWY elevation is equal to or above 1,075 feet msl, then the annual release volume is scheduled to be 8.23 maf. If the projected Lake Mead EOWY elevation is below 1,075 feet msl, however, then a volume of water is scheduled for annual release from Lake Powell to the extent necessary to balance storage in the two reservoirs, constrained by being no more than 9.50 maf and no less than 7.00 maf.

In years when the Lake Powell EOWY elevation is projected to be less than 3,575 feet msl, then a volume of water is scheduled for annual release from Lake Powell to the extent necessary to balance storage in the two reservoirs, constrained by being no more than 9.50 maf and no less than 7.00 maf.

Table A-11
Lake Powell Release Patterns and Resulting Fractions
Water Supply Alternative

Total Release	7,000 kaf		8,230 kaf		9,500 kaf	
Month	Release (kaf)	Fraction	Release (kaf)	Fraction	Release (kaf)	Fraction
October	480	0.069	600	0.073	600	0.063
November	500	0.077	600	0.079	600	0.067
December	600	0.100	800	0.114	800	0.096
January	600	0.111	800	0.128	850	0.113
February	600	0.124	600	0.110	650	0.098
March	500	0.118	600	0.124	650	0.108
April	500	0.134	600	0.142	650	0.121
May	500	0.155	600	0.165	800	0.170
June	600	0.221	650	0.215	900	0.231
July	800	0.377	850	0.357	1,050	0.350
August	800	0.606	900	0.588	1,100	0.564
September	520	1.000	630	1.000	850	1.000
Total	7,000	-----	8,230	-----	9,500	-----

A.5.9.5 Reservoir Storage Alternative

Under the Reservoir Storage Alternative, when projected EOWY storage in the Upper Basin is less than the 602(a) storage requirement, a higher priority rule ensures that the Lake Powell operation will satisfy a water year release to the Lower Basin between 7.80 maf and 9.50 maf, depending on projected EOWY elevations in Lake Powell and Lake Mead. Similar to the weighting and release fraction scheme used for the operational rule, a preferred release pattern for each month to meet the water year release is supplied and a fraction is computed. The fraction is computed as current month’s release divided by the sum of the current and remaining months’ releases through September. Each month the rule computes the volume of water remaining to meet the release for the current water year (accounting for the water released previously in the water year) and multiplies that volume by the release fraction. The release determined by the operational rule must then be at least as great as this resulting release for the month.

Specific release patterns (in kaf) and resulting fractions for the Reservoir Storage Alternative are provided in Table A-12.

Table A-12
Lake Powell Release Patterns and Resulting Fractions
Reservoir Storage Alternative

Total Release	7,800 kaf		8,230 kaf		9,500 kaf	
Month	Release (kaf)	Fraction	Release (kaf)	Fraction	Release (kaf)	Fraction
October	600	0.077	600	0.073	600	0.063
November	600	0.083	600	0.079	600	0.067
December	600	0.091	800	0.114	800	0.096
January	800	0.133	800	0.128	850	0.113
February	600	0.115	600	0.110	650	0.098
March	600	0.130	600	0.124	650	0.108
April	600	0.150	600	0.142	650	0.121
May	600	0.176	600	0.165	800	0.170
June	600	0.214	650	0.215	900	0.231
July	800	0.364	850	0.357	1,050	0.350
August	800	0.571	900	0.588	1,100	0.564
September	600	1.000	630	1.000	850	1.000
Total	7,800	-----	8,230	-----	9,500	-----

In years when Lake Powell EOWY volume is projected to be below the 602(a) storage requirement, and Lake Powell EOWY elevation is equal to or above 3,595 feet msl, then the annual release volume is scheduled at 8.23 maf.

In years when the Lake Powell EOWY elevation is projected to be lower than 3,595 feet msl and equal to or above 3,560 feet msl, then the annual release volume is scheduled at 7.80 maf.

In years when Lake Powell EOWY elevation is projected to be below 3,560 feet msl, the annual release is scheduled at the volume of water required to balance the volumes of Lake Powell and Lake Mead, constrained by being no more than 9.50 maf and no less than 7.80 maf.

A.5.9.6 Preferred Alternative

Water year releases for Lake Powell under the Preferred Alternative are identical to those of the Basin States and Conservation Before Shortage alternatives.

A.6 Lake Mead Operation

Lake Mead is operated primarily to meet downstream demands, including downstream depletions (both United States and Mexico) and reservoir regulation requirements. In any month, the rule computes the downstream depletions based on schedules that have been set as input data (or by other rules) and the amount of water necessary to meet the storage targets for downstream Lake Mohave and Lake Havasu and to overcome evaporation losses at those lakes. The rule sets the total release necessary each month from Lake Mead to meet the total downstream demand, taking into account gains and losses below Lake Mead.

The depletions from Lake Mead and downstream of Hoover Dam are affected by the determination of the water supply conditions (Normal, Surplus, or Shortage). Additional rules determine the water supply condition and set the appropriate depletion schedule for the entities affected, as described in Sections A.6.2 and A.6.3.

Under certain conditions, Lake Mead may release water in addition to downstream demand. This condition is termed “flood control” and is guided by the United States Army Corps of Engineers’ (USACE) flood control regulations as contained in the USACE’s Water Control Manual for Flood Control, Hoover Dam and Lake Mead, Colorado River, Nevada and Arizona (Water Control Manual) dated December 1982. These flood control operations and their simulation in the CRSS model are described in Section A.6.1.

A.6.1 Lake Mead/Hoover Dam Flood Control

There are three flood control procedures currently in effect for different times of the year. These procedures were developed in the original CRSS and are based on the Field Working Agreement between Reclamation and the USACE (United States Army Corps of Engineers 1982). The first procedure is in effect throughout the year. Its objective is to maintain a minimum space of 1.5 maf in Lake Mead, primarily for extreme rain events. This space is referred to as the exclusive flood control space and is represented by the space above elevation 1,219.61 feet msl. The second procedure is used during the period from January through July. The objective during this period is to route the maximum inflow forecast through the reservoir system using specific rates of Hoover Dam discharge, assuming that Lake Mead will fill to elevation 1,219.61 feet msl at the end of July. The third procedure is used during the space building or drawdown period (August through December). The objective during this period is to gradually draw down the reservoir system to meet the total system space requirements in each month in anticipation of the next year’s runoff.

A.6.1.1 Exclusive Flood Control Space Requirement

This requirement states that there must be a minimum space of 1.5 maf in Lake Mead at all times. If the release computed to meet downstream demand results in a Lake Mead storage that would violate this space requirement, the rule computes the additional release necessary to maintain that space.

A.6.1.2 January through July Operation

The flood control policy requires that the maximum forecast be used where that forecast is defined as the estimated inflow volume that, on average, will not be exceeded 19 times out of 20 (a 95 percent non-exceedance). The rule first computes the inflow forecast to Lake Mead by taking the Lake Powell forecast (Section A.5) and adds the long-term, average natural tributary inflows between Lake Powell and Lake Mead. The maximum forecast is then estimated by adding an additional volume (the “forecast error term”) to that inflow forecast. The forecast error term (in maf) is provided in Table A-13, taken from the original CRSS data.

Table A-13
Lake Mead January through July Forecast Error

Forecast Period	Forecast Error Term (maf)
January – July	4.980
February – July	4.260
March – July	3.600
April – July	2.970
May – July	2.525
June – July	2.130
July – July	0.750

The Field Working Agreement defines an iterative algorithm by which the current month's release (in cfs) is determined. Certain release levels are specified, as listed in Table A-14.

Table A-14
Lake Mead Flood Control Release Levels

Release Level	Release (cfs)	Description
1	19,000	Parker Powerplant capacity
2	28,000	Davis Powerplant capacity
3	35,000	Hoover Powerplant capacity (in 1987)
4	40,000	Approximate maximum flow non-damaging to streambed
5	73,000	Hoover Dam controlled discharge capacity

The flood control release needed for the current month is determined by:

> release needed for the current month = maximum forecast inflow – current storage space in Lake Powell (below 3,700 feet msl) – current storage space in Lake Mead (below 1,229 feet msl) + 1.5 maf (exclusive space) – evaporation and bank storage losses from Lake Powell and Lake Mead – Southern Nevada depletion – future volume of water released (assuming a release level from Table A-14 for the remaining months through July)

If the computed release for the current month is greater than that assumed for the future months, the future level is increased and the current month release is re-computed. The computation stops once the computed release for the current month is less than or equal to that assumed for the future months. If the computed release is greater than the previously assumed level, that release is used for the current month; otherwise, the previously assumed level is used.

The rule sets Lake Mead's release to the flood control release if it is greater than the release previously computed to meet downstream demands.

A.6.1.3 Space Building (August to December)

The flood control policy states the flood control storage space (in maf) in Lake Mead (storage below elevation 1,229 feet msl) required at the beginning of each month from August through January, as listed in Table A-15.

Table A-15
Lake Mead Flood Control Required Storage Space

Date	Required Storage Space (maf)
August	1.50
September	2.27
October	3.04
November	3.81
December	4.58
January	5.35

However, these targets may be reduced to the minimum of 1.5 maf in each month if additional space is available upstream in live storage. Certain upstream reservoirs are specified with a maximum creditable space (in maf) that can be applied towards the total required flood control space. The creditable storage space allowed for each of these reservoirs is listed in Table A-16.

Table A-16
Lake Mead Flood Control Maximum Creditable Storage Space

Reservoir	Maximum Creditable Storage Space (maf)
Powell	3.8500
Navajo	1.0359
Blue Mesa	0.7485
Flaming Gorge plus Fontenelle	1.5072

In each month (July through December), if the release computed to meet downstream demands results in an end-of-month Lake Mead storage that would violate the space requirement adjusted for upstream storage, the rule computes the additional release necessary to maintain that space. However, these releases are constrained to be less than or equal to 28,000 cfs.

A.6.2 Lower Basin Surplus Strategies

Under the No Action Alternative, the Interim Surplus Guidelines (ISG) are assumed to be in effect through 2016. Beginning in 2017, surpluses are determined based on the 70R Strategy (Section A.6.2.4.). The action alternatives use some or all of the surplus conditions and vary by the duration that each type is in effect. A summary comparison of the surplus strategy for each alternative is provided in Attachment A to this appendix (Table Att. A-2). Surplus schedules by entity are provided in Appendix D. The ISG are specified in the Record of Decision (ROD), Colorado River ISG, Final Environmental Impact Statement, January 2001, and the model implements those as follows:

A.6.2.1 Normal Conditions

If the model determines that neither surplus or shortage conditions exists, the model assigns the Normal schedules to all diversion points in the Lower Basin. The Normal schedules total 7.5 maf of annual consumptive use in the Lower Basin.

A.6.2.2 Partial Domestic Surplus

If the modeled January 1 Lake Mead elevation is at or above 1,125 feet msl and below 1,145 feet msl, the model assigns the Partial Domestic Surplus schedules to Metropolitan Water District of Southern California (MWD) and the Southern Nevada Water Authority (SNWA). All other diversion points remain at Normal schedules. The Partial Domestic Surplus schedules yield the amount of surplus for MWD and SNWA as specified in the ROD, and are documented in the Final Environmental Impact Statement, Implementation Agreement, Inadvertent Overrun and Payback Policy, and Other Federal Actions (SIA-EIS, Bureau of Reclamation 2002).

A.6.2.3 Full Domestic Surplus

If the modeled January 1 Lake Mead elevation is at or above 1,145 feet msl but below the spill avoidance strategy assuming the runoff value of the 70^{th} percentile of exceedance based on the historic record of runoff above Lake Powell (i.e., the 70R Strategy), the model assigns the Full Domestic Surplus schedules to MWD and SNWA. All other diversion points remain at Normal schedules. The Full Domestic Surplus schedules yield the amount of surplus for MWD and SNWA as specified in the ROD, and are documented in the Implementation Agreement Final EIS (Reclamation 2002).

A.6.2.4 Quantified Surplus (70R Strategy)

Under the 70R Strategy, a surplus condition is based on the system space requirement at the beginning of each year. Based on the 70^{th} percentile historical runoff, a normal 7.5 maf delivery to the Lower Division states, the Upper Basin scheduled use, and Lake Powell and Lake Mead volumes at the beginning of the year, the volume of water in excess of the system space requirement at the end of the year is estimated. If that volume is greater than zero, a Surplus is declared. The quantity of the surplus volume (*SurVol*) is computed as follows:

SurVol = (PowellStorage + MeadStorage – maxStorage)* (1 + aveBankStorCoef) + runoff – UBDemand – LBDemand

Where:

Powell Storage	=	Lake Powell storage at the beginning of the year
Mead Storage	=	Lake Mead storage at the beginning of the year
maxStorage	=	maximum combined storage of Lake Powell and Lake Mead that will meet the system space requirement at the beginning of the year, assuming 30% of that requirement will be met by the reservoirs upstream of Lake Powell (computed as live capacity of Lake Powell and Lake Mead – 70% * Lake Mead space requirement at the beginning of the year equal to 5.35 maf = 47.96 maf)
aveBankStorCoef	=	average of Lake Powell and Lake Mead bank storage coefficients
runoff	=	assumed percentile runoff
UBDemand	=	Upper Basin depletion scheduled for the year + the average evaporation loss in the Upper Basin (same as assumed in the 602(a) calculation, 560 kaf)
LBDemand	=	sum of depletions below Lake Powell + the evaporation losses in the Lower Basin (average loss of 900 kaf at Lake Mead and computed for Lake Mohave and Lake Havasu, based on target storage) – average gains between Lake Powell and Lake Mead – average gains below Lake Mead

Once the quantity of surplus volume is known, the model computes each state's share (50 percent to California, 46 percent to Arizona, and 4 percent to Nevada). The model then assigns the Full Domestic Surplus schedules to MWD and SNWA. Arizona's share of the surplus is assigned to the Central Arizona Project (CAP), up to their Full Surplus schedule. If surplus water is still available for California, up to 300 kaf is made available to the Imperial Irrigation District (IID) and the Coachella Valley Water District (CVWD).

A.6.2.5 Flood Control Surplus

If the modeled January 1 system volumes projects Hoover Dam flood control releases based on the Field Working Agreement between Reclamation and the USACE for the flood control operation of Hoover Dam and Lake Mead (USACE 1982), the model assigns the Full Surplus schedules to MWD, SNWA, CAP, IID, and CVWD. In addition, the model assigns an additional delivery of up to 200 kaf to Mexico. All other diversion points remain at Normal schedules. The Full Domestic Surplus schedules are documented in the Secretarial Implementation Agreement Final EIS (2002).

A.6.3 Lower Basin Shortage Strategies

A summary comparison of the shortage strategy for each alternative is provided in Attachment A to this appendix (Table Att. A-2).

A.6.3.1 No Action Alternative

In the absence of specific shortage guidelines, modeling assumptions were made that followed assumptions for previous environmental compliance documents. Based on these assumptions a two-level shortage protection strategy was employed. This strategy established the elevations in Lake Mead to be protected and the protection strategy (probabilistic or absolute). Within the two protection levels are two methods or stages for allocating the required shortage amount as explained below. See Section 4.2, Volume I, in this Final EIS for a description of the methodology regarding the shortage sharing assumptions under the two stages of shortage.

In Level 1 protection, the shortage determination is based on comparing the January 1 Lake Mead elevation to a user-input trigger elevation, where the trigger elevations are determined from other modeling studies to protect a significant elevation within a given degree of confidence. The Level 1 shortage trigger elevations are presented in Table A-17.

Table A-17
Level 1 Shortage Trigger Elevations

Year	Elevations (feet msl)	Year	Elevations (feet msl)	Year	Elevations (feet msl)
2008	1,079	2026	1,101	2043	1,127
2009	1,082	2027	1,103	2044	1,129
2010	1,083	2028	1,104	2045	1,132
2011	1,084	2029	1,106	2046	1,133
2012	1,085	2030	1,107	2047	1,135
2013	1,086	2031	1,108	2048	1,137
2014	1,086	2031	1,108	2049	1,138
2015	1,087	2032	1,109	2050	1,140
2016	1,088	2033	1,110	2051	1,142
2017	1,090	2034	1,112	2052	1,144
2018	1,091	2035	1,113	2053	1,145
2019	1,093	2036	1,114	2054	1,147
2020	1,094	2037	1,116	2055	1,149
2021	1,095	2038	1,117	2056	1,151
2022	1,096	2039	1,119	2057	1,152
2023	1,097	2040	1,120	2058	1,154
2024	1,098	2041	1,123	2059	1,156
2025	1,100	2042	1,125	2060	1,157

Under Level 1 protection, if Lake Mead's elevation at the beginning of the year is less than the trigger elevation, a Stage 1 shortage is declared and certain Lower Basin depletions are reduced. The shortage remains in effect for that calendar year. A Stage 1 shortage is defined as a shortage of magnitude less than that which would cause Arizona 4th priority uses to be reduced to zero.

Level 1 protection of elevation 1,050 feet msl (minimum water level for operation of Southern Nevada's upper diversion intake and minimum power pool) was used in this study. Trigger elevations were input to protect each elevation with an approximately 80 percent probability; however, actual model simulations showed that the protection was less, approximately 70 percent over the entire simulation period. Under Level 1 protection a Stage 1 shortage is declared and the CAP depletion is set to 1.0 maf, and other Arizona 4th priority uses are reduced proportionately, as described in the equations below.

$$CAP_{short} = CAP_{norm} - 1.0maf$$

$$OtherAZP4_{short} = (CAP_{short} * \frac{CAP_{norm} + OtherAZP4_{norm}}{CAP_{norm}}) - CAP_{short}$$

Where: the subscript norm denotes the normal depletion amount and the subscript short denotes the shortage amount. The shortage amount is subtracted from the normal depletion amount to solve for the shorted depletion amount.

The percent shortage applied to each Arizona 4th priority in OtherAZP4 is computed as a fraction of their normal use divided by the total other Arizona 4th priority use.

Other Lower Basin depletions are reduced according to the percents presented in Table A-18.

Table A-18
Modeling Assumptions for Distribution of Stage 1 Shortages[a]

Entity	Percentage of Total Lower Basin Shortage	Calculation
Arizona[b]	80	♦ Computed assuming that Arizona takes the remaining amount of shortage after Nevada and Mexico take their respective shares ♦ Calculated as: 1.0 – 0.1667 – 0.0333 = 0.80 or 80.0 percent
California	0	♦ Does not receive shortage under Stage 1
Nevada	3.33	♦ Computed as a ratio of Nevada's apportionment to the total apportionments of the Lower Division states and Mexico ♦ Calculated as: 0.3 maf / 9.0 maf – 0.0333 or 3.33 percent
Mexico [1]	16.67	♦ Computed as a ratio of Mexico's allotment to the total allotments of the Lower Division states and Mexico ♦ Calculated as: 1.5 maf / 9.0 maf = 0.1667 or 16.67 percent

a. *These modeling assumptions do not reflect policy decisions and are not intended to constitute an interpretation or application of the 1944 Treaty.*
b. *Within the CAP, Ak-Chin and Salt River Pima-Maricopa Indian Community tribes have pre-1968 contracts for the delivery of 72 kaf that is not reduced until a Stage 2 Shortage is applied.*

Mexico and SNWA are reduced by 16.67 and 3.33 percent of the total Stage 1 shortage, respectively. The MWD does not take a Stage 1 shortage. The total Stage 1 shortage is computed as:

$$TotalStage1Short = \frac{CAP_{short} + OtherAZP4_{short}}{100\% - (3.33\% + 16.67\%)}$$

Under Level 2 protection, the shortage required to keep Lake Mead above elevation 1,000 feet msl (minimum elevation for operation of Southern Nevada's lower diversion intake) is computed and distributed among Lower Basin users as described in Table A-19. In each month, January through September, a rule estimates the end-of-April through end-of-September Lake Mead elevation (using Stage 1 shortage schedules and normal schedules for other users). April through September is generally the high demand period from Lake Mead. If in any month during the high demand period the estimated Lake Mead elevation is below 1,000 feet msl, Arizona 4th priority users are reduced to zero and SNWA and Mexico take their respective percents of the total shortage for the current month. This type of pre-emptive shortage approach is required to avoid the

[1] The proposed federal action is for the purpose of adopting additional operational guidelines to improve the Department's annual management and operation of key Colorado River reservoirs for an interim period through 2026. However, in order to assess the potential effects of the proposed federal action in this Final EIS, certain modeling assumptions (discussed in Chapter 2, Volume I) are used that display projected water deliveries to Mexico. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico.

The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

situation when, in a given month, the shortage required to keep Lake Mead above elevation of 1,000 feet msl is greater than the available demand. If, in the current month the shortage required to protect elevation 1,000 feet msl does not require Arizona 4th priority users to be reduced to zero, the lesser shortage amount is allocated.

If, in any month additional shortage beyond Stage 1 is required to protect Lake Mead elevation of 1,000 feet msl, a Stage 2 shortage is declared. The Stage 2 shortage amount is the amount in excess of the Stage 1 shortage amount required to protect elevation 1,000 feet msl absolutely. In a Stage 2 shortage Mexico and SNWA are further reduced and Arizona 2nd and 3rd priority uses and MWD are reduced. These entities are reduced according to the percentage values provided in Table A-19.

Table A-19
Modeling Assumptions for Distribution of Stage 2 Shortages[1]
No Action Alternative

Entity	Percentage of Total Lower Basin Shortage	Calculation
Arizona	15 to 20	▪ The percentage changes as Arizona's 4th priority use schedule changes and ranges between 15 and 20 percent ▪ Computed as a ratio of Arizona's apportionment less the amount of shortage applied to Arizona under Stage 1, to the total apportionments of the Lower Division states and Mexico less the total amount shorted to users under Stage 1 ▪ Calculated as: (2.8 – Arizona Stage 1 shortage) / (9.0 – total Stage 1 shortage)
California	60 to 65	▪ California shortage sharing percentage changes as Arizona's 4th priority use schedule changes and ranges between 60 and 65 percent ▪ Computed assuming that California takes the remaining amount of the additional shortage ▪ Calculated as: 1.0 – 0.1667 – 0.0333 – Arizona's Stage 2 percentage expressed as a fraction
Nevada	3.33	▪ Computed as a ratio of Nevada's apportionment less the amount of shortage applied to Nevada under Stage 1, to the total apportionments of the Lower Division states and Mexico less the amount shorted to users under Stage 1 ▪ Calculated as: (0.3 – Nevada Stage 1 shortage) / (9.0 – total Stage 1 shortage) = 0.0333 or 3.33 percent
Mexico	16.67	▪ Computed as a ratio of Mexico's apportionment less the amount of shortage applied to Mexico under Stage 1, to the total apportionments of the Lower Division states and Mexico less the total amount shorted to users under Stage 1 ▪ Calculated as: (1.5 – Mexico Stage 1 shortage) / (9.0 – total Stage 1 shortage) = 0.1667 or 16.67percent

1. *These modeling assumptions do not reflect policy decisions and are not intended to constitute an interpretation or application of the 1944 Treaty. They have been developed for comparison of the alternatives.*

The maximum amount of Stage 2 shortage that can be applied is dictated by MWD demand. If the amount of Stage 2 shortage required is greater then MWD demand, then the Stage 2 shortage amount becomes

$$TotalStage2Short_{Constrained} = \frac{MWD_{norm}}{100\% - (3.33\% + 16.67\% + AZP2and3Short\%)}$$

In the event that a Stage 2 shortage is constrained and not fully allocated, Lake Mead elevation decline to below 1,000 feet msl. If Lake Mead elevation drops below 1,000 feet msl, SNWA is reduced to zero (due to physical limitations) for the current month and the other users maintain their shortage amounts as if SNWA had not been completely reduced.

A.6.3.2 Basin States Alternative

The Basin States Alternative provides discrete stepped levels of shortage associated with specific Lake Mead elevations. These shortage amounts and the corresponding elevations are provided in Attachment A to this appendix (Table Att. A-2). The maximum shortage is 600 kaf below elevation 1,025 feet msl. The shortage determination is based on comparing the January 1 Lake Mead elevation to the specific Lake Mead trigger elevations. If Lake Mead's elevation at the beginning of the year is less than the trigger elevation, a shortage of the corresponding amount is declared and certain Lower Basin depletions are reduced. The shortage remains in effect for that calendar year. The shortage is allocated according to the percentages used under a Stage 1 shortage in the No Action Alternative provided in Table A-19. As under the No Action Alternative, SNWA is reduced to zero for the current month if, in the previous month Lake Mead elevation is below 1,000 feet msl.

A.6.3.3 Conservation Before Shortage Alternative

The shortage strategy under the Conservation Before Shortage Alternative is identical to the Level 2 shortage protection in the No Action Alternative. The Level 1 shortage protection in the No Action Alternative is replaced with various levels of voluntary conservation in the Conservation Before Shortage Alternative. Modeling assumptions regarding the voluntary conservation portion of this alternative are located in Appendix M. The amounts of voluntary conservation and the corresponding reservoir elevations are identical to the shortage amounts and corresponding reservoir elevations under the Basin States Alternative.

A.6.3.4 Water Supply Alternative

There is no shortage strategy in place in the Water Supply Alternative. The only reduction in use occurs when, in the previous month Lake Mead elevation is below 1,000 feet msl. In this event SNWA is reduced to zero for the current month.

A.6.3.5 Reservoir Storage Alternative

Like the Basin States Alternative, the Reservoir Storage Alternative provides discrete stepped levels of shortage associated with specific Lake Mead elevations. These shortage amounts and the corresponding elevations are provided in Attachment A to this appendix (Table Att. A-2). The maximum shortage is 1,200 kaf below elevation 1,025 feet msl. Shortage determination and allocation occurs in the same way as under the Basin States Alternative.

A.6.3.6 Preferred Alternative

The Preferred Alternative utilizes identical shortage assumptions as the Basin States Alternative.

A.6.4 Lake Mead Storage and Delivery of Conserved System and/or Non-system Water

Detailed modeling assumptions regarding the Lake Mead storage and delivery mechanism for conserved system and/or non-system water as part of the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, is provided in Appendix M.

A.7 Summary Comparison of Lake Powell and Lake Mead Operations

A summary comparison of Lake Powell and Lake Mead operations under the No Action Alternative and the action alternatives is provided in Attachment A to this appendix (Tables Att. A-1 and Att. A-2, respectively).

A.8 Lake Mohave and Lake Havasu Operations

Lake Mohave and Lake Havasu are operated to meet user-specified target storages at the end of each month. This operation remained consistent for all alternatives. The storage targets and the corresponding elevations for Lake Mohave and Lake Havasu are presented in Tables B-4 and B-5, respectively, in Appendix B.

A.9 Energy Generation

RiverWare™ includes a variety of methods that can be chosen to compute power generation. All methods compute power and energy on a monthly basis. The following sections describe the methods used to compute power at Glen Canyon Dam, Hoover Dam, Davis Dam and Parker Dam.

A.9.1 Glen Canyon Dam

The computation of power and energy generated at Glen Canyon Dam is based on the turbine release for the current month and a power coefficient which is a function of the turbine release and operating head. Turbine release is the lesser value of the maximum power release or the result of outflow minus spill. The power coefficient is computed through table interpolation given the operating head. The table used for interpolation is chosen based on the turbine release and can represent either flow through the turbine for most efficient power generation or the maximum flow through the turbine. The power coefficient may also be an intermediate value, computed through interpolation of both tables, if the turbine release is between the most efficient for power generation and the maximum flow through the turbine.

Once the power coefficient is computed, power generated for the current month is computed as

$$Power = PowerCoefficient * Turbine\ Release$$

Energy is calculated as the power multiplied by the length of the month in hours.

If the previous month's elevation is less than 3,490 feet msl, there is no power or energy generated for the current month. This elevation reflects the minimum power pool elevation at Lake Powell.

A.9.2 Hoover Dam

The method that computes power and energy generated at the Hoover Dam assumes two levels of power generation. The lower level of generation occurs at base flow while the upper level occurs at peak flow. The method computes the fraction of the month that the powerplant is operated at peak flow and base flow. The peaking flow is the most efficient flow through the turbines for the current operating head while the baseflow represents the minimum flow through the turbines to produce energy.

The base flow and corresponding power generation is based on the outflow for the current month. The peak flow must be computed through an iterative procedure using operating head, tailwater elevation and turbine release. The initial turbine release is assumed to be that corresponding to maximum power production. Tailwater elevation at Hoover Dam is computed as function of Lake Mohave elevation, and Hoover Dam release.

The monthly Hoover Dam release volume at base flow is computed by applying the base flow over the month. The monthly release volume at peak flow is computed as

$$PeakFlowVolume = TurbineReleaseVolume - BaseFlowVolume$$

Next, the number of hours required for operation at base and peak flows are then computed as

$$PeakHours = \frac{PeakFlowVolume}{(PeakFlow - BaseFlow) * 3600}$$

$$BaseHours = \frac{SecondsInMonth}{3600} - PeakHours$$

where 3600 is the amount of seconds per hour.

If the peak hours are greater than the length of the month, the peak hours value is set equal to the length of the month and base hours value is set to zero. The peak and base hours are then multiplied by the powerplant capacity at each level and added together to obtain the total energy produced for the month. Power is computed as the energy divided by the length of the month in hours.

The algorithm described above allows generation at elevations below 1,050 feet msl, the minimum power pool at Lake Mead. According to the algorithm, power is generated as long as the minimum operating head of 360 feet is available, corresponding to an elevation of about 1,011 feet msl. Because there is no operating experience at these elevations, it is impossible to verify if CRSS mimics the actual turbine performance at such low heads. It is therefore critical to view energy results from CRSS in a relative manner and not in a strict numeric sense.

A.9.3 Davis Dam

The method that computes power and energy generation at Davis Dam is the same method used for Hoover Dam.

A.9.4 Parker Dam

The method that computes power and energy generation at Parker Dam is the same method used for Hoover Dam.

A.10 Reservoir Evaporation

Evaporation at Lake Powell and Lake Mead is calculated in CRSS by multiplying the reservoir surface area by user-supplied evaporation coefficients. Specifically, the average reservoir surface area over the previous and current month (in acres) is multiplied by the monthly evaporation coefficient (in feet per month) to produce the rate of evaporation in acre-feet per month as specified by the following equation:

$$Evaporation(t) = EvaporationCoefficient(t) * \frac{(SurfaceArea(t) + SurfaceArea(t-1))}{2} * TimestepLength$$

Where: t = current time-step

$t\text{-}1$ = previous time-step

The monthly evaporation coefficients for Lake Powell and Lake Mead are presented in Table A-20.

Table A-20
Monthly Evaporation Coefficients for Lake Powell and Lake Mead

Month	Evaporation Coefficient (feet/month)	
	Lake Powell	Lake Mead
January	0.198	0.36
February	0.186	0.33
March	0.233	0.37
April	0.265	0.46
May	0.359	0.53
June	0.411	0.64
July	0.466	0.80
August	0.478	0.85
September	0.415	0.70
October	0.375	0.51
November	0.312	0.51
December	0.261	0.44

A.11 Model Input and Simulation

CRSS is used to simulate the future conditions of the system on a monthly time step. Output data include reservoir storage, releases from dams, hydroelectric generation, etc. Input data for the model includes monthly natural flow at 29 nodes throughout the Colorado River system. Input data also includes physical parameters (e.g., individual reservoir storage capacity, evaporation rates, and reservoir release capabilities), initial reservoir conditions, and the diversion and depletion schedules for entities in the Colorado River Basin States and Mexico. Operating rules for current or proposed operating policies are considered input.

Although several methods are available for ascertaining the range of possible future inflows, Reclamation utilized the existing historical record of natural flows to create several distinct and synthetic hydrologic sequences that are then used in a series of simulations. For this process, Reclamation used a particular technique for sampling from the historical record known as the Indexed Sequential Method, or ISM (Reclamation 1985; Ouarda et al. 1997). Each future hydrologic sequence is generated from the historical natural flow record by "cycling" through the record. This method produces the "n" possible flow sequences, where n corresponds to the number of years in the flow data set. Using the historical natural flow data from 1906 through 2005 with ISM results in a set of 100 separate simulations referred to as "traces." This enables an evaluation of proposed criteria over a broad range of possible future hydrologic conditions. Evaluations typically include all 100 traces using statistical techniques.

A.12 Model Uncertainty

Using ISM, CRSS generates a wide range of hydrologic possibilities which include periods of extreme drought and periods of much above average flow, allowing evaluation of the proposed federal action under a wide range of future flows. However, it is possible that future flows may include periods of wet or dry conditions that are outside of all the possible sequences seen in the historical record. Appendix N provides alternate hydrologic inflow scenarios for comparison with the 1906 through 2005 natural flow record using ISM.

Model output is also sensitive to input diversion and depletion schedules. The best available data for future diversions and depletions are input to CRSS (Appendix C and Appendix D). Actual future depletion schedules, especially when simulating system conditions far into the future (beyond about 20 years from the present) may differ.

A.13 References

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Attachment A

Summary Comparison of Lake Powell and Lake Mead Operations Under the No Action Alternative and the Action Alternatives

This attachment to Appendix A contains the summary comparison table of the Lake Powell and Lake Mead operational strategies for each alternative.

Table Att. A-1
Lake Powell
Comparison of Alternatives
Coordinated Reservoir Operations Element of the Proposed Federal Action

Lake Powell Elevation (feet msl)	No Action Alternative	Basin States Alternative	Conservation Before Shortage Alternative	Water Supply Alternative	Reservoir Storage Alternative	Preferred Alternative	Lake Powell Storage (maf)
3,700	Equalize, avoid spills or release 8.23 maf	Equalize, avoid spills or release 8.23 maf	Equalize, avoid spills or release 8.23 maf	Equalize, avoid spills or release 8.23 maf	Equalize, avoid spills or release 8.23 maf	Equalize, avoid spills or release 8.23 maf	24.3
Equalization	**602(a)**	**Upper Equalization Line**	**Upper Equalization Line**	**602(a)**	**602(a)**	**Upper Equalization Line**	Equalization
	Release 8.23 maf	Release 8.23 maf; if Lake Mead < 1,075 feet msl, balance contents with a min/max release of 7.0 and 9.0 maf	Release 8.23 maf; if Lake Mead < 1,075 feet msl, balance contents with a min/max release of 7.0 and 9.0 maf	Release 8.23 maf; if Lake Mead < 1,075 feet msl, balance contents with a min/max release of 7.0 and 9.5 maf	Release 8.23 maf	Release 8.23 maf; if Lake Mead < 1,075 feet msl, balance contents with a min/max release of 7.0 and 9.0 maf	
3,595					Release 7.8 maf		11.3
3,575		Release 7.48 maf; if Lake Mead < 1,025 feet msl, release 8.23 maf	Release 7.48 maf; if Lake Mead < 1,025 feet msl, release 8.23 maf	Balance contents with a min/max release of 7.0 and 9.5 maf		Release 7.48 maf; if Lake Mead < 1,025 feet msl, release 8.23 maf	9.5
3,560					Balance contents with a min/max release of 7.8 and 9.5 maf		8.3
3,525		Balance contents with a min/max release of 7.0 and 9.5 maf	Balance contents with a min/max release of 7.0 and 9.5 maf			Balance contents with a min/max release of 7.0 and 9.5 maf	5.9
3,490							4.0
3,370							0

Table Att. A-2
Lake Mead
Comparison of Alternatives
Coordinated Reservoir Operations Element of the Proposed Federal Action

Lake Mead Elevation (feet msl)	No Action Alternative	Basin States Alternative	Conservation Before Shortage Alternative	Water Supply Alternative	Reservoir Storage Alternative	Preferred Alternative	Lake Mead Storage (maf)
1,220	Flood Control or 70R Surplus	Flood Control or 70R Surplus	Flood Control or 70R Surplus	Flood Control or 70R Surplus	Flood Control or 70R Surplus	Flood Control or 70R Surplus	25.9
1,200	Full Domestic Surplus (through 2016)	Domestic Surplus	Domestic Surplus	Full Domestic Surplus	Normal Operations	Domestic Surplus	22.9
1,145	Partial Domestic Surplus (through 2016)	Normal Operations	Normal Operations	Partial Domestic Surplus		Normal Operations	15.9
1,125	Normal Operations			Normal Operations			13.9
1,100	Shortage 80 percent Protection of elevation 1,050 feet msl				Shortage 500[1] kaf		11.5
1,075		Shortage 333 kaf[1]	Voluntary Conservation		Shortage 667[1] kaf	Shortage 333 kaf[1]	9.4
1,050		Shortage 417 kaf[1]			Shortage 833[1] kaf	Shortage 417 kaf[1]	7.5
1,025		Shortage 500 kaf[1] and Consultation[2]			Shortage 1,000[1] kaf	Shortage 500 kaf[1] and Consultation[2]	5.8
1,000	Shortage Absolute Protection of elevation 1,000 feet msl		Shortage Absolute Protection of elevation 1,000 feet msl				4.3
895							0

[1] These are amounts of shortage (i.e., reduced deliveries in the United States). As in the Draft EIS, the Final EIS includes modeling assumptions that identify water deliveries to Mexico pursuant to the 1944 Treaty.
[2] If Lake Mead falls below elevation 1,025, the Department will initiate efforts to develop additional guidelines for shortages at lower Lake Mead elevations.

Attachment B

Elevation, Capacity, and Surface Area Relationships for Lake Powell and Lake Mead

This attachment to Appendix A contains tables used in the CRSS model which present the corresponding values for the range of operational elevations at Lake Powell and Lake Mead to the live capacity, total capacity, and surface area for each respective reservoir.

Table Att. B-1
Lake Powell Elevation to Storage Volume and Surface Area Relationships

Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)		Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)
3,370	0	1,895,000	20,303		3,410	964,242	2,859,242	28,054
3,371	20,393	1,915,393	20,483		3,411	992,396	2,887,396	28,253
3,372	40,966	1,935,966	20,663		3,412	1,020,748	2,915,748	28,452
3,373	61,719	1,956,719	20,843		3,413	1,049,299	2,944,299	28,651
3,374	82,651	1,977,651	21,023		3,414	1,078,050	2,973,050	28,850
3,375	103,764	1,998,764	21,203		3,415	1,106,999	3,001,999	29,049
3,376	125,056	2,020,056	21,382		3,416	1,136,148	3,031,148	29,248
3,377	146,529	2,041,529	21,562		3,417	1,165,496	3,060,496	29,448
3,378	168,181	2,063,181	21,742		3,418	1,195,043	3,090,043	29,647
3,379	190,013	2,085,013	21,922		3,419	1,224,790	3,119,790	29,846
3,380	212,025	2,107,025	22,102		3,420	1,254,735	3,149,735	30,045
3,381	234,226	2,129,226	22,300		3,421	1,284,896	3,179,896	30,278
3,382	256,625	2,151,625	22,498		3,422	1,315,290	3,210,290	30,510
3,383	279,222	2,174,222	22,696		3,423	1,345,917	3,240,917	30,743
3,384	302,017	2,197,017	22,894		3,424	1,376,777	3,271,777	30,976
3,385	325,010	2,220,010	23,092		3,425	1,407,869	3,302,869	31,208
3,386	348,201	2,243,201	23,290		3,426	1,439,194	3,334,194	31,441
3,387	371,590	2,266,590	23,488		3,427	1,470,751	3,365,751	31,674
3,388	395,177	2,290,177	23,686		3,428	1,502,541	3,397,541	31,907
3,389	418,962	2,313,962	23,884		3,429	1,534,564	3,429,564	32,139
3,390	442,945	2,337,945	24,082		3,430	1,566,820	3,461,820	32,372
3,391	467,126	2,362,126	24,280		3,431	1,599,308	3,494,308	32,605
3,392	491,505	2,386,505	24,478		3,432	1,632,029	3,527,029	32,837
3,393	516,082	2,411,082	24,676		3,433	1,664,983	3,559,983	33,070
3,394	540,857	2,435,857	24,874		3,434	1,698,170	3,593,170	33,303
3,395	565,830	2,460,830	25,072		3,435	1,731,589	3,626,589	33,535
3,396	591,001	2,486,001	25,270		3,436	1,765,241	3,660,241	33,768
3,397	616,370	2,511,370	25,468		3,437	1,799,125	3,694,125	34,001
3,398	641,937	2,536,937	25,666		3,438	1,833,242	3,728,242	34,234
3,399	667,702	2,562,702	25,864		3,439	1,867,592	3,762,592	34,466
3,400	693,665	2,588,665	26,062		3,440	1,902,175	3,797,175	34,699
3,401	719,827	2,614,827	26,261		3,441	1,937,016	3,832,016	34,982
3,402	746,187	2,641,187	26,460		3,442	1,972,139	3,867,139	35,265
3,403	772,747	2,667,747	26,659		3,443	2,007,546	3,902,546	35,548
3,,404	799,506	2,694,506	26,859		3,444	2,043,236	3,938,236	35,831
3,405	826,464	2,721,464	27,058		3,445	2,079,209	3,974,209	36,115
3,406	853,622	2,748,622	27,257		3,446	2,115,465	4,010,465	36,398
3,407	880,978	2,775,978	27,456		3,447	2,152,004	4,047,004	36,681
3,408	908,534	2,803,534	27,655		3,448	2,188,826	4,083,826	36,964
3,409	936,289	2,831,289	27,854		3,449	2,225,932	4,120,932	37,247

Table Att. B-1
Lake Powell Elevation to Storage Volume and Surface Area Relationships

Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)		Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)
3,450	2,263,320	4,158,320	37,530		3,490	3,997,163	5,892,163	49,330
3,451	2,300,992	4,195,992	37,813		3,491	4,046,646	5,941,646	49,636
3,452	2,338,946	4,233,946	38,096		3,492	4,096,435	5,991,435	49,942
3,453	2,377,184	4,272,184	38,379		3,493	4,146,529	6,041,529	50,247
3,454	2,415,705	4,310,705	38,662		3,494	4,196,929	6,091,929	50,553
3,455	2,454,509	4,349,509	38,946		3,495	4,247,634	6,142,634	50,858
3,456	2,493,596	4,388,596	39,229		3,496	4,298,645	6,193,645	51,164
3,457	2,532,966	4,427,966	39,512		3,497	4,349,962	6,244,962	51,469
3,458	2,572,619	4,467,619	39,795		3,498	4,401,584	6,296,584	51,775
3,459	2,612,556	4,507,556	40,078		3,499	4,453,512	6,348,512	52,080
3,460	2,652,775	4,547,775	40,361		3,500	4,505,745	6,400,745	52,386
3,461	2,693,284	4,588,284	40,657		3,501	4,558,308	6,453,308	52,741
3,462	2,734,088	4,629,088	40,952		3,502	4,611,226	6,506,226	53,095
3,463	2,775,189	4,670,189	41,248		3,503	4,664,498	6,559,498	53,450
3,464	2,816,585	4,711,585	41,544		3,504	4,718,125	6,613,125	53,804
3,465	2,858,276	4,753,276	41,840		3,505	4,772,106	6,667,106	54,159
3,466	2,900,264	4,795,264	42,135		3,506	4,826,442	6,721,442	54,513
3,467	2,942,547	4,837,547	42,431		3,507	4,881,132	6,776,132	54,868
3,468	2,985,125	4,880,125	42,727		3,508	4,936,177	6,831,177	55,222
3,469	3,028,000	4,923,000	43,022		3,509	4,991,576	6,886,576	55,577
3,470	3,071,170	4,966,170	43,318		3,510	5,047,330	6,942,330	55,931
3,471	3,114,636	5,009,636	43,614		3,511	5,103,438	6,998,438	56,286
3,472	3,158,397	5,053,397	43,909		3,512	5,159,901	7,054,901	56,640
3,473	3,202,455	5,097,455	44,205		3,513	5,216,718	7,111,718	56,994
3,474	3,246,808	5,141,808	44,501		3,514	5,273,890	7,168,890	57,349
3,475	3,291,456	5,186,456	44,797		3,515	5,331,416	7,226,416	57,704
3,476	3,336,401	5,231,401	45,092		3,516	5,389,297	7,284,297	58,058
3,477	3,381,641	5,276,641	45,388		3,517	5,447,532	7,342,532	58,412
3,478	3,427,176	5,322,176	45,684		3,518	5,506,122	7,401,122	58,767
3,479	3,473,008	5,368,008	45,979		3,519	5,565,066	7,460,066	59,122
3,480	3,519,135	5,414,135	46,275		3,520	5,624,365	7,519,365	59,476
3,481	3,565,563	5,460,563	46,581		3,521	5,684,034	7,579,034	59,863
3,482	3,612,296	5,507,296	46,886		3,522	5,744,090	7,639,090	60,249
3,483	3,659,335	5,554,335	47,192		3,523	5,804,532	7,699,532	60,635
3,484	3,706,679	5,601,679	47,497		3,524	5,865,361	7,760,361	61,022
3,485	3,754,329	5,649,329	47,803		3,525	5,926,576	7,821,576	61,409
3,486	3,802,285	5,697,285	48,108		3,526	5,988,178	7,883,178	61,795
3,487	3,850,546	5,745,546	48,414		3,527	6,050,166	7,945,166	62,181
3,488	3,899,113	5,794,113	48,719		3,528	6,112,541	8,007,541	62,568
3,489	3,947,985	5,842,985	49,025		3,529	6,175,302	8,070,302	62,955

Table Att. B-1
Lake Powell Elevation to Storage Volume and Surface Area Relationships

Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)		Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)
3,530	6,238,450	8,133,450	63,341		3,570	9,107,080	11,002,080	80,824
3,531	6,301,984	8,196,984	63,727		3,571	9,188,146	11,083,146	81,308
3,532	6,365,905	8,260,905	64,114		3,572	9,269,697	11,164,697	81,793
3,533	6,430,212	8,325,212	64,501		3,573	9,351,731	11,246,731	82,277
3,534	6,494,906	8,389,906	64,887		3,574	9,434,250	11,329,250	82,761
3,535	6,559,986	8,454,986	65,274		3,575	9,517,254	11,412,254	83,246
3,536	6,625,453	8,520,453	65,660		3,576	9,600,741	11,495,741	83,730
3,537	6,691,306	8,586,306	66,047		3,577	9,684,713	11,579,713	84,214
3,538	6,757,546	8,652,546	66,433		3,578	9,769,170	11,664,170	84,698
3,539	6,824,172	8,719,172	66,820		3,,579	9,854,110	11,749,110	85,183
3,540	6,891,185	8,786,185	67,206		3,580	9,939,535	11,834,535	85,667
3,541	6,958,610	8,853,610	67,645		3,581	10,025,445	11,920,445	86,153
3,542	7,026,475	8,921,475	68,083		3,582	10,111,841	12,006,841	86,639
3,543	7,094,777	8,989,777	68,522		3,583	10,198,723	12,093,723	87,125
3,544	7,163,519	9,058,519	68,961		3,584	10,286,091	12,181,091	87,611
3,545	7,232,699	9,127,699	69,400		3,585	10,373,945	12,268,945	88,097
3,546	7,302,319	9,197,319	69,839		3,586	10,462,285	12,357,285	88,583
3,547	7,372,376	9,267,376	70,277		3,587	10,551,111	12,446,111	89,069
3,548	7,442,873	9,337,873	70,716		3,588	10,640,423	12,535,423	89,555
3,549	7,513,808	9,408,808	71,155		3,589	10,730,221	12,625,221	90,041
3,550	7,585,183	9,480,183	71,594		3,590	10,820,505	12,715,505	90,527
3,551	7,656,995	9,551,995	72,032		3,591	10,911,275	12,806,275	91,013
3,552	7,729,247	9,624,247	72,471		3,592	11,002,531	12,897,531	91,499
3,553	7,801,937	9,696,937	72,910		3,593	11,094,273	12,989,273	91,985
3,554	7,875,067	9,770,067	73,348		3,594	11,186,501	13,081,501	92,471
3,555	7,948,634	9,843,634	73,787		3,595	11,279,215	13,174,215	92,957
3,556	8,022,641	9,917,641	74,226		3,596	11,372,415	13,267,415	93,443
3,557	8,097,086	9,992,086	74,665		3,597	11,466,101	13,361,101	93,929
3,558	8,171,970	10,066,970	75,104		3,598	11,560,273	13,455,273	94,415
3,559	8,247,293	10,142,293	75,542		3,599	11,654,931	13,549,931	94,901
3,560	8,323,055	10,218,055	75,981		3,600	11,750,075	13,645,075	95,387
3,561	8,399,278	10,294,278	76,465		3,601	11,845,726	13,740,726	95,914
3,562	8,475,986	10,370,986	76,950		3,602	11,941,903	13,836,903	96,441
3,563	8,553,177	10,448,177	77,434		3603	12,038,608	13,933,608	96,968
3,564	8,630,853	10,525,853	77,918		3,,604	12,135,840	14,030,840	97,495
3,565	8,709,014	10,604,014	78,402		3,605	12,233,599	14,128,599	98,023
3,566	8,787,658	10,682,658	78,887		3,606	12,331,885	14,226,885	98,550
3,567	8,866,787	10,761,787	79,371		3,607	12,430,698	14,325,698	99,077
3,568	8,946,401	10,841,401	79,855		3,608	12,530,038	14,425,038	99,604
3,569	9,026,498	10,921,498	80,340		3,609	12,629,906	14,524,906	100,131

Table Att. B-1
Lake Powell Elevation to Storage Volume and Surface Area Relationships

Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)		Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)
3,610	12,730,300	14,625,300	100,658		3,650	17,215,718	19,110,718	124,477
3,611	12,831,222	14,726,222	101,185		3,651	17,340,515	19,235,515	125,119
3,612	12,932,670	14,827,670	101,712		3,652	17,465,955	19,360,955	125,761
3,613	13,034,646	14,929,646	102,239		3,653	17,592,037	19,487,037	126,403
3,614	13,137,149	15,032,149	102,766		3,654	17,718,762	19,613,762	127,046
3,615	13,240,179	15,135,179	103,294		3,655	17,846,128	19,741,128	127,688
3,616	13,343,736	15,238,736	103,821		3,656	17,974,137	19,869,137	128,330
3,617	13,447,820	15,342,820	104,348		3,657	18,102,788	19,997,788	128,972
3,618	13,552,431	15,447,431	104,875		3,658	18,232,082	20,127,082	129,615
3,619	13,657,570	15,552,570	105,402		3,659	18,362,017	20,257,017	130,257
3,620	13,763,235	15,658,235	105,929		3,660	18,492,595	20,387,595	130,899
3,621	13,869,467	15,764,467	106,535		3,661	18,623,863	20,518,863	131,636
3,622	13,976,306	15,871,306	107,142		3,662	18,755,868	20,650,868	132,374
3,623	14,083,750	15,978,750	107,748		3,663	18,888,610	20,783,610	133,111
3,624	14,191,801	16,086,801	108,354		3,664	19,022,090	20,917,090	133,849
3,625	14,300,458	16,195,458	108,960		3,665	19,156,308	21,051,308	134,586
3,626	14,409,722	16,304,722	109,567		3,666	19,291,262	21,186,262	135,323
3,627	14,519,591	16,414,591	110,173		3,667	19,426,954	21,321,954	136,061
3,628	14,630,067	16,525,067	110,779		3,668	19,563,384	21,458,384	136,798
3,629	14,741,149	16,636,149	111,385		3,669	19,700,551	21,595,551	137,536
3,630	14,852,838	16,747,838	111,992		3,670	19,838,455	21,733,455	138,273
3,631	14,965,132	16,860,132	112,598		3,671	19,977,097	21,872,097	139,010
3,632	15,078,033	16,973,033	113,204		3,672	20,116,476	22,011,476	139,748
3,633	15,191,540	17,086,540	113,810		3,673	20,256,592	22,151,592	140,485
3,634	15,305,654	17,200,654	114,417		3,674	20,397,446	22,292,446	141,223
3,635	15,420,373	17,315,373	115,023		3,675	20,539,038	22,434,038	141,960
3,636	15,535,699	17,430,699	115,629		3,676	20,681,366	22,576,366	142,697
3,637	15,651,631	17,546,631	116,235		3,677	20,824,432	22,719,432	143,435
3,638	15,768,170	17,663,170	116,842		3,678	20,968,236	22,863,236	144,172
3,639	15,885,314	17,780,314	117,448		3,679	21,112,777	23,007,777	144,910
3,640	16,003,065	17,898,065	118,054		3,680	21,258,055	23,153,055	145,647
3,641	16,121,440	18,016,440	118,696		3,681	21,404,080	23,299,080	146,404
3,642	16,240,458	18,135,458	119,339		3,682	21,550,863	23,445,863	147,161
3,643	16,360,117	18,255,117	119,981		3,683	21,698,402	23,593,402	147,918
3,644	16,480,419	18,375,419	120,623		3,684	21,846,698	23,741,698	148,674
3,645	16,601,363	18,496,363	121,265		3,685	21,995,751	23,890,751	149,431
3,646	16,722,950	18,617,950	121,908		3,686	22,145,560	24,040,560	150,188
3,647	16,845,178	18,740,178	122,550		3,687	22,296,127	24,191,127	150,945
3,648	16,968,049	18,863,049	123,192		3,688	22,447,450	24,342,450	151,702
3,649	17,091,562	18,986,562	123,834		3,689	22,599,530	24,494,530	152,459

Table Att. B-1
Lake Powell Elevation to Storage Volume and Surface Area Relationships

Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)		Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)
3,690	22,752,368	24,647,368	153,216		3,701	24,483,556	26,378,556	161,598
3,691	22,905,961	24,800,961	153,972		3,702	24,645,562	26,540,562	162,413
3,692	23,060,312	24,955,312	154,729		3,703	24,808,381	26,703,381	163,227
3,693	23,215,420	25,110,420	155,486		3,704	24,972,015	26,867,015	164,041
3,694	23,371,284	25,266,284	156,243		3,705	25,136,463	27,031,463	164,855
3,695	23,527,906	25,422,906	157,000		3,706	25,301,726	27,196,726	165,670
3,696	23,685,284	25,580,284	157,757		3,707	25,467,802	27,362,802	166,484
3,697	23,843,419	25,738,419	158,513		3,708	25,634,693	27,529,693	167,298
3,698	24,002,311	25,897,311	159,270		3,709	25,802,398	27,697,398	168,112
3,699	24,161,959	26,056,959	160,027		3,710	25,970,918	27,865,918	168,927
3,700	24,322,365	26,217,365	160,784					

Table Att. B-2
Lake Mead Elevation to Storage Volume and Surface Area Relationships

Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)		Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)
895	0	2,035,000	28,911		937	1,413,865	3,448,865	38,456
896	29,011	2,064,011	29,119		938	1,452,433	3,487,433	38,682
897	58,234	2,093,234	29,327		939	1,491,228	3,526,228	38,908
898	87,665	2,122,665	29,535		940	1,530,249	3,565,249	39,134
899	117,303	2,152,303	29,742		941	1,569,495	3,604,495	39,357
900	147,153	2,182,153	29,950		942	1,608,964	3,643,964	39,581
901	177,220	2,212,220	30,183		943	1,648,656	3,683,656	39,804
902	207,519	2,242,519	30,416		944	1,688,572	3,723,572	40,027
903	238,052	2,273,052	30,649		945	1,728,711	3,763,711	40,251
904	268,818	2,303,818	30,882		946	1,769,073	3,804,073	40,474
905	299,817	2,334,817	31,116		947	1,809,659	3,844,659	40,697
906	331,049	2,366,049	31,349		948	1,850,468	3,885,468	40,921
907	362,515	2,397,515	31,582		949	1,891,500	3,926,500	41,144
908	394,213	2,429,213	31,815		950	1,932,756	3,967,756	41,367
909	426,145	2,461,145	32,048		951	1,974,256	4,009,256	41,633
910	458,310	2,493,310	32,281		952	2,016,021	4,051,021	41,898
911	490,708	2,525,708	32,515		953	2,058,052	4,093,052	42,164
912	523,339	2,558,339	32,748		954	2,100,348	4,135,348	42,429
913	556,203	2,591,203	32,981		955	2,142,910	4,177,910	42,695
914	589,300	2,624,300	33,214		956	2,185,737	4,220,737	42,960
915	622,631	2,657,631	33,447		957	2,228,830	4,263,830	43,225
916	656,195	2,691,195	33,680		958	2,272,188	4,307,188	43,491
917	689,992	2,724,992	33,913		959	2,315,812	4,350,812	43,756
918	724,022	2,759,022	34,147		960	2,359,701	4,394,701	44,022
919	758,285	2,793,285	34,380		961	2,403,855	4,438,855	44,287
920	792,781	2,827,781	34,613		962	2,448,275	4,483,275	44,553
921	827,507	2,862,507	34,839		963	2,492,960	4,527,960	44,818
922	862,459	2,897,459	35,065		964	2,537,911	4,572,911	45,083
923	897,637	2,932,637	35,291		965	2,583,127	4,618,127	45,349
924	933,041	2,968,041	35,517		966	2,628,609	4,663,609	45,614
925	968,671	3,003,671	35,743		967	2,674,356	4,709,356	45,880
926	1,004,527	3,039,527	35,969		968	2,720,369	4,755,369	46,145
927	1,040,609	3,075,609	36,195		969	2,766,646	4,801,646	46,411
928	1,076,918	3,111,918	36,421		970	2,813,190	4,848,190	46,676
929	1,113,452	3,148,452	36,647		971	2,859,995	4,894,995	46,934
930	1,150,212	3,185,212	36,873		972	2,907,058	4,942,058	47,192
931	1,187,199	3,222,199	37,099		973	2,954,380	4,989,380	47,450
932	1,224,411	3,259,411	37,326		974	3,001,959	5,036,959	47,709
933	1,261,850	3,296,850	37,552		975	3,049,797	5,084,797	47,967
934	1,299,515	3,334,515	37,778		976	3,097,893	5,132,893	48,225
935	1,337,405	3,372,405	38,004		977	3,146,247	5,181,247	48,483
936	1,375,522	3,410,522	38,230		978	3,194,859	5,229,859	48,741

Table Att. B-2
Lake Mead Elevation to Storage Volume and Surface Area Relationships

Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)		Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)
979	3,243,729	5,278,729	48,999		1,021	5,552,628	7,587,628	61,469
980	3,292,857	5,327,857	49,257		1,022	5,614,254	7,649,254	61,783
981	3,342,244	5,377,244	49,516		1,023	5,676,195	7,711,195	62,098
982	3,391,888	5,426,888	49,774		1,024	5,738,449	7,773,449	62,412
983	3,441,791	5,476,791	50,032		1,025	5,801,018	7,836,018	62,726
984	3,491,952	5,526,952	50,290		1,026	5,863,901	7,898,901	63,040
985	3,542,371	5,577,371	50,548		1,027	5,927,098	7,962,098	63,354
986	3,593,048	5,628,048	50,806		1,028	5,990,610	8,025,610	63,668
987	3,643,983	5,678,983	51,064		1,029	6,054,435	8,089,435	63,983
988	3,695,177	5,730,177	51,322		1,030	6,118,575	8,153,575	64,297
989	3,746,628	5,781,628	51,581		1,031	6,183,029	8,218,029	64,611
990	3,798,338	5,833,338	51,839		1,032	6,247,797	8,282,797	64,925
991	3,850,325	5,885,325	52,136		1,033	6,312,879	8,347,879	65,239
992	3,902,611	5,937,611	52,434		1,034	6,378,275	8,413,275	65,553
993	3,955,194	5,990,194	52,732		1,035	6,443,986	8,478,986	65,868
994	4,008,074	6,043,074	53,029		1,036	6,510,011	8,545,011	66,182
995	4,061,252	6,096,252	53,327		1,037	6,576,350	8,611,350	66,496
996	4,114,728	6,149,728	53,625		1,038	6,643,003	8,678,003	66,810
997	4,168,502	6,203,502	53,922		1,039	6,709,970	8,744,970	67,124
998	4,222,573	6,257,573	54,220		1,040	6,777,251	8,812,251	67,438
999	4,276,942	6,311,942	54,518		1,041	6,844,882	8,879,882	67,823
1,000	4,331,609	6,366,609	54,816		1,042	6,912,897	8,947,897	68,208
1,001	4,386,583	6,421,583	55,133		1,043	6,981,297	9,016,297	68,592
1,002	4,441,874	6,476,874	55,449		1,044	7,050,082	9,085,082	68,977
1,003	4,497,482	6,532,482	55,766		1,045	7,119,251	9,154,251	69,361
1,004	4,553,407	6,588,407	56,083		1,046	7,188,804	9,223,804	69,746
1,005	4,609,649	6,644,649	56,400		1,047	7,258,742	9,293,742	70,130
1,006	4,666,208	6,701,208	56,717		1,048	7,329,065	9,364,065	70,515
1,007	4,723,084	6,758,084	57,034		1,049	7,399,772	9,434,772	70,899
1,008	4,780,277	6,815,277	57,351		1,050	7,470,864	9,505,864	71,284
1,009	4,837,787	6,872,787	57,668		1,051	7,542,340	9,577,340	71,669
1,010	4,895,613	6,930,613	57,985		1,052	7,614,201	9,649,201	72,053
1,011	4,953,757	6,988,757	58,302		1,053	7,686,447	9,721,447	72,438
1,012	5,012,218	7,047,218	58,619		1,054	7,759,077	9,794,077	72,822
1,013	5,070,996	7,105,996	58,936		1,055	7,832,091	9,867,091	73,207
1,014	5,130,090	7,165,090	59,253		1,056	7,905,490	9,940,490	73,591
1,015	5,189,502	7,224,502	59,570		1,057	7,979,274	10,014,274	73,976
1,016	5,249,231	7,284,231	59,887		1,058	8,053,442	10,088,442	74,360
1,017	5,309,277	7,344,277	60,204		1,059	8,127,995	10,162,995	74,745
1,018	5,369,639	7,404,639	60,521		1,060	8,202,932	10,237,932	75,130
1,019	5,430,319	7,465,319	60,838		1,061	8,278,239	10,313,239	75,485
1,020	5,491,315	7,526,315	61,155		1,062	8,353,902	10,388,902	75,840

Table Att. B-2
Lake Mead Elevation to Storage Volume and Surface Area Relationships

Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)		Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)
1,063	8,429,920	10,464,920	76,196		1,105	11,943,866	13,978,866	91,423
1,064	8,506,293	10,541,293	76,551		1,106	12,035,485	14,070,485	91,814
1,065	8,583,022	10,618,022	76,906		1,107	12,127,494	14,162,494	92,204
1,066	8,660,106	10,695,106	77,262		1,108	12,219,893	14,254,893	92,595
1,067	8,737,546	10,772,546	77,617		1,109	12,312,683	14,347,683	92,985
1,068	8,815,340	10,850,340	77,972		1,110	12,405,864	14,440,864	93,376
1,069	8,893,490	10,928,490	78,328		1,111	12,499,435	14,534,435	93,766
1,070	8,971,996	11,006,996	78,683		1,112	12,593,397	14,628,397	94,157
1,071	9,050,857	11,085,857	79,038		1,113	12,687,749	14,722,749	94,548
1,072	9,130,073	11,165,073	79,394		1,114	12,782,492	14,817,492	94,938
1,073	9,209,644	11,244,644	79,749		1,115	12,877,626	14,912,626	95,329
1,074	9,289,571	11,324,571	80,105		1,116	12,973,149	15,008,149	95,719
1,075	9,369,853	11,404,853	80,460		1,117	13,069,064	15,104,064	96,110
1,076	9,450,491	11,485,491	80,815		1,118	13,165,369	15,200,369	96,500
1,077	9,531,484	11,566,484	81,171		1,119	13,262,064	15,297,064	96,891
1,078	9,612,832	11,647,832	81,526		1,120	13,359,150	15,394,150	97,281
1,079	9,694,536	11,729,536	81,881		1,121	13,456,647	15,491,647	97,713
1,080	9,776,595	11,811,595	82,237		1,122	13,554,576	15,589,576	98,145
1,081	9,859,002	11,894,002	82,578		1,123	13,652,937	15,687,937	98,577
1,082	9,941,751	11,976,751	82,919		1,124	13,751,730	15,786,730	99,008
1,083	10,024,841	12,059,841	83,261		1,125	13,850,954	15,885,954	99,440
1,084	10,108,272	12,143,272	83,602		1,126	13,950,610	15,985,610	99,872
1,085	10,192,045	12,227,045	83,943		1,127	14,050,698	16,085,698	100,304
1,086	10,276,159	12,311,159	84,285		1,128	14,151,218	16,186,218	100,736
1,087	10,360,614	12,395,614	84,626		1,129	14,252,169	16,287,169	101,167
1,088	10,445,411	12,480,411	84,967		1,130	14,353,553	16,388,553	101,599
1,089	10,530,549	12,565,549	85,309		1,131	14,455,368	16,490,368	102,031
1,090	10,616,028	12,651,028	85,650		1,132	14,557,615	16,592,615	102,463
1,091	10,701,869	12,736,869	86,032		1,133	14,660,293	16,695,293	102,895
1,092	10,788,092	12,823,092	86,414		1,134	14,763,404	16,798,404	103,326
1,093	10,874,698	12,909,698	86,796		1,135	14,866,946	16,901,946	103,758
1,094	10,961,685	12,996,685	87,178		1,136	14,970,920	17,005,920	104,190
1,095	11,049,054	13,084,054	87,560		1,137	15,075,326	17,110,326	104,622
1,096	11,136,805	13,171,805	87,942		1,138	15,180,164	17,215,164	105,054
1,097	11,224,939	13,259,939	88,324		1,139	15,285,433	17,320,433	105,485
1,098	11,313,454	13,348,454	88,706		1,140	15,391,135	17,426,135	105,917
1,099	11,402,352	13,437,352	89,089		1,141	15,497,372	17,532,372	106,558
1,100	11,491,631	13,526,631	89,471		1,142	15,604,251	17,639,251	107,199
1,101	11,581,297	13,616,297	89,861		1,143	15,711,770	17,746,770	107,840
1,102	11,671,354	13,706,354	90,252		1,144	15,819,930	17,854,930	108,480
1,103	11,761,801	13,796,801	90,642		1,145	15,928,731	17,963,731	109,121
1,104	11,852,638	13,887,638	91,033		1,146	16,038,172	18,073,172	109,762

Table Att. B-2
Lake Mead Elevation to Storage Volume and Surface Area Relationships

Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)		Elevation (feet msl)	Volume Live Capacity (af)	Volume Total Capacity (af)	Surface Area (acres)
1,147	16,148,255	18,183,255	110,403		1,189	21,364,868	23,399,868	138,210
1,148	16,258,978	18,293,978	111,044		1,190	21,503,408	23,538,408	138,870
1,149	16,370,342	18,405,342	111,684		1,191	21,642,579	23,677,579	139,472
1,150	16,482,347	18,517,347	112,325		1,192	21,782,352	23,817,352	140,074
1,151	16,594,992	18,629,992	112,966		1,193	21,922,727	23,957,727	140,677
1,152	16,708,279	18,743,279	113,607		1,194	22,063,705	24,098,705	141,279
1,153	16,822,206	18,857,206	114,248		1,195	22,205,285	24,240,285	141,881
1,154	16,936,774	18,971,774	114,888		1,196	22,347,468	24,382,468	142,483
1,155	17,051,983	19,086,983	115,529		1,197	22,490,252	24,525,252	143,086
1,156	17,167,833	19,202,833	116,170		1,198	22,633,639	24,668,639	143,688
1,157	17,284,323	19,319,323	116,811		1,199	22,777,628	24,812,628	144,290
1,158	17,401,454	19,436,454	117,452		1,200	22,922,220	24,957,220	144,893
1,159	17,519,226	19,554,226	118,092		1,201	23,067,429	25,102,429	145,526
1,160	17,637,639	19,672,639	118,733		1,202	23,213,271	25,248,271	146,159
1,161	17,756,711	19,791,711	119,410		1,203	23,359,746	25,394,746	146,792
1,162	17,876,460	19,911,460	120,087		1,204	23,506,855	25,541,855	147,425
1,163	17,996,885	20,031,885	120,764		1,205	23,654,596	25,689,596	148,058
1,164	18,117,988	20,152,988	121,441		1,206	23,802,971	25,837,971	148,691
1,165	18,239,767	20,274,767	122,118		1,207	23,951,978	25,986,978	149,324
1,166	18,362,224	20,397,224	122,795		1,208	24,101,619	26,136,619	149,957
1,167	18,485,357	20,520,357	123,472		1,209	24,251,893	26,286,893	150,590
1,168	18,609,168	20,644,168	124,149		1,210	24,402,800	26,437,800	151,224
1,169	18,733,655	20,768,655	124,826		1,211	24,554,316	26,589,316	151,808
1,170	18,858,820	20,893,820	125,503		1,212	24,706,417	26,741,417	152,393
1,171	18,984,661	21,019,661	126,180		1,213	24,859,103	26,894,103	152,978
1,172	19,111,179	21,146,179	126,857		1,214	25,012,373	27,047,373	153,563
1,173	19,238,375	21,273,375	127,534		1,215	25,166,229	27,201,229	154,148
1,174	19,366,247	21,401,247	128,211		1,216	25,320,669	27,355,669	154,733
1,175	19,494,796	21,529,796	128,888		1,217	25,475,695	27,510,695	155,318
1,176	19,624,022	21,659,022	129,565		1,218	25,631,305	27,666,305	155,903
1,177	19,753,925	21,788,925	130,242		1,219	25,787,500	27,822,500	156,488
1,178	19,884,505	21,919,505	130,919		1,220	25,944,281	27,979,281	157,073
1,179	20,015,762	22,050,762	131,595		1,221	26,101,666	28,136,666	157,697
1,180	20,147,696	22,182,696	132,272		1,222	26,259,675	28,294,675	158,322
1,181	20,280,298	22,315,298	132,932		1,223	26,418,310	28,453,310	158,947
1,182	20,413,560	22,448,560	133,592		1,224	26,577,569	28,612,569	159,572
1,183	20,547,482	22,582,482	134,252		1,225	26,737,453	28,772,453	160,196
1,184	20,682,064	22,717,064	134,911		1,226	26,897,962	28,932,962	160,821
1,185	20,817,305	22,852,305	135,571		1,227	27,059,095	29,094,095	161,446
1,186	20,953,206	22,988,206	136,231		1,228	27,220,854	29,255,854	162,071
1,187	21,089,767	23,124,767	136,891		1,229	27,383,237	29,418,237	162,695
1,188	21,226,987	23,261,987	137,550					

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Appendix B

Colorado River System Facilities and Current River System Operations From Lake Powell to SIB

This appendix describes the dams, reservoirs and river reaches on the mainstream of the Colorado River from Lake Powell to the Southerly International Border with Mexico. This appendix also describes the historical and current operation of those facilities.

Table of Contents

List of Figures

List of Tables

B.1 Natural Runoff and Storage of Water

The Colorado River serves as a source of water for irrigation, domestic, and other uses in the States of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming, and in Mexico. The Colorado River also serves as a source of water for a variety of recreational and environmental uses. The Colorado River Basin is located in the southwestern United States and occupies an area of approximately 250,000 square miles. The Colorado River is approximately 1,400 miles in length and originates along the Continental Divide in Rocky Mountain National Park in Colorado. Elevations in the Colorado River Basin range from sea level to over 14,000 feet above mean sea level (msl) in the mountainous headwaters.

Climate varies significantly throughout the Colorado River Basin. Most of the Colorado River Basin is comprised of arid or semi-arid rangelands, which generally receive less than 10 inches of precipitation per year. In contrast, many of the mountainous areas that rim the northern portion of the Colorado River Basin receive, on average, over 40 inches of precipitation per year. Most of the total annual flow in the Colorado River Basin results from natural runoff from mountain snowmelt. Because of this, natural flow is very high in the late spring and early summer, diminishing rapidly by mid-summer. While flows in late summer through autumn sometimes increase following rain events, natural flow in the late summer through winter is generally low.

Due to variability in climatic conditions, the natural flow in the Colorado River system is highly variable from year to year. In any case, the natural flow of the river represents an estimate of runoff flows that would exist in a natural setting, without storage, alteration or depletion by man. About 86 percent of the Colorado River System annual runoff originates in only 15 percent of the watershed—in the mountains of Colorado, Utah, Wyoming and New Mexico. While the average annual natural flow at the Lees Ferry Compact Point (Lees Ferry) is calculated at approximately 15.1 million acre-feet (maf), annual flows in excess of 23 maf and as little as 5 maf have occurred.

The flow in the Colorado River above Lake Powell reaches its annual maximum during the April through July period. During the summer and fall, thunderstorms occasionally produce additional peaks in the river. However, these flows are usually smaller in volume than the snowmelt peaks and of much shorter duration.

Flows immediately below Glen Canyon Dam consist almost entirely of water released from Lake Powell. Downstream of Glen Canyon Dam, annual river gains from tributaries, groundwater discharge, and occasional flash floods from side canyons average 900,000 acre-feet (af).

Immediately downstream of Hoover Dam, the river flows consist almost entirely of water released from Lake Mead. Downstream of Hoover Dam, the Colorado River gains additional waters from tributaries such as the Bill Williams River and the Gila River, groundwater discharge, and return flows.

Total storage capacity in the Colorado River system is nearly four times the river's average natural flow or about 60 maf. However, the two largest reservoirs in the system, Lake Powell and Lake Mead account for approximately 50 maf of this storage capacity. The various reservoirs that provide storage, their respective capacities and modes of operation, along with the respective river reaches are described in more detail in Section B.2.

Annually, approximately 9 maf are released from Lake Mead to meet the delivery orders of water entitlement holders in the United States and for 1944 Treaty water deliveries to Mexico. Of this amount, some 7.5 maf are entitlements for the Lower Division states (Arizona, California, and Nevada), while the remaining 1.5 maf is delivered to Mexico.

Figure B-1 presents an overview of the historical natural flow calculated at Lees Ferry for 1906 through 2005 (calendar years). The natural flow represents an estimate of the flows that would originate or exist above the Lees Ferry without storage, alteration or depletion by man. This is different than the recorded or historical stream flows that represent actual measured flows. Figure B-2 presents an overview of the historical flows recorded at Lees Ferry for 1922 through 2005.

Figure B-1
Natural Flow of the Colorado River Calculated at Lees Ferry, Arizona
1906 through 2005

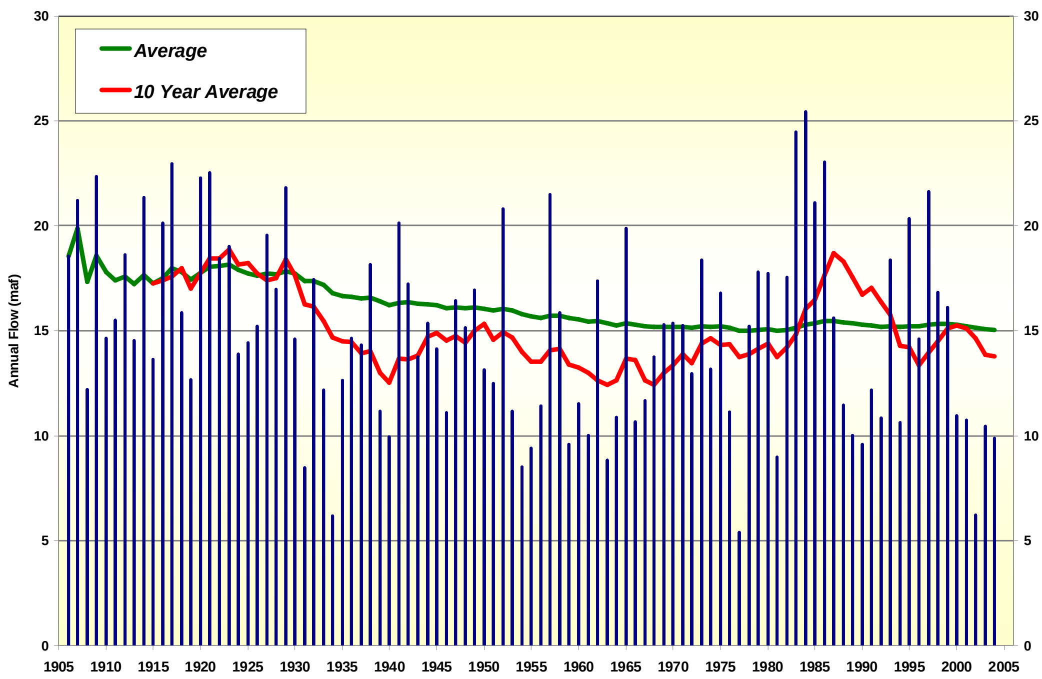
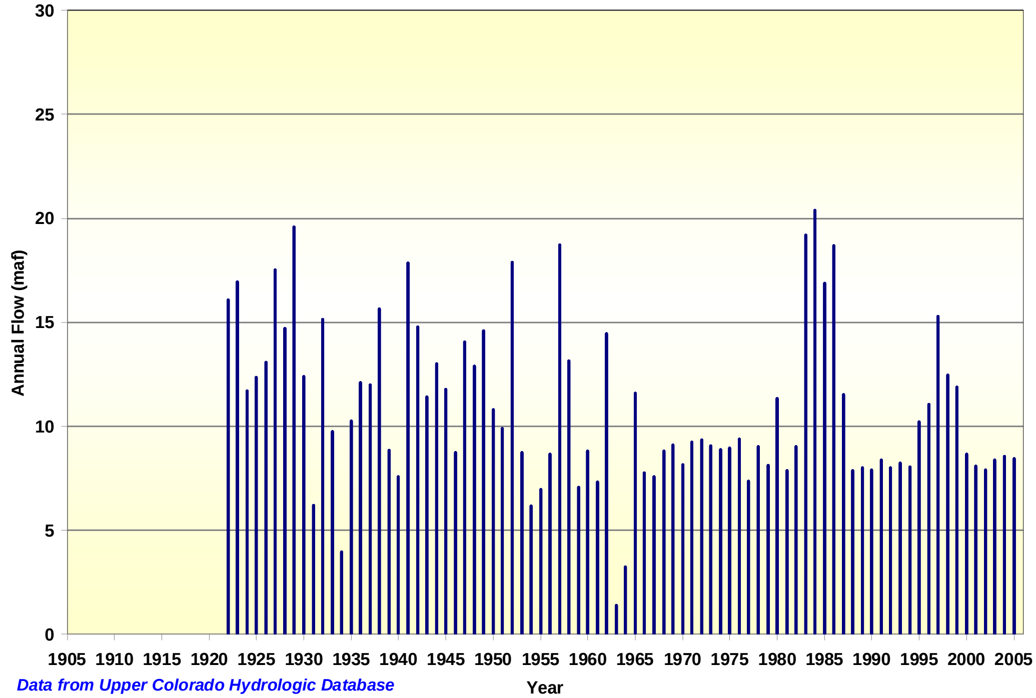


Figure B-2
Historic Annual Flow of the Colorado River Recorded at Lees Ferry, Arizona
1922 through 2005



B.2 Operation of the Colorado River System

The Secretary of the Department of the Interior (Secretary), acting through the Bureau of Reclamation (Reclamation), is vested with the responsibility of managing the mainstream waters of the lower Colorado River pursuant to applicable federal law. This responsibility is carried out consistent with a body of documents referred to as the Law of the River. The Law of the River comprises numerous operating criteria, regulations, and administrative decisions included in federal and state statutes, interstate compacts, court decisions and decrees, an international treaty, and contracts with the Secretary applicable to the allocation, appropriation, development, exportation and management of the waters of the Colorado River Basin. There is no single, universally agreed upon definition of the Law of the River, but it is useful as a shorthand reference to describe this longstanding and complex body of legal agreements governing the management of the Colorado River.

Operation of the Colorado River system and delivery of Colorado River water to the seven Basin States (Arizona, California, Colorado, Nevada, Utah, New Mexico, and Wyoming) and Mexico are conducted in accordance with the Law of the River. Water cannot be released from storage unless there is a reasonable beneficial use for the water. The exceptions to this are releases required for flood control, river regulation, or dam safety. In the Lower Basin, water is released from the system to satisfy water delivery orders and to satisfy other purposes set forth in the Consolidated Decree entered by the United States Supreme Court in the case of *Arizona v. California*, 547 U.S. 150 (2006) (Consolidated Decree). The principal facilities that were constructed to manage the water in the Colorado River system include Glen Canyon Dam and Hoover Dam.

The Colorado River system is operated by Reclamation pursuant to the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Long-Range Operating Criteria or LROC) through the issuance of the Annual Operating Plan for Colorado River Reservoirs (AOP). The AOP is required by the Colorado River Basin Project Act of 1968 (CRBPA). The AOP is formulated for the upcoming year under a variety of potential scenarios or conditions. The plan is developed based on projected demands, existing storage conditions, and probable inflows. The AOP is prepared by Reclamation, acting on behalf of the Secretary, in consultation with the Basin States, the Upper Colorado River Commission, Indian tribes, appropriate federal agencies, representatives of the academic and scientific communities, environmental organizations, the recreation industry, water delivery contractors, contractors for the purpose of federal power, others interested in Colorado River operations, and the general public.

Prior to the beginning of the calendar year, Lower Basin diversion schedules are requested from water users entitled to Colorado River water. These schedules are estimated monthly diversions and return flows that allow Reclamation to determine a tentative schedule of monthly releases through the Hoover Powerplant. Actual monthly releases are determined by the demand for water downstream of Hoover Dam, Davis Dam, and Parker Dam. Daily changes in water orders are made to accommodate emergencies, temperature and weather for water orders downstream of Parker Dam.

A minimum of 1.5 maf is delivered annually to Mexico in accordance with the 1944 Treaty. The 1944 Treaty contains provisions for delivery of up to 200,000 af above the 1.5 maf when Lake Mead is in flood control operations and there exists water in excess of that necessary to satisfy the uses in the United States and the guaranteed quantity of 1.5 maf to Mexico. Additionally, excess flows above the 200,000 af may become available to Mexico coincident with Lake Mead flood control releases and Gila River flood flows provided that the reasonable beneficial uses of the Lower Division states have been satisfied.

The Colorado River from Hoover Dam to the Southerly International Boundary with Mexico (SIB) is contained within the shallow Colorado River Valley in which Lake Mohave, Lake Havasu and other smaller diversion reservoirs are located. Within this segment, especially along river reaches below Parker Dam, the Colorado River is fringed with riparian vegetation and marshy backwaters, and contains a number of diversion dams and a system of levees. The northern reach of this segment, including Lake Mohave, lies within the Lake Mead National Recreation Area (LMNRA). The lower reach is bordered by a combination of federal, Tribal and private land. The last 23.7 miles is along the international border with Mexico. Reclamation retains authority and discretion for river operations in the reaches of this segment.

Under the Boulder Canyon Project Act of 1928 (BCPA) and the Decree, releases from Hoover Dam are governed by orders for downstream water deliveries to Arizona, California, Nevada, and Mexico. However, releases may exceed orders when flood releases are required under the United States Army Corps of Engineers' (USACE) flood control criteria, or for other purposes consistent with the BCPA and the Consolidated Decree.

B.2.1 Lake Powell and Glen Canyon Dam

Lake Powell is a large reservoir on the Colorado River formed by Glen Canyon Dam. The reservoir is narrow and over 100 miles long. Lake Powell provides water storage for use in meeting delivery requirements of the Upper Basin to the Lower Basin.

The normal operating range of Lake Powell is between elevations 3,490 feet msl and 3,700 feet msl. Elevation 3,490 feet msl corresponds to the minimum power pool. Releases from Glen Canyon Dam can be made below 3,490 feet msl down to elevation 3,370 feet msl via the river bypass tubes. Elevation 3,700 feet msl corresponds to the top of the spillway radial gates. During floods, the elevation of Lake Powell can go above 3,700 feet msl by raising the radial spillway gates, resulting in spillway releases. In 1983, Lake Powell reached a high elevation of 3,708.34 feet msl. Lake Powell is located within the Glen Canyon National Recreation Area (GCNRA), which is administered by the National Park Service (NPS). Reclamation retains authority and discretion for the operation of Glen Canyon Dam and Lake Powell.

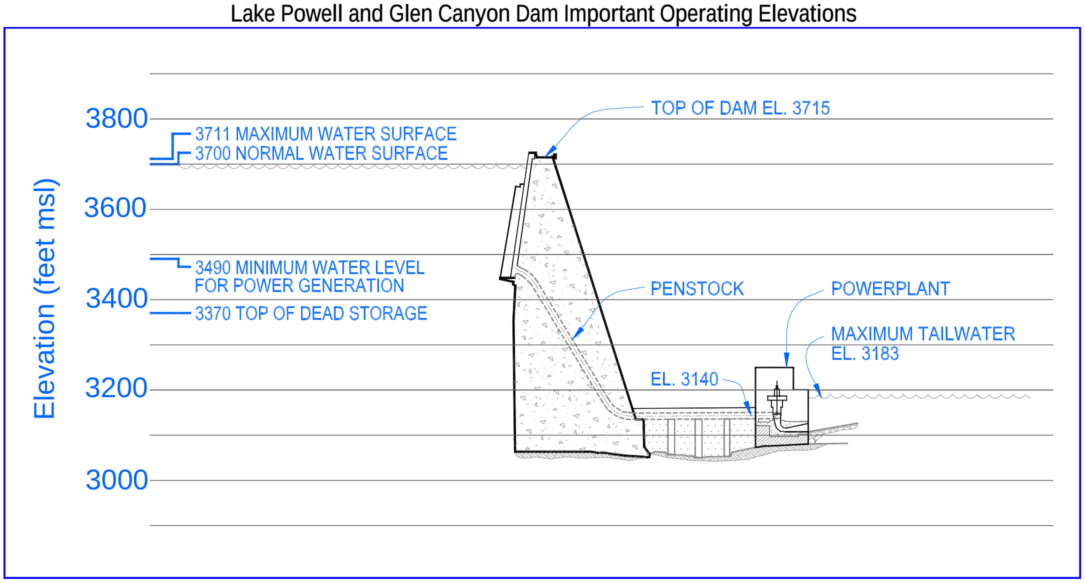
B.2.1.1 Dam and Reservoir Configuration

Glen Canyon Dam is a concrete arch dam rising approximately 700 feet above the level of the Colorado River streambed. A profile of the dam is depicted on Figure B-3. Except during flood conditions, the "full reservoir" water level is 3,700 feet msl, corresponding to the top of the spillway gates. Under normal operating conditions, releases from Glen Canyon Dam are made through Glen Canyon Powerplant by means of gates on the upstream face of the dam. The minimum reservoir elevation at which hydroelectric power can be generated is 3,490 feet msl. Releases in excess of the powerplant capacity may be made when flood conditions are caused by high runoff in the upstream portion of the Colorado River Basin, or when needed to provide Beach/Habitat-Building Flows (BHBF) downstream of the dam.

There are four river outlets at Glen Canyon Dam, comprising 96-inch diameter steel pipes with hollow-jet valves for regulation, each with a capacity of 3,750 cubic feet per second (cfs). The release rate is controlled by the hollow-jet valves from elevation 3,500 feet msl to 3,700 feet msl. At elevation 3,700 feet msl, a hollow-jet valve opening of 79 percent produces the 3,750 cfs. At elevation 3,500 feet msl, the hollow-jet valve must be fully opened to achieve 3,750 cfs.

At elevations below 3,500 feet msl, with the hollow-jet valve fully opened, the flow is reduced below 3,750 cfs as the head is lowered. At elevation 3,490 feet msl, for instance, one river outlet with the hollow-jet valve fully opened will release about 3,660 cfs. At elevation 3,460 feet msl, one river outlet will release about 3,380 cfs. An annual release of 8.23 maf equates to a continuous release of 11,368 cfs. With all four river outlets in service, this release can be achieved down to about elevation 3,440 feet msl. At this elevation, the release capacity from the four river outlets is approximately 11,440 cfs (2,860 cfs per unit).

Figure B-3
Lake Powell and Glen Canyon Dam Important Operating Elevations



B.2.1.2 Operation of Glen Canyon Dam

Flows below Glen Canyon Dam are influenced by storage and release decisions that are scheduled and implemented on an annual, monthly and hourly basis from Glen Canyon Dam.

The annual volume of water released from Glen Canyon Dam is made according to the provisions of the LROC that includes a minimum objective release of 8.23 maf, storage equalization between Lake Powell and Lake Mead under prescribed conditions, and the avoidance of spills. Annual releases from Lake Powell greater than the minimum occur if Upper Basin storage is greater than the storage required by Section 602(a) of the CRBPA, and if the storage in Lake Powell is greater than the storage in Lake Mead. Annual release volumes greater than the minimum objective of 8.23 maf are also made to avoid anticipated spills.

Monthly operational decisions are generally intermediate targets needed to systematically achieve the annual operating requirements. The actual volume of water released from Lake Powell each month depends on the forecast inflow, storage targets and annual release requirements described above. Demand for energy is also considered and accommodated as long as the annual release and storage requirements are not affected.

The National Weather Service's Colorado Basin River Forecast Center (CBRFC) provides the monthly forecasts of expected inflow into Lake Powell and other Upper Basin reservoirs. The CBRFC uses a satellite-telemetered network of hundreds of data collection points within the Upper Basin that gather data on snow water content, precipitation, temperature and streamflow. Telemetry data is input into regression and real-time conceptual computer models to derive an inflow forecast. Reclamation's future release volumes are based on these derived forecasts. Particular attention is paid to April through July forecast which historically has the most impact on the hydrology of the region. Due to the variability in climatic conditions, modeling and data errors, these forecasts are based, in part, on large uncertainties. The greatest period of uncertainty occurs in early winter and decreases as the snow accumulation period progresses into the snowmelt season, often forcing modifications to the monthly schedule of releases.

An objective in the operation of Glen Canyon Dam is to attempt to safely fill Lake Powell each summer. When carryover storage from the previous year in combination with forecast inflow allows, Lake Powell is targeted to reach a storage of about 23.8 maf in July (0.5 maf from full pool). In years when Lake Powell fills or nearly fills in the summer, releases in the late summer and early winter are generally made to lower the reservoir elevation, so that there is at least 2.4 maf of vacant space in Lake Powell on January 1. Storage targets are always reached in a manner consistent with the LROC.

Glen Canyon Dam is operated consistent with the 1996 Glen Canyon Dam Record of Decision (ROD) (62 C.F.R. pt. 9447-9448) developed as directed under the Grand Canyon Protection Act of 1992. The 1996 Glen Canyon Dam ROD describes criteria for dam operations and includes other measures to ensure Glen Canyon Dam is operated in a manner consistent with the Grand Canyon Protection Act of 1992. Among these are an Adaptive Management Program (AMP), BHBFs, and further study of temperature control. Scheduling of BHBF releases from Glen Canyon Dam are discussed in Section B.2.2. The daily and hourly release constraints of Glen Canyon Dam are as provided in Table B-1.

Table B-1
Glen Canyon Dam Release Constraints

Parameter	Flow Rate (cfs)	Conditions
Maximum Flow[1]	25,000	
Minimum Flow	5,000	Nighttime
	8,000	7:00 a.m. to 7:00 p.m.
Ramp Rates		
Ascending	4,000	Per hour
Descending	1,500	Per hour
Daily Fluctuations[2]	5,000 to 8,000	

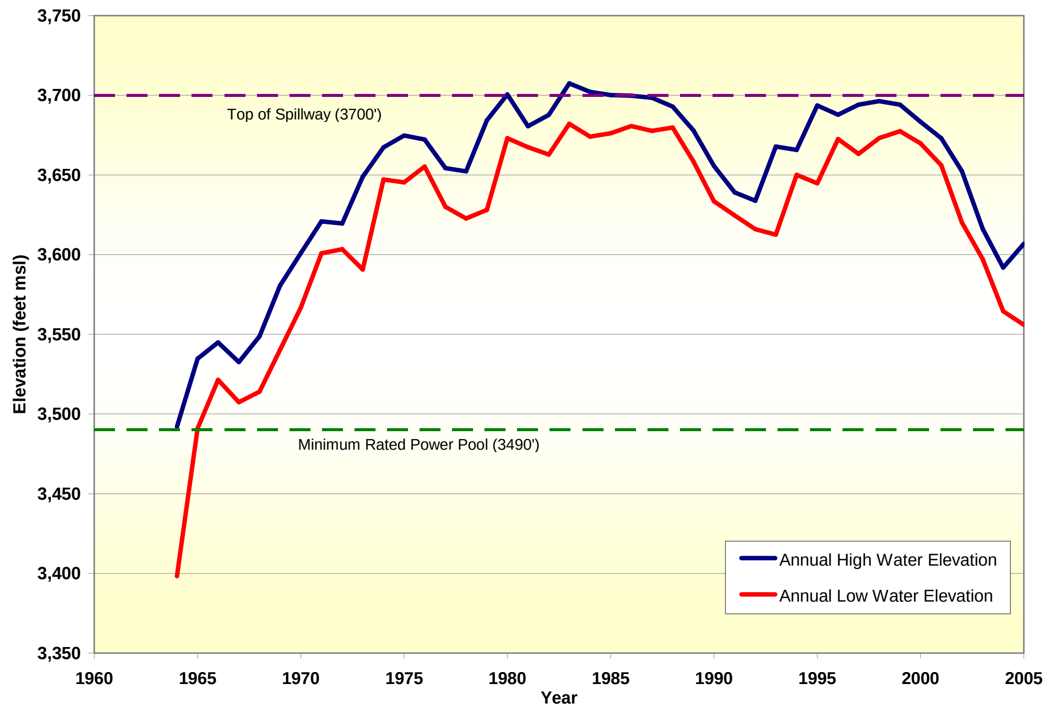
[1] *To be evaluated and potentially increased as necessary and in years when delivery to Lower Basin exceeds 8.23 maf.*

[2] *Daily fluctuation limit is 5,000 cfs for months with release volumes less than 0.6 maf; 6,000 cfs for monthly release volumes of 0.6 maf to 0.8 maf; and 8,000 cfs for monthly volumes over 0.8 maf.*

B.2.1.3 Historic Lake Powell Elevations

Glen Canyon Dam and Lake Powell were designed to operate from a normal maximum elevation of 3,700 feet msl to a minimum elevation of 3,490 feet msl, the minimum for hydroelectric power production. During flood conditions, the elevation of Lake Powell can exceed 3,700 feet msl by raising and adding additional supported panels to the spillway radial gates. Since first reaching equalization storage with Lake Mead in 1974, Lake Powell's elevation has fluctuated from a high of 3,708 feet msl to a low of approximately 3,555 feet msl, as illustrated on Figure B-4.

Figure B-4
Historic Lake Powell Elevations
(Annual Highs and Lows)



B.2.2 Glen Canyon Dam to Lake Mead

The segment of the Colorado River between Glen Canyon Dam and Lake Mead is comprised of a narrow river corridor through the Grand Canyon that is administered primarily by the Grand Canyon National Park.[1] Flows within this reach of the river consist primarily of releases from Glen Canyon Dam as discussed in Section B.2.1.

Issues that may need to be reconsidered within this segment of the river are those associated with a revised program of low steady summer flows and BHBF releases, as well as the ongoing temperature control studies.

B.2.2.1 River Flows between Glen Canyon Dam and Lake Mead

Colorado River flows between Glen Canyon Dam and Lake Mead are a result of controlled releases from Glen Canyon Dam (Lake Powell) and include gains from tributaries in this reach of the river. Releases from Glen Canyon Dam are managed as discussed in Section B.2.1. The most significant gains from tributaries include inflows from the Little Colorado River (approximately 315 miles long) that provides the principal

[1] The 15.9 mile reach between Glen Canyon Dam and Lees Ferry is managed by the Glen Canyon National Recreation Area.

drainageway for the Painted Desert, and the Paria River (approximately 75 miles long) which drains the rugged and arid region northwest of the Colorado River. However, inflows from these perennial streams is concentrated over very short periods of time, and on average, make up approximately two percent of the total annual flow in this reach of the river.

B.2.2.2 Glen Canyon Dam Releases and the Adaptive Management Program

A function of Glen Canyon Dam operations is to maximize power generation. However, power generation was found to be having a negative impact on downstream resources. Realizing the occurrences of such impacts, the Secretary determined in July 1989 that an Environmental Impact Statement (EIS) should be prepared. The *Operation of Glen Canyon Dam EIS* developed and analyzed alternative operation scenarios that met statutory responsibilities for protecting downstream resources and achieving other authorized purposes, while protecting Native American interests. A final EIS was completed in March 1995, and the Secretary signed a ROD on October 8, 1996. Reclamation also consulted with the United States Fish and Wildlife Service (FWS) under the Endangered Species Act of 1973, as amended (ESA) and incorporated FWS's recommendations into the 1996 Glen Canyon Dam ROD. Glen Canyon Dam operates under the 1996 Glen Canyon Dam ROD (Section B.2.1).

The AMP provides a process for assessing the effects of current operations of Glen Canyon Dam on downstream resources, and using the results of these assessments for developing recommendations that in turn can be used to modify operating criteria and other resource management actions. This is accomplished through the Adaptive Management Work Group (AMWG), a federal advisory committee. The AMWG consists of stakeholders that are federal and state resource management agencies, representatives of the seven Basin States, Indian Tribes, hydroelectric power marketers, environmental and conservation organizations and recreational and other interest groups. The duties of the AMWG are in an advisory capacity only. Coupled with this advisory role are long-term monitoring and research activities that provide a continual record of resource conditions and new information to evaluate the effectiveness of the operational modifications.

BHBF and Beach Habitat Maintenance Flow (BHMF) releases are scheduled high releases of short duration that are in excess of power plant capacity required for dam safety purposes and are made according to certain specific criteria. These BHBFs are designed to rebuild high elevation sandbars, deposit nutrients, restore backwater channels, and provide some of the dynamics of a natural system. The first test of a BHBF was conducted in the spring of 1996.

BHFMs releases are releases at or near power plant capacity, which are intended to maintain favorable beach and habitat conditions for recreation and fish and wildlife, and to protect Tribal interests. BHMF releases can be made in years when no BHBF releases are made.

Both BHBFs and BHMFs, along with the testing and evaluation of other types of releases under the AMP, were recommended by FWS to verify a program of flows that would improve habitat conditions for endangered fish. The proposed shortage guidelines and action alternatives could affect the range of storage conditions in Lake Powell and alter the flexibility to schedule and conduct such releases or to test other flow patterns.

In 1994, FWS issued a *Biological Opinion on the Operation of Glen Canyon Dam* (Biological Opinion). One of the elements of the reasonable and prudent alternative in the Biological Opinion, also a common element in the Glen Canyon Dam EIS, was the evaluation of methods to control release temperatures and, if viable, implement controls. Reclamation agreed with this recommendation and included it in the *Operation of Glen Canyon Dam Final Environmental Impact Statement* and subsequent ROD.

Reclamation has also recently initiated planning activities that will consider possible modifications to Glen Canyon Dam for controlling downstream temperatures. The investigations associated with these planning activities are very preliminary and significant information is currently not available to report on this planning process.

In addition, on September 1, 2006, Reclamation and the Center for Biological Diversity, Arizona Wildlife Federation, Living Rivers, Sierra Club – Grand Canyon Chapter, and Glen Canyon Institute entered into a settlement agreement whereby Reclamation agreed to assess the impacts of current and modified operations of Glen Canyon Dam on the Humpback Chub, Bonytail Chub, Razorback Sucker and Colorado Pikeminnow. Reclamation plans to conduct further related environmental studies and anticipates that it will prepare an EIS by October 15, 2008.

B.2.3 Lake Mead and Hoover Dam

Lake Mead is a large reservoir on the Colorado River formed by Hoover Dam. The reservoir provides water storage for use in regulating the water supply and meeting delivery requirements in the Lower Basin. The normal operating range of the reservoir is between elevations 1,219.61 feet msl and 1,050 feet msl. Elevation 1,050 feet msl corresponds to the minimum power-pool of Hoover Dam Powerplant. Releases can be made from Hoover Dam below elevation 1,050 feet msl down to 895 feel msl via the intake towers. During floods, the elevation of Lake Mead can go above 1,219.61 feet msl. The top of the raised spillway gates is at elevation 1,221.0 feet msl. Since its initial filling in the late 1930s, the reservoir elevation has fluctuated from a high of 1,225.85 feet msl (as occurred in July 1983) to a low of 1,083.21 feet msl (as occurred in April 1956).

The reservoir is located within the LMNRA, which is administered by the NPS. However, Reclamation retains authority and discretion for the operation of Hoover Dam and Lake Mead.

The Las Vegas Wash is the primary channel through which the Las Vegas Valley's excess water returns to Lake Mead. The water flowing through the wash comprises less than two percent of the water in Lake Mead and consists of urban runoff, shallow groundwater, stormwater, and releases from the valley's three water reclamation facilities.

The lower wash stretches 12 miles from the southeast part of the Las Vegas Valley to Lake Mead, entering the lake at Las Vegas Bay. Its once-plentiful wetlands helped polish urban flows on their way to Lake Mead. However, erosion in the wash has reduced wetlands acreage from a peak of approximately 2,000 acres to about 200 acres.

B.2.3.1 Dam and Reservoir Configuration

Hoover Dam and Lake Mead are operated with the following three main priorities:

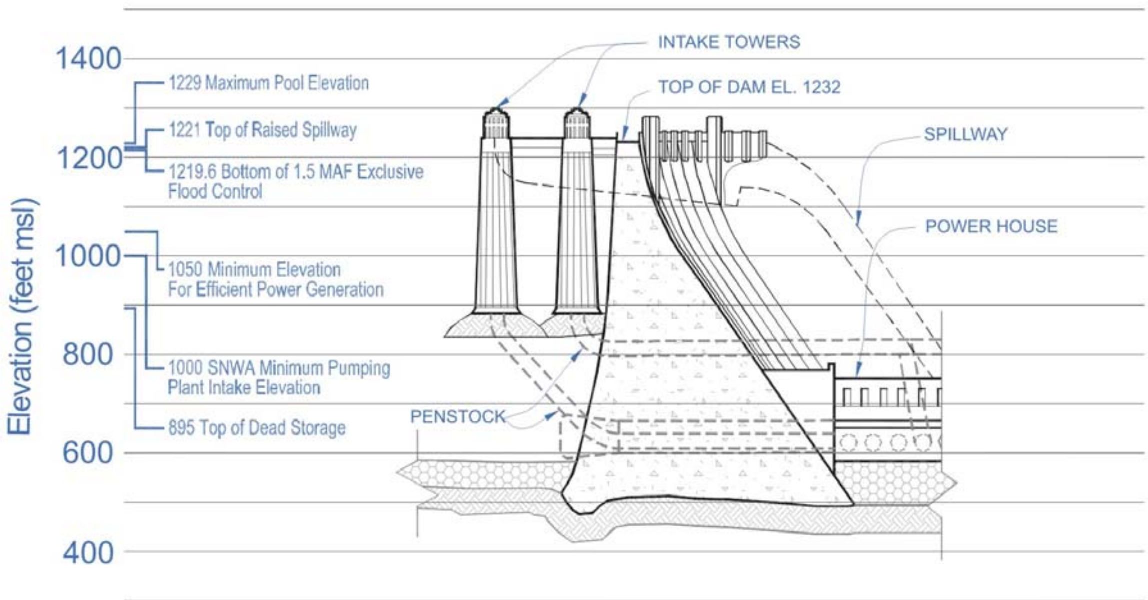
1) river regulation, improvement of navigation, and flood control;
2) irrigation and domestic uses, including the satisfaction of present perfected water rights; and
3) power.

The BCPA specified flood control as the project purpose having first priority for operation of Hoover Dam and Lake Mead.

Hoover Dam is the northernmost Reclamation facility on the lower Colorado River and along with Lake Mead it is located at River Mile 342.2. Hoover Dam provides flood control protection and Lake Mead provides the majority of the storage capacity for the Lower Basin as well as significant recreation opportunities. Lake Mead storage capacity is currently estimated to 27.38 maf at a maximum elevation of 1,229.0 feet msl. At this elevation, Lake Mead’s water surface area would equal 163,000 acres. The dam’s four intake towers draw water from the reservoir at elevations above 895 feet msl to drive 17 generators within the dam’s powerplant. The minimum elevation for effective power generation is 1,050 feet msl.

Flood control regulations for Lake Mead were established to manage potential flood events arising from rain and snowmelt. Lake Mead’s uppermost 1.5 maf of storage capacity, between elevations 1,219.61 feet msl and 1,229.0 feet msl, is defined as exclusive flood control. Within this capacity allocation, 1.218 maf of flood storage is above elevation 1,221.40 feet msl, the top of the raised spillway gates. Figure B-5 illustrates some of the important Hoover Dam and Lake Mead elevations that are referenced in subsequent sections.

Figure B-5
Lake Mead and Hoover Dam Important Operating Elevations



Lake Mead usually is at its maximum water level in November and December. If required, system storage space-building is achieved between the period of August 1 to January 1. Hoover Dam storage space-building releases are limited to 28,000 cfs, while the mean daily releases to meet the water delivery orders of Colorado River water entitlement holders and power users normally range between 8,000 cfs to 18,000 cfs.

In addition to controlled releases from Lake Mead to meet water supply and power requirements, water is also diverted from Lake Mead at SNWA's Saddle Island intake facilities, Boulder City's Hoover Dam intake, and the Basic Management, Inc.'s (BMI) intake facility for use in the Las Vegas area for domestic purposes by SNWA, BMI and other users.

The diversions by SNWA at its Saddle Island intake facilities entail pumping the water from the intake to SNWA's water transmission facilities for treatment and further conveyance to the greater Las Vegas area and Boulder City. SNWA has low intake facilities. The elevation of the original SNWA intake is approximately 1,000 feet msl. However, the minimum required Lake Mead elevation necessary to operate the pumping units at SNWA's original intake facility is 1,050 feet msl. A second SNWA intake was constructed more recently and it has a second pumping plant with an intake elevation of 950 feet msl. The minimum required Lake Mead elevation necessary to operate the pumping units at SNWA's second intake facility is 1,000 feet msl. The second SNWA intake provides only a portion of the capacity required by SNWA to meet its Lake Mead water supply needs. Therefore, the intake elevation of SNWA's original pumping plant is critical to its ability to divert its full Colorado River water entitlement.

B.2.3.2 Operation of Hoover Dam

Hoover Dam is managed to provide at least 7.5 maf annually for consumptive use by the Lower Division states plus the United States' Colorado River water supply obligation to Mexico pursuant to the 1944 Treaty. Hoover Dam releases are managed on an hourly basis to maximize the value of generated power by providing peaking during high-demand periods. This results in fluctuating flows below Hoover Dam that can range from 1,000 cfs to 49,000 cfs. The upper value is the maximum flow-through capacity through Hoover Dam Powerplant (49,000 cfs). However, because these flows enter Lake Mohave downstream, the affected zone of fluctuation is only a few miles because these flows are regulated in Lake Mohave.

Releases of water from Hoover Dam may also be affected by the Secretary's determinations relating to Normal, Surplus or Shortage Conditions (Section 4.4 of this Final EIS). Another type of release includes flood control releases. For Hoover Dam, flood control releases are defined in this Final EIS as releases in excess of downstream demands.

Flood control was specified as a primary project purpose by the BCPA, the act authorizing Hoover Dam. The USACE is responsible for developing the Flood Control Operation Plan for Hoover Dam and Lake Mead as indicated in 33 C.F.R. pt. 208.11. The Flood Control Operation Plan is the result of a coordinated effort by the USACE and Reclamation. However, the USACE is responsible for providing the flood control regulations and has authority for final approval of the flood control operation plan. Any deviations from the flood control operating instructions provided by the flood control operation plan must be authorized by the USACE. The Secretary is responsible for operating Hoover Dam in accordance with these regulations.

Lake Mead's uppermost 1.5 maf of storage capacity, between elevations 1,219.61 feet msl and 1,229.0 feet msl, is defined as exclusive flood control space. Within this capacity allocation, 1.218 maf of flood storage is above elevation 1,221.0 feet msl, which is the top of the raised spillway gates.

Flood control regulations specify that once Lake Mead flood releases exceed 40,000 cfs, the releases shall be maintained at the highest rate until the reservoir drops to elevation 1,221.0 feet msl. Releases may then be gradually reduced to 40,000 cfs until the prescribed seasonal storage space is available.

The regulations set forth two primary criteria for flood control operations related to snowmelt: 1) preparatory reservoir space requirements; and 2) application of runoff forecasts to determine releases.

In preparation for each annual season of snow accumulation and associated runoff, progressive expansion of total Colorado River system reservoir space is required during the latter half of each year. Minimum available flood control space increases from 1.5 maf on August 1 to 5.35 maf on January 1. Required flood storage space can be accumulated within Lake Mead and upstream in Lake Powell, Navajo, Blue Mesa, Flaming Gorge and Fontenelle reservoirs. The minimum space required to be reserved exclusively for flood control storage in Lake Mead is 1.5 maf. Table B-2 presents the amount of required flood storage space within the Colorado River system by date:

Table B-2
Minimum Required Colorado River System Storage Space

Date	Storage Volume (maf)
August 1	1.50
September 1	2.27
October 1	3.04
November 1	3.81
December 1	4.58
January 1	5.35

Normal space-building releases from Lake Mead to meet the required August 1 to January 1 flood control space are limited to a maximum of 28,000 cfs. Releases in any month based on water entitlement holders' demand are much less than 28,000 cfs (on the order of 20,000 cfs or less).

Between January 1 and July 31, flood control releases, based on forecast inflow, may be required to prevent filling of Lake Mead beyond its 1.5 maf minimum space requirement. Beginning on January 1 and continuing through July, the CBRFC issues monthly runoff forecasts. These forecasts are used by Reclamation in estimating releases from Hoover Dam. The release schedule contained in the USACE regulations is based on increasing releases in six steps listed in Table B-3.

Table B-3
Minimum Flood Control Releases at Hoover Dam

Step	Flow Rate (cfs)
Step 1	0
Step 2	19,000
Step 3	28,000
Step 4	35,000
Step 5	40,000
Step 6	73,000

The lowest step, zero cfs, corresponds to times when the regulations do not require flood control releases. Hoover Dam releases are then made to meet water and power objectives. The second step, 19,000 cfs, is based on the Parker Powerplant capacity. The third step, 28,000 cfs, corresponds to Davis Powerplant's capacity. In recent years both Parker and Davis Powerplants have undergone an upgrading program to improve the efficiency of the individual powerplants. The current maximum releases are slightly higher for both the Parker Powerplant and Davis Powerplant outputs, as follows: 22,000 cfs and 31,000 cfs, respectively. The fourth step in the USACE release schedule is 35,000 cfs. This flow corresponds to the powerplant flow-through capacity of Hoover Dam in 1987. However, the present powerplant flow-through capacity at Hoover Dam is 49,000 cfs. At the time Hoover Dam was completed, 40,000 cfs was the approximate maximum flow from the dam considered to be non-damaging to the downstream streambed. The 40,000 cfs flow now forms the fifth step. Releases of 40,000 cfs and greater would result from low-probability hydrologic events. The sixth and final step in the series (73,000 cfs) is the maximum controlled release from Hoover Dam that can occur without spillway flow.

Flood control releases are required when forecast inflow exceeds downstream demands, available storage space at Lake Mead and Lake Powell and allowable space in other Upper Basin reservoirs. This includes accounting for projected bank storage and evaporation losses at both lakes, plus net withdrawal from Lake Mead by the SNWA. The USACE regulations set the procedures for releasing the volume that cannot be impounded, as discussed above.

Average monthly Hoover Dam releases are determined early in each month and apply only to the current month. The releases are progressively revised in response to updated runoff forecasts and changing reservoir storage levels during each subsequent month throughout the January 1 through July 31 runoff period. If the reservoirs are full, drawdown is accomplished to vacate flood control space as required. Unless flood control is necessary, Hoover Dam is operated to meet downstream demands.

During non-flood operations, Lake Mead elevations fluctuate as releases increase and decrease due to downstream water uses, Glen Canyon Dam releases, and 1944 Treaty deliveries to Mexico. Lake Mead's elevations will fluctuate throughout the year for meeting the end-of-month target elevations for Lake Mohave and Lake Havasu, and for releasing to meet downstream requirements. Normally, Lake Mead elevations decline with increasing irrigation deliveries through June or later and then begin to rise again. Lake Mead's storage capacity provides for the majority of Colorado River regulation from Glen Canyon Dam to the border with Mexico.

Each month, Reclamation's water operations personnel send to Western Area Power Administration (Western) a monthly Hoover Powerplant energy target that is based upon Reclamation's most current daily operational data. In order to meet water orders downstream of Hoover Dam, a monthly energy target is set based on water demands below Parker Dam and Davis Dam. The energy target for Hoover Powerplant is broken down into weekly schedules but often it is the monthly target that drives the release at Hoover Dam. Because Hoover Dam is a peaking powerplant, releases will often vary significantly to meet the energy demand. Monitoring of Hoover Dam releases is checked each day for both hourly and daily values.

Hoover Powerplant turbines are fed by four penstocks which in turn are fed by four intake towers. The reservoir elevations that allow water to be fed into the penstocks are 1,045 feet msl and 895 feet msl for the two intake towers, respectively. Eight cylinder gate valves are located at the eight respective intake locations (two for each penstock).

The cylinder gate valves are 75 years old, being part of the original construction of Hoover Dam. Because of their age, each gate valve is operated as either completely open, or completely shut. This is necessary to avoid perturbations associated with partially opening of the valves. Wicket gates located upstream of each turbine control real-time flow and peak power generation.

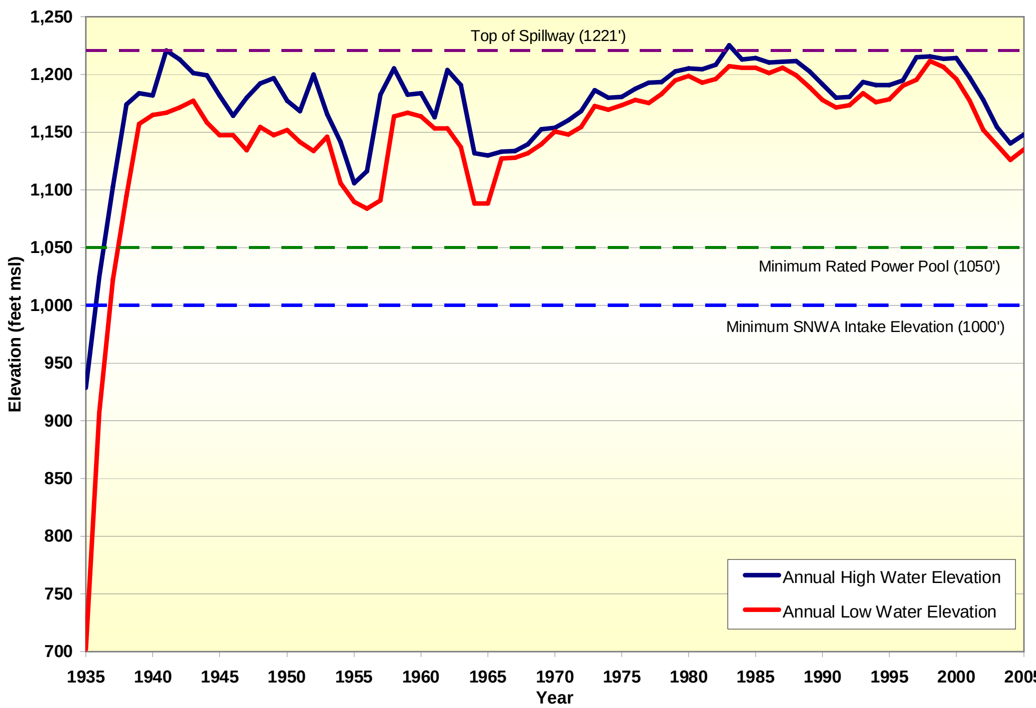
B.2.3.3 Historic Lake Mead Elevations

Figure B-6 illustrates the historic annual elevations (maximum and minimum) of Lake Mead. The annual change in elevations of Lake Mead has ranged from less than ten feet to as much as 75 feet (Figure B-6). The decrease in the elevations within a year observed after the mid-1960s can be attributed to the regulation provided by Lake Powell.

Historic Lake Mead elevations have dropped down to about 1,083 feet msl during two periods (1954 to 1957 and 1965 to 1966). The maximum Lake Mead elevation of approximately 1,225.6 feet msl occurred once, in 1983.

Three Lake Mead elevations of interest are shown in Figure B-6. The first elevation is 1,221 feet msl, the top of the spillway gates. The second elevation is 1,050 feet msl, the minimum elevation for the effective generation of power. The third elevation is 1,000 feet msl, the minimum elevation required for the operation of SNWA's lower intake.

Figure B-6
Historic Lake Mead Elevations
(Annual Highs and Lows)



B.2.4 Hoover Dam to Davis Dam

This reach extends from Hoover Dam to Davis Dam and includes Lake Mohave up to its full pool elevation. Lake Mohave generally comprises the approximately 67-mile length of this reach of the Colorado River. Lake Mohave is formed by Davis Dam and is bound for most of its 67-mile length by the steep walls of Pyramid, El Dorado, and Black Canyons. The lake is relatively narrow, not more than four miles across at its widest point, but provides significant recreation opportunities, and habitat for fish and wildlife. Lake Mohave also captures and delays flash flood discharge from side washes downstream of Hoover Dam. Typical flow time from Hoover Dam to Lake Mohave is four to six hours. Lake Mohave has a storage capacity of approximately 1.818 maf. Davis Dam and Davis Powerplant are located 67 miles downstream from Hoover Dam, and approximately two miles upstream from Laughlin, Nevada, and Bullhead City, Arizona.

B.2.4.1 River Flows between Hoover Dam and Davis Dam

Flows in the Colorado River reach between Hoover Dam and Davis Dam are comprised almost entirely of releases from Hoover Dam. Lake Mohave's primary purpose is to re-regulate Hoover Dam releases and aid in the delivery of water supplies to downstream United States entitlement holders, and to Mexico. Located on the Arizona side of the Colorado River, Davis Dam Powerplant has five generating units, with a generating capacity of 255,000 kW, and with a combined hydraulic capacity of 31,000 cfs. The power is marketed by Western.

Reclamation, as provided in the Interim Surplus Guidelines (ISG) ROD, will continue existing operations in Lake Mohave that benefit native fish through the effective period of the ISG and will explore additional ways to provide benefits to native fish. The normal filling pattern of these two reservoirs coincides well with the fishery spawning period. Since Lake Mohave elevations will be typical of previous years, normal conditions are expected for boating and other recreational uses in future years.

Reclamation is the lead agency in the Native Fish Work Group, a multi-agency group of scientists attempting to augment the ageing stock of the endangered razorback sucker in Lake Mohave. Larval razorback suckers are captured by hand in and around spawning areas in late winter and early spring for rearing at Willow Beach Fish Hatchery which is located below Hoover Dam. The following year, 1-year old razorback suckers are placed into predator-free, lake-side backwaters for rearing through the spring and summer. When Lake Mohave is normally drawn down during August through October, these fish are harvested from these rearing areas and then released to the lake. The razorback suckers grow very quickly, usually exceeding 10 inches in length by September. In 2004, 17,266 razorback suckers were repatriated into Lake Mohave from all sources. In 2005, 12,200 wild larvae were captured from natural spawning congregations on Lake Mohave and delivered to Willow Beach Hatchery.

Under normal conditions, flows in this river reach comprise water deliveries to Colorado River water users that divert water from this reach, and to others located downstream of Parker Dam.

Historic daily river flows since 1963 in this river reach have ranged between 590 cfs to 50,800 cfs. The higher flow rates have been associated with flood flows. Releases since 1963 from Davis Dam have ranged between 1,200 cfs to 44,106 cfs.

B.2.4.2 Historic Lake Mohave Elevations

Hoover Dam flood control releases are passed through Davis Dam. Flood control requirements for Davis Dam were developed through the monthly target elevations developed for Lake Mohave. Flood control releases (from Hoover Dam), as well as side wash inflows, were considered in the development of the target elevations.

Reclamation has discretion to develop and manage Lake Mohave's target elevations and allocated flood control reserved capacity that changes throughout the year by making releases through Davis Dam. This flood control reserved capacity is considered and taken into account in the Davis Dam release calculation. Specifically, the operators use a rule curve with target elevations that coincide with respective vacant storage capacity. The target elevations that are used to assure that sufficient flood control storage capacity is allocated for Lake Mohave are listed in Table B-4 and illustrated on Figure B-7.

Figure B-7
Lake Mohave Monthly Target Elevations

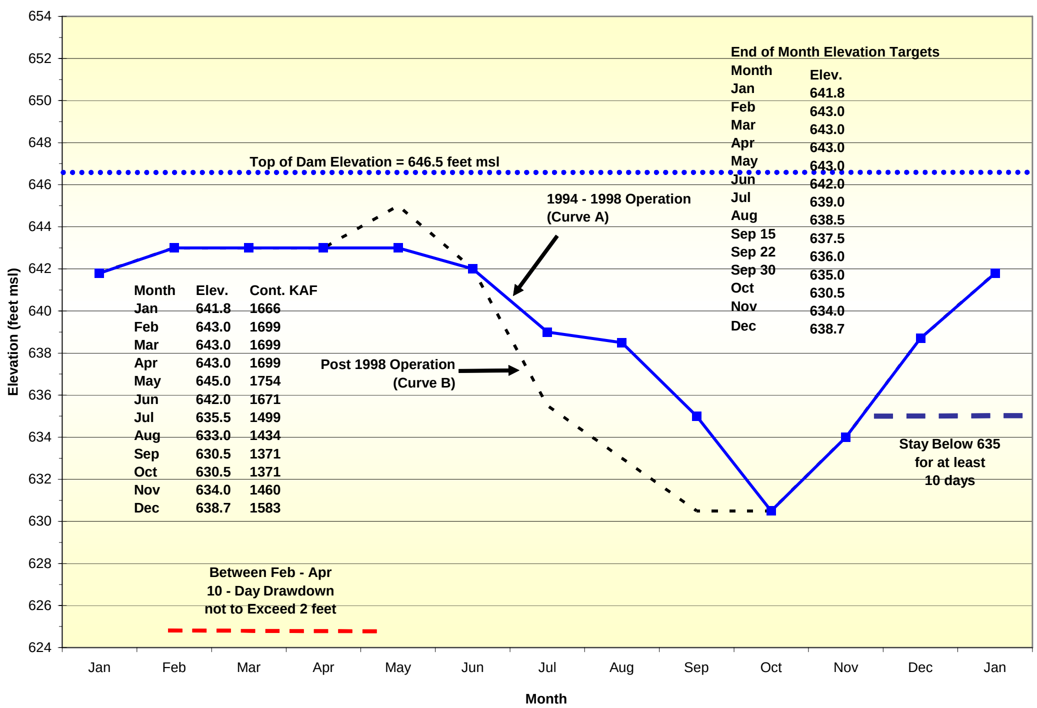


Table B-4
Lake Mohave Monthly Target Elevations

Month	Lake Mohave Target Elevation (feet msl)	Lake Mohave Target Storage (kaf)
January	641.8	1,666
February	643.0	1,699
March	643.0	1,699
April	643.0	1,699
May	645.0	1,754
June	642.0	1,671
July	635.5	1,499
August	633.0	1,434
September	630.5	1,371
October	630.5	1,371
November	634.0	1,460
December	638.7	1,583

The razorback sucker backcove rearing program that began in 1994 can also limit the drawdown to no more than two feet in a ten-day period during the razorback sucker spawning season. Further, the program also requires that the Lake Mohave elevation be maintained above 640 feet msl between March 15 and June 15 to provide sufficient depth for the backcove rearing areas. These limitations require closer coordination of Lake Mohave with that of downstream Lake Havasu as well as adjustment to the Hoover Dam hourly water release and energy production schedules. The operators take all these factors into account in the management of the Lake Mohave daily elevations.

As shown on Figure B-7, Lake Mohave generally reaches its maximum elevation in the spring and its minimum elevation in the fall. Reclamation generally lowers the lake elevation in the fall to provide flood control storage space for runoff that results from large hurricane-type storms coming up-river from Mexico. However, it needs to be noted that these are target elevations only. The actual elevations will sometimes differ from the target elevations with the regulation of Hoover Dam releases and the balancing of arriving flows with downstream water demands.

As with releases from Hoover Dam, factors that must be considered when making the Davis Dam releases include the need to meet downstream water requirements throughout the month and the objective to maintain non-damaging flow levels downstream.

B.2.4.3 Operation of Davis Dam

The primary purpose of Davis Dam is to re-regulate Hoover Dam releases and aid in the delivery of water supplies to downstream United States entitlement holders and the annual delivery of 1.5 maf to Mexico pursuant to the 1944 Treaty. Other benefits provided by Davis Dam and Lake Mohave include flood control protection, navigation, recreation, and power production.

Reclamation's water schedulers collect and compile water delivery orders from the Central Arizona Project (CAP), the Metropolitan Water District of Southern California (MWD), and other Colorado River entitlement holders that divert water between Davis Dam and Parker Dam. The hourly release schedule for Davis Dam is then integrated with the scheduled water releases of Parker Dam and other objectives to coordinate the maximum release through the power facilities at the time of the peak usage of electricity; to the extent such release is compatible with the timing of the water deliveries and other constraints.

Since 1980, annual release from Davis Dam has varied from a low of 7.3 maf to a high of 21.7 maf. The maximum instantaneous release for Davis Dam is approximately 44,000 cfs and the minimum instantaneous release that can be expected under other than normal operating conditions is about 1,000 cfs. The minimum amount represents approximately one half of the release needed to turn one of the Davis Powerplant's turbines. Such low flows are usually associated with downstream flooding, construction, search and rescue, or other emergency conditions.

Davis Powerplant's generating units are capable of providing moment-to-moment dynamic control. However, there is minimal use of this dynamic capability. If there are changes to hourly flows, the schedule change usually begins ten minutes to the hour and the change is fully implemented ten minutes after the hour. These flow changes are computer controlled and the changes to the unit releases are programmed well in advance.

The minimum elevation of Lake Mohave without resetting the intake stops is at about 630 feet msl. The maximum elevation is 646.5 feet msl, where wave action begins to leak into Davis Dam's inspection gallery. The daily releases are coordinated such that the end of month target elevations are achieved.

B.2.5 Davis Dam to Parker Dam

This reach extends from Davis Dam to Parker Dam and includes Lake Havasu up to its full pool elevation. Parker Dam is located approximately 155 miles downstream of Hoover Dam and approximately 88 miles downstream of Davis Dam. The lower portion of this reach comprises Lake Havasu. Formed by Parker Dam, Lake Havasu is about 45 miles long and can store nearly 648,000 af of water. At its maximum elevation of 450.5 feet msl, Lake Havasu has a surface area of approximately 20,390 acres.

Lake Havasu provides a forebay and desilting basin from which water is pumped into the Colorado River Aqueduct (California) and into the CAP aqueduct system. The pumping plant that pumps water into the Colorado River Aqueduct is located on the west side of the Colorado River and it is operated by the MWD. The pumping plant that pumps water into the

CAP aqueduct system is located on the east side of the Colorado River and it is operated by the Central Arizona Water Conservation District (CAWCD).

B.2.5.1 River Flows between Davis Dam and Parker Dam

The majority of the flows in this river reach are releases from Hoover Dam and flows that pass through Lake Mohave and Davis Dam. There are also some minor gains in this river reach from tributaries such as the Bill Williams River, groundwater discharge, and return flows from agriculture.

Under normal conditions, flows in this river reach comprise water deliveries to Colorado River water users that divert water from this reach, and to others located downstream of Parker Dam.

Historical river flows since 1963 in this river reach have ranged between 1,200 cfs to 44,106 cfs. The higher flow rates have been associated with flood flows.

B.2.5.2 Operation of Parker Dam

Parker Dam's primary purpose is to regulate the storage at and releases from Lake Havasu. Parker Dam also has a powerplant function and may provide a minimal amount of flood control, capturing and delaying flash floods into the Colorado River from tributaries below Davis Dam.

Releases at Parker Dam are scheduled on a daily basis to meet the short-term demands of Colorado River water users located downstream. The hourly release profile may be adjusted to meet electric service customer requirements.

Parker Dam Powerplant is located on the California side of the Colorado River immediately below the dam. It houses four hydroelectric generating units. The installed generating capacity is 120,000 kW, but due to high tailrace elevation, the generation production is approximately 108,000 kW. Four 22-foot diameter penstocks carry up to 5,500 cfs each to feed the generating units. About 50 percent of the plant's power output is reserved in perpetuity by MWD for pumping water along the Colorado River Aqueduct to the southern California coastal area. The remaining power is marketed by Western.

B.2.5.3 Historic Lake Havasu Elevations

Hoover Dam flood control releases also are passed through Parker Dam after deliveries are made to the CAP and MWD diversion facilities at Lake Havasu, and to other users upstream of Parker Dam. Flood control requirements for Parker Dam were developed through the monthly target elevations developed for Lake Havasu. Flood control releases from Hoover Dam, as well as side wash inflows and flood flows on Bill Williams River, were considered in those target elevations. Reclamation has discretion to develop and manage the target elevations of Lake Havasu by making releases through Parker Dam. Lakes Havasu is operated to meet a user-specified target storage at the end of each month. These storage target elevations are provided in Table B-5.

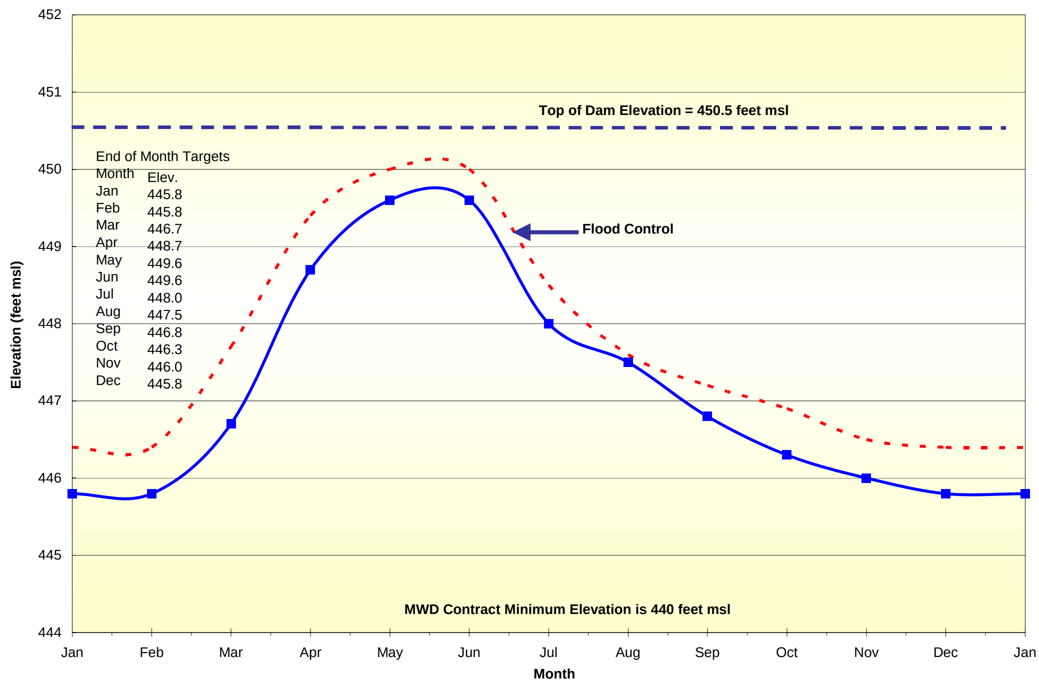
Lake Havasu generally reaches its maximum elevation in the spring and its minimum elevation in the winter. Reclamation generally lowers the lake elevation during the winter months to provide flood control storage space for runoff that results from large storms coming up river from Baja California, Mexico. The actual elevations will sometimes differ from the target elevations (Figure B-8) with the regulation of Hoover Dam and Parker Dam releases and the balancing of arriving flows with downstream water demands.

Figure B-8 illustrates the average, maximum, and minimum monthly elevations of Lake Havasu (elevations measured at midnight on last day of month) for the non-flood control years. The maximum average elevation of approximately 448.7 feet msl occurs in May and the minimum average elevation of about 446.0 feet msl occurs in February. The minimum target elevation for marina operators is 445.8 feet msl. Reclamation attempts to accommodate this minimum target elevation when other higher priority uses are not compromised. The maximum Lake Havasu elevation is 450.5 feet msl.

Table B-5
Lake Havasu Monthly Target Elevations

Month	Lake Havasu Target Elevations (feet msl)	Lake Havasu Target Storage (kaf)
January	445.8	539.1
February	445.8	539.1
March	446.7	557.4
April	448.7	593.6
May	449.6	611.4
June	449.6	611.4
July	448.0	580.0
August	447.5	561.1
September	446.8	557.4
October	446.3	548.2
November	446.0	542.7
December	445.8	539.1

Figure B-8
Lake Havasu Monthly Target Elevations



B.2.6 Parker Dam to Imperial Dam

Parker Dam is the last major dam on the lower Colorado River and provides the last opportunity for Reclamation to provide any significant regulation of river flows. Once released from Parker Dam, water flows relatively unregulated until it reaches Imperial Dam. The transit time between Parker Dam and Imperial Dam is approximately 3 days.

B.2.6.1 River Flows between Parker Dam and Imperial Dam

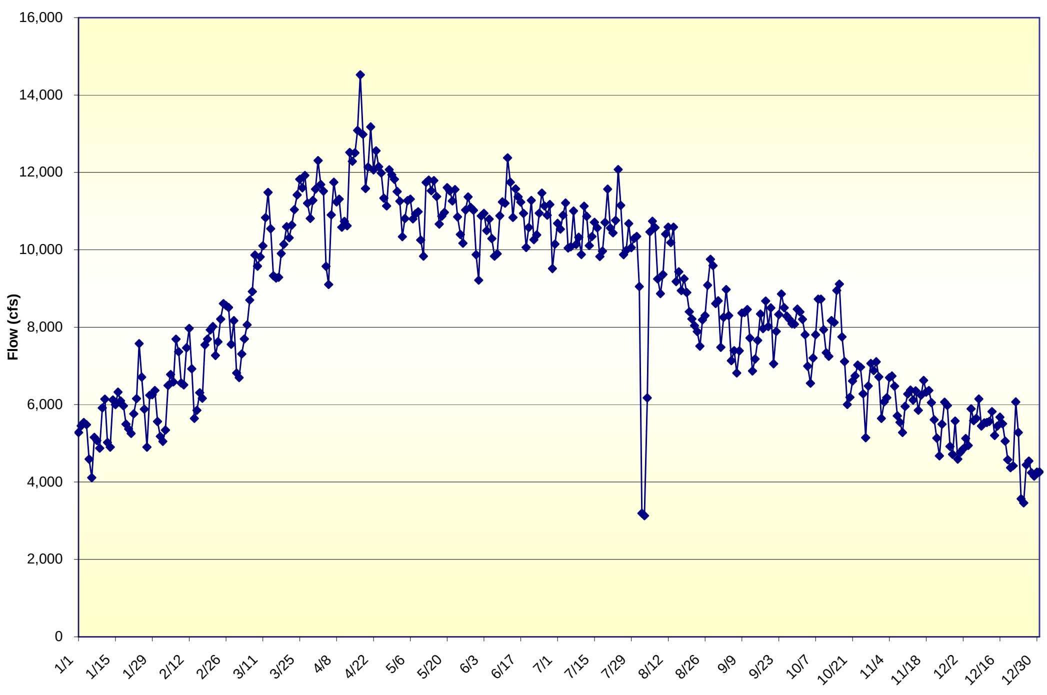
The flow of the Colorado River between Parker Dam and Imperial Dam is normally set at the amount needed to meet the United States consumptive use requirements downstream of Parker Dam plus deliveries to Mexico at the Morelos Diversion Dam. The scheduling and subsequent release of water through Parker Dam creates short-term fluctuations in river flows, depths, and elevations downstream of Parker Dam. These fluctuations of elevations in the Colorado River are most noticeable in the section of the river located immediately downstream of Parker Dam and lessen as the downstream distance increases.

Several features located downstream of Parker Dam are also used to manage the flows in the river and make deliveries to the Colorado River water users that divert water downstream of Parker Dam. These features include the Headgate Rock Dam, Palo Verde Diversion Dam, Senator Wash Dam, Imperial Dam, and Laguna Dam, as discussed in detail below.

Historical river flows since 1963 in this river reach have ranged between 30 cfs to 40,000 cfs. The higher flow rates have been associated with flood flows. An example of the daily fluctuation in flows in this river reach is illustrated on Figure B-9. Historical annual diversions since 1963 from this river reach have ranged between zero af and 152,496 af.

Future flows in this reach of the Colorado River are expected to be affected by the water transfers and exchanges between the California agricultural water agencies and MWD, which will change the point of diversion of some water deliveries. For example, under water transfer between Imperial Irrigation District (IID) and MWD (or San Diego County Water Authority [SDCWA]), the flow that would normally be diverted at Imperial Dam instead would be diverted upstream of Parker Dam. The existing and future California intrastate transfers are included in the simulations of the No Action Alternative and the action alternatives. The California intrastate transfers and any potential environmental effects that would occur as a result of those transfers were previously addressed in the *Implementation Agreement, Inadvertent Overrun and Payback Policy, and Related Federal Actions EIS* (Reclamation 2002).

Figure B-9
Variation of Daily Flows Arriving at Imperial Dam
(reported 1996 daily river flow measurements at Cibola Stream Gage, RM 87.3)



B.2.6.2 Operation of Headgate Rock Dam

Headgate Rock Dam was completed in 1941and forms Lake Moovalya which serves as a diversion dam for the Colorado River Indian Irrigation Project (CRIIP). The dam controls the elevation of a 16-mile stretch of the Colorado River that reaches almost to the tail water of Parker Dam less the diversion by the CRIIP. There is very little daily fluctuation in the elevations upstream of Headgate Rock Dam. Downstream elevations of Headgate Rock Dam reflect the releases from Parker Dam. Irrigation water is diverted from upstream of Parker Dam almost 12 months out of the year. When water is being diverted, the upstream elevation is kept at or around 364.4 feet msl. When water is not being diverted, the elevation of the upstream Lake Moovalya can be lowered by opening the spillway gates, and the elevation is kept at or around 363.4 feet msl and possibly lower, if needed.

When Headgate Rock Powerplant is operational, power is generated through up to three 6.5-megawatt turbine units depending on water release through Parker Dam. The power is used for irrigation projects, Bureau of Indian Affairs' (BIA) needs, power sales, and off-reservation exchanges.

CRIIP's main canal is 18 miles long and includes six major control or diversion structures, as well as minor delivery, drainage, and highway structures. CRIIP operates the diversion on a demand basis. Water users must place their order at least 48 hours in advance, and the irrigation office usually provides that water within 48 hours from the posted end-of-order time each day. Accumulated daily water orders are relayed to Headgate Rock Dam, so that gates on the dam and main canal intake structure are raised or lowered to divert the correct quantity into the irrigation system.

The CRIIP Irrigation Office prepares and submits an annual report that provides the annual projected water use to the River Operations Branch of Reclamation. This report estimates the monthly flow to be diverted for CRIIP use in the next crop year.

B.2.6.3 Operation of Palo Verde Diversion Dam

The Palo Verde Diversion Dam is the intake for the Palo Verde Irrigation District (PVID). Flows between the Palo Verde Diversion Dam and Imperial Dam are set by downstream demands and required deliveries to Mexico.

Palo Verde Diversion Dam is operated by PVID. The diversion dam maintains a constant elevation at the PVID canal intake during periods of normal riverflow. Except during periods of high river discharge, this forebay elevation is maintained at 283.5 feet msl.

B.2.6.4 Operation of Senator Wash Dam

Senator Wash Dam and Regulating Reservoir is located 20 miles northeast of the city of Yuma, Arizona, on the California side of the Colorado River and approximately two miles upstream of Imperial Dam. This strategic off-stream water storage reservoir was constructed by Reclamation to facilitate water scheduling and to help in balancing the river flows and supply with demands. This is achieved by storing part of the Colorado River flow when excess flows are available above Imperial Dam and releasing the water in storage back to the river for downstream use when needed.

Senator Wash Reservoir was designed to have a water surface area of about 470 acres at a maximum operating elevation of 251 feet msl. At this elevation, the design storage capacity is approximately 13,840 af. The reservoir has inactive (dead) storage below elevation 210 feet msl which has an estimated capacity of about 1,577 af. The design active storage is located between elevations 210 feet msl and 251 feet msl and is estimated to be about 12,259 af.

Current operational restrictions limit the use of the full storage capacity available at Senator Wash Reservoir. The operational restriction of Senator Wash Reservoir is associated with Safety of Dams concerns. Previous structural evaluation, studies of the dam, and related facilities have shown evidence of potential piping through and around the foundation of the dam (transportation of dam embankment foundation material caused by seepage that could lead to failure of the dam or dikes). There is a potential for failure of the foundation or embankment which could result from liquefaction during an earthquake. The maximum operating elevation of Senator Wash Reservoir was previously restricted to 235 feet msl with temporary incursions up to 240 feet msl. However, with the recent installation of a geomembrane liner along the bottom of a portion of the reservoir, the maximum unrestricted operating elevation has been raised to 240 feet msl.

B.2.7 Imperial Dam to NIB

This reach extends from Imperial Dam to the NIB between the United States and Mexico. The entire extent of the channel is bound by a system of levees. Several features located between Imperial Dam and the NIB are used to manage river flows and make deliveries to the Colorado River water users that divert water at and downstream of Imperial Dam. This includes Imperial Dam, Laguna Dam, Laguna Desilting Basin, Morelos Diversion Dam, California Wasteway, and Pilot Knob Wasteway. Other features include water conveyance system components (levees, bypass channels, wasteways, etc.), access roads, farmlands, and vegetation. Mittry Lake is also located on the Arizona side of the Colorado River.

The All-American Canal (AAC) system diverts water from the California side of Imperial Dam and serves IID, Coachella Valley Water District (CVWD), the Yuma Project in Arizona and California, and the City of Yuma.

The Gila Gravity Main Canal system diverts water from the Arizona side of Imperial Dam and serves the north and south Gila Valley, Yuma Mesa, and Wellton-Mohawk area. Imperial Dam is also used to regulate deliveries to Mexico.

The AAC Desilting Works, which is located adjacent to the AAC diversion structure, is used to remove most of the sediment carried by the Colorado River prior to the water entering the AAC. The Imperial National Wildlife Refuge (NWR) is located mostly on the Arizona side of the Colorado River. Martinez Lake is a small water cove formed by the impoundment and backwater area located above Imperial Dam.

B.2.7.1 Operation of Imperial Dam

Imperial Dam and the impoundment that it forms upstream of the dam is used to raise the elevation of the upstream river flows by approximately 25 feet to provide controlled gravity flow of water into the AAC and into the Gila Gravity Main Canal. Imperial Dam is situated on the Colorado River some 18 miles northeast of Yuma, Arizona.

The flows arriving at Imperial Dam normally range from a high of about 14,400 cfs (usually occurring in late spring to summer) to a low of about 2,500 cfs. The low flow period usually follows heavy rainfall in the area below Imperial Dam (usually November, December, and January). During these wet weather periods, the rain saturates the farm fields, and the farmers and respective water agencies adjust or cancel their water delivery orders. Mexico's water order is required to be delivered regardless of wet weather or excess rainfall conditions.

The reservoir created by Imperial Dam initially had a capacity of 83,000 af. This storage capacity was not considered a project feature and, as anticipated, the reservoir quickly filled with sediment. The reservoir capacity is now considered to be approximately 1,000 af and intermittent dredging is required to maintain the required diversion capacity at the AAC and the Gila Gravity Main Canal headworks.

The normal operating range of reservoir elevations for Imperial Dam is between 180 feet msl and 180.85 feet msl. However, if the amount of water arriving at Imperial Dam is less than the demands, and pulling water out of the Senator Wash Reservoir cannot keep the reservoir elevation of Imperial Dam from continuing to fall, diversions at elevations below 180.0 feet msl can be made to the AAC or the Gila Gravity Main Canal. Under certain conditions, it is possible to draw down reservoir elevations of Imperial Dam to as low as 178.5 feet msl.

Imperial Dam is operated primarily as a diversion dam, providing water to the AAC and the Gila Gravity Main Canal to meet the beneficial use requirements of entitlement holders in California and Arizona. Releases may also be made to meet a portion of the 1944 Treaty deliveries to Mexico. Occasionally (two to three times per month), water is released through the sluice gates at Imperial Dam to move accumulated sediment to the Laguna Desilting Basin which is located about two miles downstream from Imperial Dam. The Laguna Desilting Basin, located within the Colorado River channel, is used to decant the water that is released from or that passes Imperial Dam.

B.2.7.2 River Flows between Imperial Dam and NIB

The flows in the Colorado River below Imperial Dam are primarily comprised of water delivered to Mexico in accordance with the 1944 Treaty. Mexico's principal diversion is at Morelos Diversion Dam, which is located approximately nine miles southwest of Yuma, Arizona. Mexico owns, operates, and maintains Morelos Diversion Dam.

Much of the water that is delivered to Mexico at the NIB is diverted at Imperial Dam into the AAC where it is conveyed and then returned to the Colorado River through Siphon Drop and Pilot Knob Powerplants. A portion of the NIB deliveries remains in the river, passing through Imperial Dam and Laguna Dam to the Morelos Diversion Dam.

Under normal conditions and when there is no runoff from the Gila River, the delivery of scheduled water to Mexico at the NIB comes from two principal sources: 1) drainage return flows that occur downstream of Imperial Dam; and 2) the diversion of flows to Mexico from Imperial Dam. The drainage return flows are nearly constant throughout the year and from year to year and comprise both gravity and pumped drainage flows.

Water may be delivered to Mexico at the NIB via one or a combination of three routes. Figure B-10 presents a schematic that shows these routes. The following provides an explanation of these three flow routing methods:

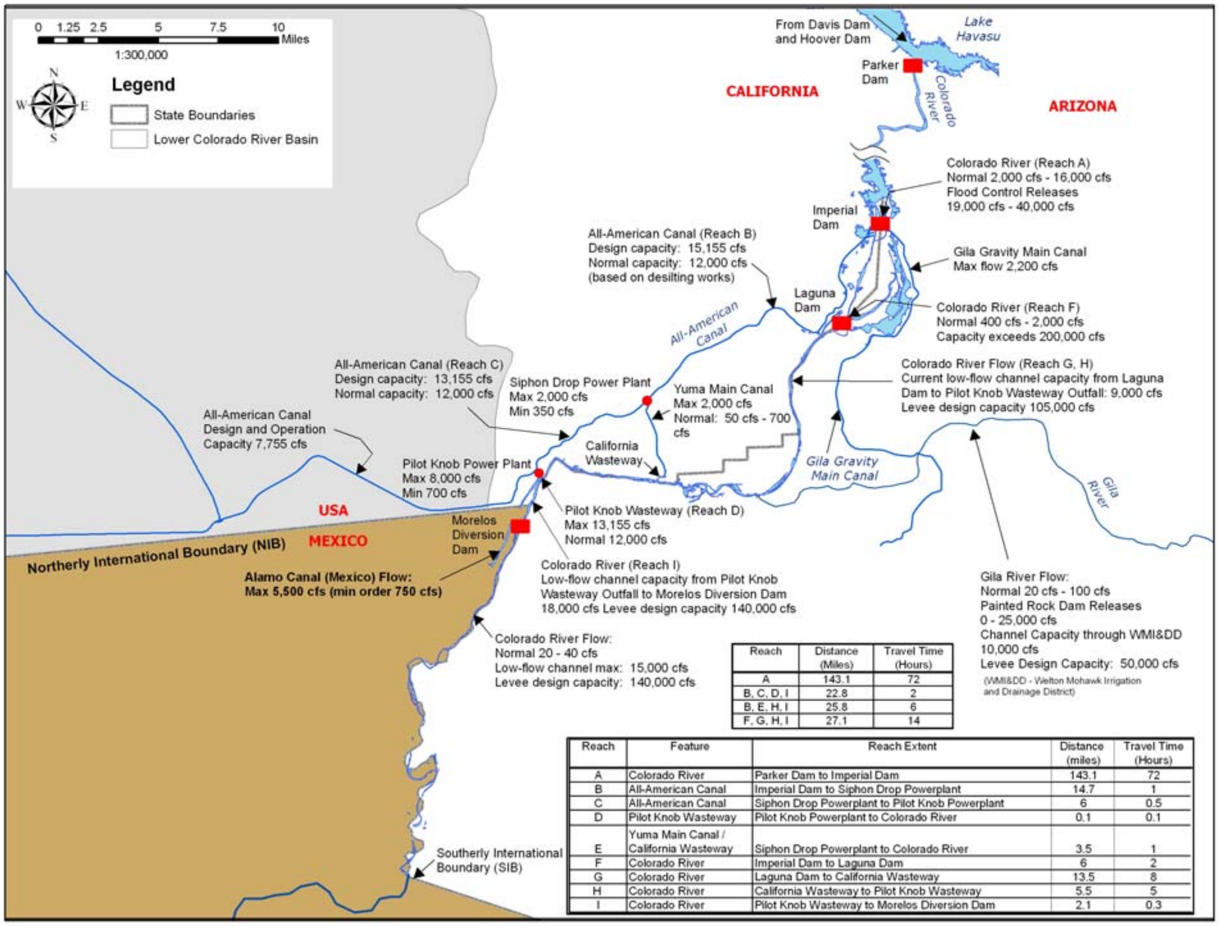
1) water scheduled to be delivered to Mexico is diverted at Imperial Dam, conveyed through the AAC to the Pilot Knob Check, and at a point above the Pilot Knob Check, the flows are diverted from the AAC through the Pilot Knob Power Plant and Wasteway back into the Colorado River. The Pilot Knob Wasteway channel discharges to the Colorado River at a point located approximately 2.1 miles upstream of the NIB;

2) water scheduled to be delivered to Mexico is diverted at Imperial Dam, conveyed through the AAC to the Siphon Drop, and at a point above the Siphon Drop, the flows are diverted from the AAC through the Siphon Drop Wasteway and into the Yuma Main Canal. The water is then conveyed some 3.5 miles within the Yuma Main Canal and then is diverted and discharged back into the Colorado River via the Yuma Main Canal Wasteway. The Yuma Main Canal Wasteway discharges to the Colorado River at a point located approximately 7.6 miles upstream of the NIB; or

3) water scheduled to be delivered to Mexico is delivered directly to the NIB via the Colorado River. Under this method, water is passed through Imperial Dam and Laguna Dam and is allowed to flow via the river channel to the NIB. These flows are in addition to the base flows in the riverbed downstream of Laguna Dam. The base flows are generally consistent throughout the year and result from gate leakage at Imperial Dam, returns to the river below Imperial Dam from the AAC Desilting Basin, and drainage flows from downstream sources. These base flows normally range from 600 cfs to 800 cfs.

Another intermittent water source that is available for delivery to Mexico at the NIB is Gila River. When releases from Painted Rock Dam occur, these flows are used to satisfy a portion of Mexico's delivery, depending on the amount of flow from the Gila River that enters the Colorado River upstream of the NIB.

Figure B-10
Water Routing from Imperial Dam to the NIB
Deliveries to Mexico Pursuant to 1944 Treaty



Reach	Distance (Miles)	Travel Time (Hours)
A	143.1	72
B, C, D, I	22.8	2
B, E, H, I	25.8	6
F, G, H, I	27.1	14

Reach	Feature	Reach Extent	Distance (miles)	Travel Time (Hours)
A	Colorado River	Parker Dam to Imperial Dam	143.1	72
B	All-American Canal	Imperial Dam to Siphon Drop Powerplant	14.7	1
C	All-American Canal	Siphon Drop Powerplant to Pilot Knob Powerplant	6	0.5
D	Pilot Knob Wasteway	Pilot Knob Powerplant to Colorado River	0.1	0.1
E	Yuma Main Canal / California Wasteway	Siphon Drop Powerplant to Colorado River	3.5	1
F	Colorado River	Imperial Dam to Laguna Dam	6	2
G	Colorado River	Laguna Dam to California Wasteway	13.5	8
H	Colorado River	California Wasteway to Pilot Knob Wasteway	5.5	5
I	Colorado River	Pilot Knob Wasteway to Morelos Diversion Dam	2.1	0.3

B.2.7.3 Operation of Laguna Dam

Laguna Dam is located on the Colorado River some 13 miles northeast of Yuma, Arizona, and about five miles downstream from Imperial Dam. The original purpose of this dam was to divert Colorado River water to the Yuma Project area. Laguna Dam now serves as a regulating structure for Colorado River water, for regulating sluicing flows from Imperial Dam, and for downstream toe protection for Imperial Dam. The reservoir created by Laguna Dam is commonly referred to as Laguna Reservoir.

Water can be stored in Laguna Reservoir between elevations 142 feet msl to 151.3 feet msl. The top of the overflow weir at Laguna Dam is at elevation

151.3 feet msl. A small amount of additional storage can be obtained by forcing water into surcharge above the weir. The current estimate of the available storage capacity at Laguna Reservoir, between elevation 142 feet msl and 151.3 feet msl, is about 400 af.

The flows that occur below Imperial Dam and that flow into the Colorado River channel and Laguna Reservoir typically range from about 250 cfs to 350 cfs and comprise principally the return flows from the AAC desilting basins and gate leakage from the California sluiceway gates at Imperial Dam. Occasionally, sluicing flows are released to remove sediment accumulated from the desilting basins in the sluiceway channel. These flows occur two to three times per month, may range from 8,000 cfs to 12,000 cfs, and the duration may be up to 20 minutes. These flows carry the sediment to the Laguna Desilting Basin located about two miles downstream of Imperial Dam.

Flow releases from Laguna Dam typically range between 300 and 500 cfs. Occasionally, flows up to 4,000 cfs or higher may occur coincident with or following heavy rainfall.

Laguna Dam is operated to regulate river flows and to temporarily store water used in sluicing operations at Imperial Dam. Any water that is captured and temporarily stored at Laguna Reservoir is released to meet a portion of the 1944 Treaty deliveries to Mexico.

B.2.7.4 Mittry Lake

Mittry Lake is located on the east side of the Colorado River between Laguna Dam and Imperial Dam. The Mittry Lake Wildlife Area generally surrounds and includes Mittry Lake and includes approximately 600 acres of water surface and 2,400 acres of marsh or upland habitat. Numerous serpentine waterways connect to the main lake body. The Mittry Lake Wildlife Area is jointly managed by the United States Bureau of Land Management, Reclamation, and the Arizona Game and Fish Department.

B.2.8 NIB to SIB

This reach extends from the NIB to the SIB between the United States and Mexico and is approximately 23.7 miles long. This section of the Colorado River serves as the international boundary between the United States and Mexico. This segment of the Colorado River has been highly altered and has levees on both sides.

Located approximately 1.1 miles downstream of the NIB is Morelos Diversion Dam. This dam functions as a diversion control structure for the Alamo Canal, which conveys water to Mexico. Morelos Diversion Dam and the limitrophe section of the Colorado River channel, including the floodplain, are designed to convey a maximum flow of 140,000 cfs. Other major features located within this reach include water conveyance system components (levee, bypass channel, wasteways, etc.), access roads, farmlands, and vegetation.

B.2.8.1 Operation of Morelos Diversion Dam

In accordance with the 1944 Treaty and Minute 242, up to 140,000 afy of Mexico’s treaty allocation of 1.5 mafy may be delivered at the SIB. Consequently, Mexico diverts the majority (approximately 1.36 mafy) of its 1944 Treaty allocation at Morelos Diversion Dam.

B.2.8.2 River Flows between Morelos Diversion Dam and the SIB

Flows in this reach of the Colorado River vary. At times the lower part of this reach is dry. Cohen and Henges-Jeck (2001) reported average total flows in this reach of 22,000 af in non-flood years and 2.12 maf in flood years.

The flows that are observed in this river reach typically are the result of seepage from Morelos Diversion Dam, flow releases from Morelos Diversion Dam (flood flows and excess water not diverted by Mexico), irrigation return flows from Mexico and canal wasteways in the United States, and groundwater accumulation from both the United States and Mexico.

The reach of the Colorado River between the NIB and the SIB is commonly referred to by Reclamation as the Limitrophe Reach. Reclamation's authority in this division is limited to maintaining the bankline road, the levee, various drains to the river, and the United States Bypass drain that carries agricultural drainage water to the Cienega de Santa Clara in Mexico. The United States Section of the International Boundary and Water Commission (USIBWC) is obligated to maintain the river channel within this division although Reclamation provides assistance to the USIBWC, when requested, for maintenance needs in this reach of the river.

Under current practice, Mexico is allowed to schedule up to an additional 200 kaf pursuant to the 1944 Treaty during flood control years when water supplies exceed those required for use in the United States. Often, the flood control releases are greater than the surplus uses in both the United States and Mexico and water in excess of Mexico's water schedule (termed excess flows) arrive at the NIB. Excess flows may also arrive at the NIB due to flooding on the Gila River and from operational activities upstream (i.e., cancelled water orders in the United States, maintenance activities, etc.). Mexico has the ability to divert the excess flows that arrive at Morelos Diversion Dam. Excess flows that are of magnitudes greater than what can be used by Mexico are passed through the Morelos Diversion Dam and flow through the Limitrophe Reach to the Colorado River Delta.

B.3 References

Bureau of Reclamation. 2002. *Final Environmental Impact Statement Implementation Agreement, Inadvertent Overrun and Payback Policy, and Related Federal Actions, Lower Colorado River and the States of Arizona, California, and Nevada*. Department of the Interior, Bureau of Reclamation, Lower Colorado Region, October.

Cohen and Henges-Jeck. 2001. *Missing Water, The Uses and Flows of Water in the Colorado River Delta*. Pacific Institute October 2001.

Appendix C

Upper Basin
States Depletion Schedules

This appendix consists of a table displaying the schedule of projected Colorado River system depletions for the Upper Basin states. These depletions were used to model the operation of the Colorado River system under the No Action Alternative and the action alternatives. Presented in the table are projected depletions of the Upper Division states (Colorado, Utah, Wyoming, and New Mexico), and Arizona's apportionment of water from the Upper Basin. The depletion schedules were developed by the Upper Basin states and compiled and submitted to Reclamation by the Upper Colorado River Commission in December 1999.

Table C-1
Upper Basin Depletion Schedule (kaf)

Calendar Year	Colorado	Utah	Wyoming	New Mexico	Arizona	Total Upper Basin
2008	2,517	940	512	529	45	4,543
2009	2,524	953	514	539	45	4,575
2010	2,580	1,009	517	548	50	4,704
2011	2,583	1,013	519	552	50	4,717
2012	2,586	1,017	520	557	50	4,729
2013	2,588	1,020	522	561	50	4,742
2014	2,591	1,024	524	565	50	4,754
2015	2,594	1,028	526	570	50	4,767
2016	2,597	1,032	527	573	50	4,779
2017	2,600	1,036	529	576	50	4,791
2018	2,603	1,041	531	579	50	4,804
2019	2,606	1,045	532	583	50	4,816
2020	2,626	1,055	535	589	50	4,855
2021	2,629	1,062	537	590	50	4,869
2022	2,633	1,069	540	591	50	4,883
2023	2,636	1,077	542	593	50	4,897
2024	2,639	1,084	544	594	50	4,911
2025	2,643	1,091	547	595	50	4,925
2026	2,646	1,099	549	597	50	4,940
2027	2,649	1,107	551	599	50	4,955
2028	2,652	1,114	553	600	50	4,971
2029	2,656	1,122	556	602	50	4,986
2030	2,675	1,129	571	604	50	5,029
2031	2,677	1,134	575	604	50	5,040
2032	2,679	1,139	580	604	50	5,052
2033	2,680	1,145	584	604	50	5,063
2034	2,682	1,150	588	604	50	5,075
2035	2,684	1,155	593	605	50	5,086
2036	2,686	1,160	597	605	50	5,097
2037	2,688	1,165	601	605	50	5,109
2038	2,689	1,171	605	605	50	5,120
2039	2,691	1,176	610	605	50	5,132
2040	2,703	1,177	615	605	50	5,150
2041	2,708	1,180	622	605	50	5,165
2042	2,712	1,184	629	605	50	5,180
2043	2,717	1,187	637	605	50	5,195
2044	2,721	1,190	644	605	50	5,210
2045	2,726	1,194	651	605	50	5,226
2046	2,731	1,197	658	605	50	5,241
2047	2,735	1,200	665	605	50	5,256
2048	2,740	1,203	673	605	50	5,271
2049	2,744	1,207	680	605	50	5,286
2050	2,776	1,207	687	605	50	5,325
2051	2,776	1,209	694	605	50	5,335
2052	2,777	1,212	701	605	50	5,344
2053	2,777	1,214	708	605	50	5,354
2054	2,777	1,216	715	605	50	5,363
2055	2,778	1,219	722	605	50	5,373
2056	2,778	1,221	729	605	50	5,383
2057	2,778	1,223	736	605	50	5,392
2058	2,778	1,225	743	605	50	5,402
2059	2,779	1,228	750	605	50	5,411
2060	2,784	1,230	760	605	50	5,429

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Appendix D

Lower Division States Depletion Schedules

This appendix contains schedules of projected Colorado River system depletions by the Lower Division states (Nevada, California, and Arizona). These schedules were used to model the operation of the Colorado River system under the No Action Alternative and the action alternatives. The schedules used to model depletions under Normal and Surplus conditions are included.

D.1 Normal Condition Depletion Schedules

The following schedules of projected Colorado River system depletions under Normal Conditions for the Lower Division states (Nevada, California, and Arizona) were used to model the operation of the Colorado River system under the No Action Alternative and the action alternatives. The depletion schedules were developed by the Lower Division states and submitted to Reclamation in 2006. Additionally, the Arizona Department of Water Resources provided updated depletion schedules for the Central Arizona Project (CAP) which included adjusted schedules for the CAP fourth priority entitlement holders in the summer of 2007. The Normal depletion schedules include:

Table Number	Depletion Schedule
D-1	Nevada
D-2a through D-2b	California
D-3a through D-3l	Arizona
D-4a through D-4d	Arizona CAP 2 M&I
D-5a through D-5b	Arizona CAP 2 Indian
D-6a through D-6b	Arizona CAP 3 NIA
D-7	Arizona CAP Summary

Tables D-1 through D-3 were used as input to the Colorado River Simulation System (CRSS), and Tables D-3 through D-7 were used as input to the Shortage Allocation Model. In some cases, slightly different schedules for Arizona on-river water users were used in CRSS and the Shortage Allocation Model. Further explanation is presented in Appendix G. Table D-3 consequently displays two columns for certain Arizona entitlement holders and the column heading indicates which schedule was used by which model. The sums of the depletions for each state do not include the columns denoted as used in the Shortage Allocation Model.

Table D-1
State of Nevada Users (af)

Calendar Year	Laughlin M&I	Mohave Steam Plant	Ft Mohave Ind. Res.	Moapa Valley WQIP	Lower Virgin WQIP	Uses Above Hoover Dam	Total State of Nevada
2008	4,000	16,000	9,000	0	0	271,000	300,000
2009	4,000	16,000	9,000	0	0	271,000	300,000
2010	4,000	16,000	9,000	0	0	271,000	300,000
2011	4,000	16,000	9,000	0	0	271,000	300,000
2012	4,000	16,000	9,000	0	0	271,000	300,000
2013	4,000	16,000	9,000	0	0	271,000	300,000
2014	4,000	16,000	9,000	0	0	271,000	300,000
2015	4,000	16,000	9,000	0	0	271,000	300,000
2016	4,000	16,000	9,000	0	0	271,000	300,000
2017	4,000	16,000	9,000	0	0	271,000	300,000
2018	4,000	16,000	9,000	0	0	271,000	300,000
2019	4,000	16,000	9,000	0	0	271,000	300,000
2020	4,000	16,000	9,000	0	0	271,000	300,000
2021	4,000	16,000	9,000	0	0	271,000	300,000
2022	4,000	16,000	9,000	0	0	271,000	300,000
2023	4,000	16,000	9,000	0	0	271,000	300,000
2024	4,000	16,000	9,000	0	0	271,000	300,000
2025	4,000	16,000	9,000	0	0	271,000	300,000
2026	4,000	8,000	9,000	0	0	279,000	300,000
2027	4,000	0	9,000	0	0	287,000	300,000
2028	4,000	0	9,000	0	0	287,000	300,000
2029	4,000	0	9,000	0	0	287,000	300,000
2030	4,000	0	9,000	0	0	287,000	300,000
2031	4,000	0	9,000	0	0	287,000	300,000
2032	4,000	0	9,000	0	0	287,000	300,000
2033	4,000	0	9,000	0	0	287,000	300,000
2034	4,000	0	9,000	0	0	287,000	300,000
2035	4,000	0	9,000	0	0	287,000	300,000
2036	4,000	0	9,000	0	0	287,000	300,000
2037	4,000	0	9,000	0	0	287,000	300,000
2038	4,000	0	9,000	0	0	287,000	300,000
2039	4,000	0	9,000	0	0	287,000	300,000
2040	4,000	0	9,000	0	0	287,000	300,000
2041	4,000	0	9,000	0	0	287,000	300,000
2042	4,000	0	9,000	0	0	287,000	300,000
2043	4,000	0	9,000	0	0	287,000	300,000
2044	4,000	0	9,000	0	0	287,000	300,000
2045	4,000	0	9,000	0	0	287,000	300,000
2046	4,000	0	9,000	0	0	287,000	300,000
2047	4,000	0	9,000	0	0	287,000	300,000
2048	4,000	0	9,000	0	0	287,000	300,000
2049	4,000	0	9,000	0	0	287,000	300,000
2050	4,000	0	9,000	0	0	287,000	300,000
2051	4,000	0	9,000	0	0	287,000	300,000
2052	4,000	0	9,000	0	0	287,000	300,000
2053	4,000	0	9,000	0	0	287,000	300,000
2054	4,000	0	9,000	0	0	287,000	300,000
2055	4,000	0	9,000	0	0	287,000	300,000
2056	4,000	0	9,000	0	0	287,000	300,000
2057	4,000	0	9,000	0	0	287,000	300,000
2058	4,000	0	9,000	0	0	287,000	300,000
2059	4,000	0	9,000	0	0	287,000	300,000
2060	4,000	0	9,000	0	0	287,000	300,000

Table D-2a
State of California Users (af)

Calendar Year	MWD	IID	CVWD	PVID	Ft. Mohave Ind. Res.	City Of Needles	Salton Sea	Havasu NWR	Chemehuevi Ind. Res.
2008	767,177	2,817,037	316,448	375,400	8,995	1,223	25,000	0	4,200
2009	739,777	2,812,800	364,000	374,200	8,995	1,223	30,000	0	4,600
2010	747,377	2,793,800	368,000	373,000	8,995	1,223	35,000	0	5,000
2011	752,777	2,774,800	372,000	371,600	8,995	1,223	40,000	0	5,600
2012	758,177	2,754,800	377,000	370,200	8,995	1,223	45,000	0	6,200
2013	763,577	2,714,800	382,000	368,800	8,995	1,223	70,000	0	6,800
2014	758,977	2,689,800	387,000	367,400	8,995	1,223	90,000	0	7,400
2015	754,377	2,664,800	392,000	366,000	8,995	1,223	110,000	0	8,000
2016	754,377	2,639,800	397,000	366,000	8,995	1,223	130,000	0	8,000
2017	754,377	2,615,800	401,000	366,000	8,995	1,223	150,000	0	8,000
2018	784,377	2,717,800	419,000	366,000	8,995	1,223	0	0	8,000
2019	814,377	2,682,800	424,000	366,000	8,995	1,223	0	0	8,000
2020	846,877	2,645,300	429,000	366,000	8,995	1,223	0	0	8,000
2021	859,377	2,627,800	434,000	366,000	8,995	1,223	0	0	8,000
2022	856,877	2,625,300	439,000	366,000	8,995	1,223	0	0	8,000
2023	854,377	2,622,800	444,000	366,000	8,995	1,223	0	0	8,000
2024	854,377	2,617,800	449,000	366,000	8,995	1,223	0	0	8,000
2025	854,377	2,612,800	454,000	366,000	8,995	1,223	0	0	8,000
2026	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2027	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2028	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2029	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2030	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2031	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2032	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2033	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2034	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2035	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2036	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2037	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2038	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2039	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2040	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2041	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2042	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2043	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2044	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2045	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2046	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2047	854,377	2,607,800	459,000	366,000	8,995	1,223	0	0	8,000
2048	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2049	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2050	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2051	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2052	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2053	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2054	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2055	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2056	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2057	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2058	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2059	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000
2060	854,377	2,610,800	456,000	366,000	8,995	1,223	0	0	8,000

Table D-2b
State of California Users (af)

Calendar Year	Others & Misc. PPRs	Imperial NWR	CO Riv. Ind. Res.	AAC Yuma Project Bard Unit	AAC Yuma Project Res. Unit Quechan	California Pumpers	Other Pumpers Below NIB	Total State of California
2008	1,605	0	15,000	18,000	26,600	0	0	4,376,685
2009	1,605	0	17,000	18,000	27,800	0	0	4,400,000
2010	1,605	0	19,000	18,000	29,000	0	0	4,400,000
2011	1,605	0	23,000	18,000	30,400	0	0	4,400,000
2012	1,605	0	27,000	18,000	31,800	0	0	4,400,000
2013	1,605	0	31,000	18,000	33,200	0	0	4,400,000
2014	1,605	0	35,000	18,000	34,600	0	0	4,400,000
2015	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2016	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2017	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2018	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2019	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2020	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2021	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2022	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2023	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2024	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2025	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2026	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2027	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2028	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2029	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2030	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2031	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2032	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2033	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2034	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2035	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2036	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2037	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2038	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2039	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2040	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2041	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2042	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2043	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2044	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2045	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2046	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2047	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2048	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2049	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2050	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2051	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2052	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2053	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2054	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2055	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2056	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2057	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2058	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2059	1,605	0	39,000	18,000	36,000	0	0	4,400,000
2060	1,605	0	39,000	18,000	36,000	0	0	4,400,000

Table D-3a
State of Arizona Users (af)

Calendar Year	CAP (CRSS)	CAP (Shortage Allocation Model)	Mohave Valley IDD (CRSS)	Mohave Valley IDD (Shortage Allocation Model)	Curtis, Armon (CRSS)	Curtis, Armon (Shortage Allocation Model)	Curtis Family Trust (CRSS)	Curtis Family Trust (Shortage Allocation Model)
2008	1,382,421.10	1,417,380	24,132	18,933.00	225.6	195	1,579.20	1,365.00
2009	1,368,604.80	1,403,743	24,233	18,933.00	226.8	195	1,587.60	1,365.00
2010	1,354,788.40	1,389,871	24,335	18,933.00	228	195	1,596.00	1,365.00
2011	1,344,368.00	1,375,999	24,434	18,933.00	228	195	1,596.00	1,365.00
2012	1,333,947.60	1,362,127	24,533	18,933.00	228	195	1,596.00	1,365.00
2013	1,323,527.20	1,351,091	24,632	18,933.00	228	195	1,596.00	1,365.00
2014	1,313,106.80	1,340,056	24,731	18,933.00	228	195	1,596.00	1,365.00
2015	1,302,686.40	1,329,021	24,830	18,933.00	228	195	1,596.00	1,365.00
2016	1,302,066.00	1,317,986	24,929	18,933.00	228	195	1,596.00	1,365.00
2017	1,301,445.60	1,306,951	25,028	18,933.00	228	195	1,596.00	1,365.00
2018	1,300,825.20	1,305,724	25,127	18,933.00	228	195	1,596.00	1,365.00
2019	1,300,204.80	1,304,575	25,226	18,933.00	228	195	1,596.00	1,365.00
2020	1,299,584.40	1,303,591	25,325	18,933.00	228	195	1,596.00	1,365.00
2021	1,298,606.20	1,302,606	25,390	18,933.00	229.5	195	1,606.50	1,365.00
2022	1,297,627.90	1,301,660	25,455	18,933.00	231	195	1,617.00	1,365.00
2023	1,296,649.70	1,301,015	25,520	18,933.00	232.5	195	1,627.50	1,365.00
2024	1,295,671.50	1,300,370	25,585	18,933.00	234	195	1,638.00	1,365.00
2025	1,294,693.80	1,299,725	25,650	18,933.00	235.5	195	1,648.50	1,365.00
2026	1,293,718.50	1,299,080	25,715	18,933.00	237	195	1,659.00	1,365.00
2027	1,292,743.20	1,298,435	25,780	18,933.00	238.5	195	1,669.50	1,365.00
2028	1,291,767.90	1,297,791	25,845	18,933.00	240	195	1,680.00	1,365.00
2029	1,290,792.60	1,297,146	25,910	18,933.00	241.5	195	1,690.50	1,365.00
2030	1,289,817.20	1,296,501	25,975	18,933.00	243	195	1,701.00	1,365.00
2031	1,288,748.80	1,295,856	26,008	18,933.00	243	195	1,701.00	1,365.00
2032	1,287,680.30	1,295,211	26,041	18,933.00	243	195	1,701.00	1,365.00
2033	1,286,611.80	1,294,299	26,074	18,933.00	243	195	1,701.00	1,365.00
2034	1,285,543.40	1,293,386	26,107	18,933.00	243	195	1,701.00	1,365.00
2035	1,284,474.90	1,292,474	26,140	18,933.00	243	195	1,701.00	1,365.00
2036	1,283,406.40	1,291,561	26,173	18,933.00	243	195	1,701.00	1,365.00
2037	1,282,338.00	1,290,649	26,206	18,933.00	243	195	1,701.00	1,365.00
2038	1,281,269.50	1,289,737	26,239	18,933.00	243	195	1,701.00	1,365.00
2039	1,280,201.00	1,288,824	26,272	18,933.00	243	195	1,701.00	1,365.00
2040	1,279,132.50	1,287,912	26,305	18,933.00	243	195	1,701.00	1,365.00
2041	1,278,593.20	1,287,000	26,344	18,933.00	243	195	1,701.00	1,365.00
2042	1,278,053.90	1,286,087	26,382	18,933.00	243	195	1,701.00	1,365.00
2043	1,277,514.50	1,285,762	26,421	18,933.00	243	195	1,701.00	1,365.00
2044	1,276,975.20	1,285,436	26,460	18,933.00	243	195	1,701.00	1,365.00
2045	1,276,435.80	1,285,111	26,499	18,933.00	243	195	1,701.00	1,365.00
2046	1,275,896.50	1,284,786	26,537	18,933.00	243	195	1,701.00	1,365.00
2047	1,275,357.20	1,284,460	26,576	18,933.00	243	195	1,701.00	1,365.00
2048	1,274,817.80	1,284,135	26,615	18,933.00	243	195	1,701.00	1,365.00
2049	1,274,278.50	1,283,810	26,653	18,933.00	243	195	1,701.00	1,365.00
2050	1,273,739.10	1,283,484	26,692	18,933.00	243	195	1,701.00	1,365.00
2051	1,273,490.20	1,283,159	26,692	18,933.00	243	195	1,701.00	1,365.00
2052	1,273,241.30	1,282,834	26,692	18,933.00	243	195	1,701.00	1,365.00
2053	1,272,992.40	1,282,585	26,692	18,933.00	243	195	1,701.00	1,365.00
2054	1,272,743.50	1,282,336	26,692	18,933.00	243	195	1,701.00	1,365.00
2055	1,272,494.60	1,282,087	26,692	18,933.00	243	195	1,701.00	1,365.00
2056	1,272,245.70	1,281,838	26,692	18,933.00	243	195	1,701.00	1,365.00
2057	1,271,996.80	1,281,750	26,692	18,933.00	243	195	1,701.00	1,365.00
2058	1,271,747.90	1,281,750	26,692	18,933.00	243	195	1,701.00	1,365.00
2059	1,271,499.00	1,281,750	26,692	18,933.00	243	195	1,701.00	1,365.00
2060	1,271,250.10	1,281,750	26,692	18,933.00	243	195	1,701.00	1,365.00

Table D-3b
State of Arizona Users (af)

Calendar Year	Jessen Family LTD (CRSS)	Jessen Family LTD (Shortage Allocation Model)	Ogram Boys Enterprises (CRSS)	Ogram Boys Enterprises (Shortage Allocation Model)	Ogram (CRSS)	Ogram (Shortage Allocation Model)	Peach, John (CRSS)	Peach, John (Shortage Allocation Model)
2008	1,080.00	702.00	694.6	601	361.2	312	437.4	296
2009	1,080.00	702.00	698.3	601	363.1	312	439.7	296
2010	1,080.00	702.00	702	601	365	312	442	296
2011	1,080.00	702.00	702	601	365	312	442	296
2012	1,080.00	702.00	702	601	365	312	442	296
2013	1,080.00	702.00	702	601	365	312	442	296
2014	1,080.00	702.00	702	601	365	312	442	296
2015	1,080.00	702.00	702	601	365	312	442	296
2016	1,080.00	702.00	702	601	365	312	442	296
2017	1,080.00	702.00	702	601	365	312	442	296
2018	1,080.00	702.00	702	601	365	312	442	296
2019	1,080.00	702.00	702	601	365	312	442	296
2020	1,080.00	702.00	702	601	365	312	442	296
2021	1,080.00	702.00	706.6	601	367.4	312	444.9	296
2022	1,080.00	702.00	711.2	601	369.8	312	447.8	296
2023	1,080.00	702.00	715.8	601	372.2	312	450.7	296
2024	1,080.00	702.00	720.4	601	374.6	312	453.6	296
2025	1,080.00	702.00	725	601	377	312	456	296
2026	1,080.00	702.00	729.6	601	379.4	312	456	296
2027	1,080.00	702.00	734.2	601	381.8	312	456	296
2028	1,080.00	702.00	738.8	601	384.2	312	456	296
2029	1,080.00	702.00	743.4	601	386.6	312	456	296
2030	1,080.00	702.00	748	601	389	312	456	296
2031	1,080.00	702.00	748	601	389	312	456	296
2032	1,080.00	702.00	748	601	389	312	456	296
2033	1,080.00	702.00	748	601	389	312	456	296
2034	1,080.00	702.00	748	601	389	312	456	296
2035	1,080.00	702.00	748	601	389	312	456	296
2036	1,080.00	702.00	748	601	389	312	456	296
2037	1,080.00	702.00	748	601	389	312	456	296
2038	1,080.00	702.00	748	601	389	312	456	296
2039	1,080.00	702.00	748	601	389	312	456	296
2040	1,080.00	702.00	748	601	389	312	456	296
2041	1,080.00	702.00	748	601	389	312	456	296
2042	1,080.00	702.00	748	601	389	312	456	296
2043	1,080.00	702.00	748	601	389	312	456	296
2044	1,080.00	702.00	748	601	389	312	456	296
2045	1,080.00	702.00	748	601	389	312	456	296
2046	1,080.00	702.00	748	601	389	312	456	296
2047	1,080.00	702.00	748	601	389	312	456	296
2048	1,080.00	702.00	748	601	389	312	456	296
2049	1,080.00	702.00	748	601	389	312	456	296
2050	1,080.00	702.00	748	601	389	312	456	296
2051	1,080.00	702.00	748	601	389	312	456	296
2052	1,080.00	702.00	748	601	389	312	456	296
2053	1,080.00	702.00	748	601	389	312	456	296
2054	1,080.00	702.00	748	601	389	312	456	296
2055	1,080.00	702.00	748	601	389	312	456	296
2056	1,080.00	702.00	748	601	389	312	456	296
2057	1,080.00	702.00	748	601	389	312	456	296
2058	1,080.00	702.00	748	601	389	312	456	296
2059	1,080.00	702.00	748	601	389	312	456	296
2060	1,080.00	702.00	748	601	389	312	456	296

Table D-3c
State of Arizona Users (af)

Calendar Year	Phillips, Milton & Jean (CRSS)	Phillips, Milton & Jean (Shortage Allocation Model)	Beattie Farms Southwest	Pasquinelli, Gary & Barbara (CRSS)	Pasquinelli, Gary & Barbara (Shortage Allocation Model)	Edward, Roy P.	Somerton (CRSS)	Somerton (Shortage Allocation Model)
2008	18	12	721.5	383.8	316	1	495	488
2009	18	12	721.5	385.9	316	1	495	488
2010	18	12	721.5	388	316	1	495	488
2011	18	12	721.5	388	316	1	495	488
2012	18	12	721.5	388	316	1	495	488
2013	18	12	721.5	388	316	1	495	488
2014	18	12	721.5	388	316	1	495	488
2015	18	12	721.5	388	316	1	495	488
2016	18	12	721.5	388	316	1	495	488
2017	18	12	721.5	388	316	1	495	488
2018	18	12	721.5	388	316	1	495	488
2019	18	12	721.5	388	316	1	495	488
2020	18	12	721.5	388	316	1	495	488
2021	18	12	721.5	390.5	316	1	495	488
2022	18	12	721.5	393	316	1	495	488
2023	18	12	721.5	395.5	316	1	495	488
2024	18	12	721.5	398	316	1	495	488
2025	18	12	721.5	400.5	316	1	495	488
2026	18	12	721.5	403	316	1	495	488
2027	18	12	721.5	405.5	316	1	495	488
2028	18	12	721.5	408	316	1	495	488
2029	18	12	721.5	410.5	316	1	495	488
2030	18	12	721.5	413	316	1	495	488
2031	18	12	721.5	413	316	1	495	488
2032	18	12	721.5	413	316	1	495	488
2033	18	12	721.5	413	316	1	495	488
2034	18	12	721.5	413	316	1	495	488
2035	18	12	721.5	413	316	1	495	488
2036	18	12	721.5	413	316	1	495	488
2037	18	12	721.5	413	316	1	495	488
2038	18	12	721.5	413	316	1	495	488
2039	18	12	721.5	413	316	1	495	488
2040	18	12	721.5	413	316	1	495	488
2041	18	12	721.5	413	316	1	495	488
2042	18	12	721.5	413	316	1	495	488
2043	18	12	721.5	413	316	1	495	488
2044	18	12	721.5	413	316	1	495	488
2045	18	12	721.5	413	316	1	495	488
2046	18	12	721.5	413	316	1	495	488
2047	18	12	721.5	413	316	1	495	488
2048	18	12	721.5	413	316	1	495	488
2049	18	12	721.5	413	316	1	495	488
2050	18	12	721.5	413	316	1	495	488
2051	18	12	721.5	413	316	1	495	488
2052	18	12	721.5	413	316	1	495	488
2053	18	12	721.5	413	316	1	495	488
2054	18	12	721.5	413	316	1	495	488
2055	18	12	721.5	413	316	1	495	488
2056	18	12	721.5	413	316	1	495	488
2057	18	12	721.5	413	316	1	495	488
2058	18	12	721.5	413	316	1	495	488
2059	18	12	721.5	413	316	1	495	488
2060	18	12	721.5	413	316	1	495	488

Table D-3d
State of Arizona Users (af)

Calendar Year	AZ State Land Dept Ag. (CRSS)	AZ State Land Dept Ag. (Shortage Allocation Model)	Smucker Park	Cocopah Ind. Res.	Hopi Tribe	North Baja LLC (CRSS)	North Baja LLC (Shortage Allocation Model)	Rayner Ranches (CRSS)
2008	5,230.60	4,294.00	0	9,137.20	3,833.90	361.2	377	3,380.00
2009	5,263.80	4,294.00	0	9,137.20	3,833.90	363.1	377	3,395.00
2010	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2011	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2012	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2013	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2014	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2015	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2016	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2017	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2018	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2019	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2020	5,297.00	4,294.00	0	9,137.20	3,833.90	365	377	3,410.00
2021	5,327.30	4,294.00	0	9,137.20	3,833.90	367.4	377	3,431.30
2022	5,357.60	4,294.00	0	9,137.20	3,833.90	369.8	377	3,452.60
2023	5,387.90	4,294.00	0	9,137.20	3,833.90	372.2	377	3,473.90
2024	5,418.20	4,294.00	0	9,137.20	3,833.90	374.6	377	3,495.20
2025	5,448.50	4,294.00	0	9,137.20	3,833.90	377	377	3,516.50
2026	5,478.80	4,294.00	0	9,137.20	3,833.90	379.4	377	3,537.80
2027	5,509.10	4,294.00	0	9,137.20	3,833.90	381.8	377	3,559.10
2028	5,539.40	4,294.00	0	9,137.20	3,833.90	384.2	377	3,580.40
2029	5,569.70	4,294.00	0	9,137.20	3,833.90	386.6	377	3,601.70
2030	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2031	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2032	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2033	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2034	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2035	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2036	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2037	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2038	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2039	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2040	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2041	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2042	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2043	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2044	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2045	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2046	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2047	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2048	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2049	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2050	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2051	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2052	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2053	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2054	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2055	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2056	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2057	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2058	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2059	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00
2060	5,600.00	4,294.00	0	9,137.20	3,833.90	389	377	3,623.00

Table D-3e
State of Arizona Users (af)

Calendar Year	Rayner Ranches (Shortage Allocation Model)	Brooke Water LLC (CRSS)	Brooke Water LLC (Shortage Allocaton Model)	Ehrenberg Impr. Assn (CRSS)	Ehrenberg Impr. Assn (Shortage Allocation Model)	Fisher Landing (CRSS)	Fisher Landing (Shortage Allocation Model)	Martinez Lake Sites
2008	2,924.00	291.2	294	325.8	358	34.5	34	15
2009	2,924.00	293.1	294	331.4	358	34.5	34	15
2010	2,924.00	295	294	337	358	34.5	34	15
2011	2,924.00	297.2	294	343	358	34.5	34	15
2012	2,924.00	299.4	294	349	358	34.5	34	15
2013	2,924.00	301.6	294	355	358	34.5	34	15
2014	2,924.00	303.8	294	361	358	34.5	34	15
2015	2,924.00	306	294	367	358	34.5	34	15
2016	2,924.00	308.2	294	373	358	34.5	34	15
2017	2,924.00	310.4	294	379	358	34.5	34	15
2018	2,924.00	312.6	294	385	358	34.5	34	15
2019	2,924.00	314.8	294	391	358	34.5	34	15
2020	2,924.00	317	294	397	358	34.5	34	15
2021	2,924.00	317.4	294	402.1	358	34.5	34	15
2022	2,924.00	317.8	294	407.2	358	34.5	34	15
2023	2,924.00	318.2	294	412.3	358	34.5	34	15
2024	2,924.00	318.6	294	417.4	358	34.5	34	15
2025	2,924.00	319	294	422.5	358	34.5	34	15
2026	2,924.00	319.4	294	427.6	358	34.5	34	15
2027	2,924.00	319.8	294	432.7	358	34.5	34	15
2028	2,924.00	320.2	294	437.8	358	34.5	34	15
2029	2,924.00	320.6	294	442.9	358	34.5	34	15
2030	2,924.00	321	294	448	358	34.5	34	15
2031	2,924.00	321.3	294	448	358	34.5	34	15
2032	2,924.00	321.6	294	448	358	34.5	34	15
2033	2,924.00	321.9	294	448	358	34.5	34	15
2034	2,924.00	322.2	294	448	358	34.5	34	15
2035	2,924.00	322.5	294	448	358	34.5	34	15
2036	2,924.00	322.8	294	448	358	34.5	34	15
2037	2,924.00	323.1	294	448	358	34.5	34	15
2038	2,924.00	323.4	294	448	358	34.5	34	15
2039	2,924.00	323.7	294	448	358	34.5	34	15
2040	2,924.00	324	294	448	358	34.5	34	15
2041	2,924.00	324.2	294	448	358	34.5	34	15
2042	2,924.00	324.4	294	448	358	34.5	34	15
2043	2,924.00	324.6	294	448	358	34.5	34	15
2044	2,924.00	324.8	294	448	358	34.5	34	15
2045	2,924.00	325	294	448	358	34.5	34	15
2046	2,924.00	325.2	294	448	358	34.5	34	15
2047	2,924.00	325.4	294	448	358	34.5	34	15
2048	2,924.00	325.6	294	448	358	34.5	34	15
2049	2,924.00	325.8	294	448	358	34.5	34	15
2050	2,924.00	326	294	448	358	34.5	34	15
2051	2,924.00	326	294	448	358	34.5	34	15
2052	2,924.00	326	294	448	358	34.5	34	15
2053	2,924.00	326	294	448	358	34.5	34	15
2054	2,924.00	326	294	448	358	34.5	34	15
2055	2,924.00	326	294	448	358	34.5	34	15
2056	2,924.00	326	294	448	358	34.5	34	15
2057	2,924.00	326	294	448	358	34.5	34	15
2058	2,924.00	326	294	448	358	34.5	34	15
2059	2,924.00	326	294	448	358	34.5	34	15
2060	2,924.00	326	294	448	358	34.5	34	15

Table D-3f
State of Arizona Users (af)

Calendar Year	Hillcrest Water Co	Quartzsite	Shepard Water Co.	Verizon	Cibola Valley IDD	Mohave County WA (CRSS)	Mohave County WA (Shortage Allocation Model - includes recommend)	Mohave Water Cons. Dist. (includes MCWA subcontract)
2008	24.9	287.6	32.5	1	7,752.20	3,833.90	4,068.40	499.8
2009	25.7	299.3	32.5	1	7,752.20	3,833.90	4,302.90	513
2010	26.4	311	32.5	1	7,752.20	3,833.90	4,537.40	526.2
2011	27.8	325	32.5	1	7,752.20	3,833.90	4,771.90	539.9
2012	29.2	339	32.5	1	7,752.20	3,833.90	5,006.40	553.5
2013	30.7	353	32.5	1	7,752.20	3,833.90	5,240.90	567.2
2014	32.1	367	32.5	1	7,752.20	3,833.90	5,475.40	580.9
2015	33.5	381	32.5	1	7,752.20	3,833.90	5,709.90	594.6
2016	35	395	32.5	1	7,752.20	3,833.90	5,944.40	608.3
2017	36.4	409	32.5	1	7,752.20	3,833.90	6,108.90	621.9
2018	37.8	423	32.5	1	7,752.20	3,833.90	6,108.90	635.6
2019	39.2	437	32.5	1	7,752.20	3,833.90	6,108.90	649.3
2020	40.7	451	32.5	1	7,752.20	3,833.90	6,108.90	663
2021	41.3	457.9	32.5	1	7,752.20	3,833.90	6,108.90	671.8
2022	41.9	464.8	32.5	1	7,752.20	3,833.90	6,108.90	680.5
2023	42.6	471.7	32.5	1	7,752.20	3,833.90	6,108.90	689.3
2024	43.2	478.6	32.5	1	7,752.20	3,833.90	6,108.90	698.1
2025	43.8	485.5	32.5	1	7,752.20	3,833.90	6,108.90	706.9
2026	44.5	492.4	32.5	1	7,752.20	3,833.90	6,108.90	715.7
2027	45.1	499.3	32.5	1	7,752.20	3,833.90	6,108.90	724.4
2028	45.7	506.2	32.5	1	7,752.20	3,833.90	6,108.90	733.2
2029	46.4	513.1	32.5	1	7,752.20	3,833.90	6,108.90	742
2030	47	520	32.5	1	7,752.20	3,833.90	6,108.90	750.8
2031	47.1	522.4	32.5	1	7,752.20	3,833.90	6,108.90	754.5
2032	47.1	524.8	32.5	1	7,752.20	3,833.90	6,108.90	758.2
2033	47.2	527.2	32.5	1	7,752.20	3,833.90	6,108.90	761.9
2034	47.3	529.6	32.5	1	7,752.20	3,833.90	6,108.90	765.6
2035	47.4	532	32.5	1	7,752.20	3,833.90	6,108.90	769.3
2036	47.5	534.4	32.5	1	7,752.20	3,833.90	6,108.90	772.9
2037	47.5	536.8	32.5	1	7,752.20	3,833.90	6,108.90	776.6
2038	47.6	539.2	32.5	1	7,752.20	3,833.90	6,108.90	780.3
2039	47.7	541.6	32.5	1	7,752.20	3,833.90	6,108.90	784
2040	47.8	544	32.5	1	7,752.20	3,833.90	6,108.90	787.7
2041	47.9	545.2	32.5	1	7,752.20	3,833.90	6,108.90	792.4
2042	48	546.4	32.5	1	7,752.20	3,833.90	6,108.90	797.2
2043	48.1	547.6	32.5	1	7,752.20	3,833.90	6,108.90	801.9
2044	48.2	548.8	32.5	1	7,752.20	3,833.90	6,108.90	806.6
2045	48.3	550	32.5	1	7,752.20	3,833.90	6,108.90	811.3
2046	48.5	551.2	32.5	1	7,752.20	3,833.90	6,108.90	816.1
2047	48.6	552.4	32.5	1	7,752.20	3,833.90	6,108.90	820.8
2048	48.7	553.6	32.5	1	7,752.20	3,833.90	6,108.90	825.5
2049	48.8	554.8	32.5	1	7,752.20	3,833.90	6,108.90	830.2
2050	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835
2051	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835
2052	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835
2053	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835
2054	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835
2055	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835
2056	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835
2057	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835
2058	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835
2059	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835
2060	48.9	556	32.5	1	7,752.20	3,833.90	6,108.90	835

Table D-3g
State of Arizona Users (af)

Calendar Year	AZ American Water Co.	AZ State Land Dept. M&I	AZ State Parks Contact Point	AZ State Parks Windsor Beach	Bullhead City (includes MCWA subcontract)	Bureau Land Mgmt	Crystal Beach WCD	Gold Dome Mining Co.
2008	289.4	290	13	20.2	7,012.20	850.9	60	0
2009	290.7	295	13	20.2	7,197.10	850.9	61	0
2010	292	300	13	20.2	7,382.00	850.9	62	0
2011	293.2	333	13	20.2	7,573.90	850.9	63	0
2012	294.4	366	13	20.2	7,765.80	850.9	64	0
2013	295.6	399	13	20.2	7,957.70	850.9	65	0
2014	296.8	432	13	20.2	8,149.60	850.9	66	0
2015	298	465	13	20.2	8,341.50	850.9	67	0
2016	299.2	498	13	20.2	8,533.40	850.9	68	0
2017	300.4	531	13	20.2	8,725.30	850.9	69	0
2018	301.6	564	13	20.2	8,917.20	850.9	70	0
2019	302.8	597	13	20.2	9,109.10	850.9	71	0
2020	304	630	13	20.2	9,301.00	850.9	72	0
2021	304.7	639	13	20.2	9,424.20	850.9	72.6	0
2022	305.4	648	13	20.2	9,547.40	850.9	73.2	0
2023	306.1	657	13	20.2	9,670.60	850.9	73.8	0
2024	306.8	666	13	20.2	9,793.80	850.9	74.4	0
2025	307.5	675	13	20.2	9,917.00	850.9	75	0
2026	308.2	684	13	20.2	10,040.20	850.9	75.6	0
2027	308.9	693	13	20.2	10,163.40	850.9	76.2	0
2028	309.6	702	13	20.2	10,286.60	850.9	76.8	0
2029	310.3	711	13	20.2	10,409.80	850.9	77.4	0
2030	311	720	13	20.2	10,533.00	850.9	78	0
2031	311.2	726	13	20.2	10,584.80	850.9	78.3	0
2032	311.4	732	13	20.2	10,636.60	850.9	78.6	0
2033	311.6	738	13	20.2	10,688.40	850.9	78.9	0
2034	311.8	744	13	20.2	10,740.20	850.9	79.2	0
2035	312	750	13	20.2	10,792.00	850.9	79.5	0
2036	312.2	756	13	20.2	10,843.80	850.9	79.8	0
2037	312.4	762	13	20.2	10,895.60	850.9	80.1	0
2038	312.6	768	13	20.2	10,947.40	850.9	80.4	0
2039	312.8	774	13	20.2	10,999.20	850.9	80.7	0
2040	313	780	13	20.2	11,051.00	850.9	81	0
2041	313.5	780	13	20.2	11,117.30	850.9	81.1	0
2042	314	780	13	20.2	11,183.60	850.9	81.2	0
2043	314.5	780	13	20.2	11,249.90	850.9	81.3	0
2044	315	780	13	20.2	11,316.20	850.9	81.4	0
2045	315.5	780	13	20.2	11,382.50	850.9	81.5	0
2046	316	780	13	20.2	11,448.80	850.9	81.6	0
2047	316.5	780	13	20.2	11,515.10	850.9	81.7	0
2048	317	780	13	20.2	11,581.40	850.9	81.8	0
2049	317.5	780	13	20.2	11,647.70	850.9	81.9	0
2050	318	780	13	20.2	11,714.00	850.9	82	0
2051	318	780	13	20.2	11,714.00	850.9	82	0
2052	318	780	13	20.2	11,714.00	850.9	82	0
2053	318	780	13	20.2	11,714.00	850.9	82	0
2054	318	780	13	20.2	11,714.00	850.9	82	0
2055	318	780	13	20.2	11,714.00	850.9	82	0
2056	318	780	13	20.2	11,714.00	850.9	82	0
2057	318	780	13	20.2	11,714.00	850.9	82	0
2058	318	780	13	20.2	11,714.00	850.9	82	0
2059	318	780	13	20.2	11,714.00	850.9	82	0
2060	318	780	13	20.2	11,714.00	850.9	82	0

Table D-3h
State of Arizona Users (af)

Calendar Year	Gold Standard Mines Corp.	Golden Shores WCD	Lake Havasu City (CRSS - includes MCWA subcontract)	Lake Havasu City (Shortage Allocation Model - includes MCWA subcontract)	McAlister, Maurice L.	Unallocated Priority 4	Marble Canyon Company	Lake Mead NRA
2008	0	428.8	12,322.40	12,322.40	3.9	0	15.6	738
2009	0	437.9	12,975.70	12,975.70	3.9	0	15.6	738
2010	0	447	13,629.00	13,629.00	3.9	0	15.6	738
2011	0	455.7	13,831.00	13,831.00	3.9	0	15.6	738
2012	0	464.4	14,033.00	14,033.00	3.9	0	15.6	738
2013	0	473.1	14,235.00	14,235.00	3.9	0	15.6	738
2014	0	481.8	14,437.00	14,437.00	3.9	0	15.6	738
2015	0	490.5	14,639.00	14,639.00	3.9	0	15.6	738
2016	0	499.2	14,841.00	14,841.00	3.9	0	15.6	738
2017	0	507.9	15,043.00	15,043.00	3.9	0	15.6	738
2018	0	516.6	15,245.00	15,245.00	3.9	0	15.6	738
2019	0	525.3	15,447.00	15,447.00	3.9	0	15.6	738
2020	0	534	15,649.00	15,611.00	3.9	0	15.6	738
2021	0	536.9	15,826.20	15,611.00	3.9	0	15.6	738
2022	0	539.8	16,003.40	15,611.00	3.9	0	15.6	738
2023	0	542.7	16,180.60	15,611.00	3.9	0	15.6	738
2024	0	545.6	16,357.80	15,611.00	3.9	0	15.6	738
2025	0	548.5	16,535.00	15,611.00	3.9	0	15.6	738
2026	0	551.4	16,712.20	15,611.00	3.9	0	15.6	738
2027	0	554.3	16,889.40	15,611.00	3.9	0	15.6	738
2028	0	557.2	17,066.60	15,611.00	3.9	0	15.6	738
2029	0	560.1	17,243.80	15,611.00	3.9	0	15.6	738
2030	0	563	17,421.00	15,611.00	3.9	0	15.6	738
2031	0	565.9	17,542.90	15,611.00	3.9	248.9	15.6	738
2032	0	568.8	17,664.80	15,611.00	3.9	497.8	15.6	738
2033	0	571.7	17,786.70	15,611.00	3.9	746.7	15.6	738
2034	0	574.6	17,908.60	15,611.00	3.9	995.6	15.6	738
2035	0	577.5	18,030.50	15,611.00	3.9	1,244.50	15.6	738
2036	0	580.4	18,152.40	15,611.00	3.9	1,493.40	15.6	738
2037	0	583.3	18,274.30	15,611.00	3.9	1,742.30	15.6	738
2038	0	586.2	18,396.20	15,611.00	3.9	1,991.20	15.6	738
2039	0	589.1	18,518.10	15,611.00	3.9	2,240.10	15.6	738
2040	0	592	18,640.00	15,611.00	3.9	2,489.00	15.6	738
2041	0	595.5	18,813.80	15,611.00	3.9	2,737.90	15.6	738
2042	0	599	18,987.60	15,611.00	3.9	2,986.80	15.6	738
2043	0	602.5	19,161.40	15,611.00	3.9	3,235.70	15.6	738
2044	0	606	19,335.20	15,611.00	3.9	3,484.60	15.6	738
2045	0	609.5	19,509.00	15,611.00	3.9	3,733.50	15.6	738
2046	0	613	19,682.80	15,611.00	3.9	3,982.40	15.6	738
2047	0	616.5	19,856.60	15,611.00	3.9	4,231.30	15.6	738
2048	0	620	20,030.40	15,611.00	3.9	4,480.20	15.6	738
2049	0	623.5	20,204.20	15,611.00	3.9	4,729.10	15.6	738
2050	0	627	20,378.00	15,611.00	3.9	4,978.00	15.6	738
2051	0	627	20,378.00	15,611.00	3.9	5,226.90	15.6	738
2052	0	627	20,378.00	15,611.00	3.9	5,475.80	15.6	738
2053	0	627	20,378.00	15,611.00	3.9	5,724.70	15.6	738
2054	0	627	20,378.00	15,611.00	3.9	5,973.60	15.6	738
2055	0	627	20,378.00	15,611.00	3.9	6,222.50	15.6	738
2056	0	627	20,378.00	15,611.00	3.9	6,471.40	15.6	738
2057	0	627	20,378.00	15,611.00	3.9	6,720.30	15.6	738
2058	0	627	20,378.00	15,611.00	3.9	6,969.20	15.6	738
2059	0	627	20,378.00	15,611.00	3.9	7,218.10	15.6	738
2060	0	627	20,378.00	15,611.00	3.9	7,467.00	15.6	738

Table D-3i
State of Arizona Users (af)

Calendar Year	Imperial NWR	Cibola NWR	Ak-Chin Ind. Comm.	SRPMIC	Havasu NWR	Lower CO River Dam Project	Army Yuma Proving Ground	Navy Marine Corps Yuma Air Station
2008	3,618	7,655	50,000	22,000	4,841	1	760	2,129
2009	3,618	8,080	50,000	22,000	4,841	1	760	2,129
2010	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2011	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2012	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2013	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2014	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2015	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2016	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2017	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2018	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2019	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2020	3,618	8,505	50,000	22,000	4,841	1	760	2,129
2021	3,618	9,356	50,000	22,000	4,841	1	760	2,129
2022	3,618	10,206	50,000	22,000	4,841	1	760	2,129
2023	3,618	11,057	50,000	22,000	4,841	1	760	2,129
2024	3,618	11,907	50,000	22,000	4,841	1	760	2,129
2025	3,618	12,758	50,000	22,000	4,841	1	760	2,129
2026	3,618	13,608	50,000	22,000	4,841	1	760	2,129
2027	3,618	14,459	50,000	22,000	4,841	1	760	2,129
2028	3,618	15,309	50,000	22,000	4,841	1	760	2,129
2029	3,618	16,160	50,000	22,000	4,841	1	760	2,129
2030	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2031	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2032	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2033	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2034	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2035	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2036	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2037	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2038	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2039	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2040	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2041	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2042	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2043	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2044	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2045	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2046	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2047	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2048	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2049	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2050	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2051	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2052	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2053	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2054	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2055	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2056	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2057	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2058	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2059	3,618	17,010	50,000	22,000	4,841	1	760	2,129
2060	3,618	17,010	50,000	22,000	4,841	1	760	2,129

Table D-3j
State of Arizona Users (af)

Calendar Year	Univ. Of Arizona	Yuma Mesa Fruit Growers Assn	Yuma Union High School	Yuma Cemetery	City Of Yuma	Yuma Irr. Dist.	Unit B IDD	Yuma Mesa IDD
2008	840	12	117	0	25,761	32,648	19,990	159,815
2009	840	12	117	0	26,240	32,754	19,882	159,585
2010	840	12	117	0	26,718	32,860	19,773	159,354
2011	840	12	117	0	27,236	32,860	19,773	159,354
2012	840	12	117	0	27,753	32,860	19,773	159,354
2013	840	12	117	0	28,271	32,860	19,773	159,354
2014	840	12	117	0	28,788	32,860	19,773	159,354
2015	840	12	117	0	29,306	32,860	19,773	159,354
2016	840	12	117	0	29,823	32,860	19,773	159,354
2017	840	12	117	0	30,341	32,860	19,773	159,354
2018	840	12	117	0	30,858	32,860	19,773	159,354
2019	840	12	117	0	31,376	32,860	19,773	159,354
2020	840	12	117	0	31,893	32,860	19,773	159,354
2021	840	12	117	0	32,463	32,966	19,686	159,047
2022	840	12	117	0	33,034	33,072	19,599	158,739
2023	840	12	117	0	33,604	33,178	19,512	158,432
2024	840	12	117	0	34,175	33,284	19,425	158,124
2025	840	12	117	0	34,745	33,390	19,339	157,817
2026	840	12	117	0	35,315	33,496	19,252	157,510
2027	840	12	117	0	35,886	33,602	19,165	157,202
2028	840	12	117	0	36,456	33,708	19,078	156,895
2029	840	12	117	0	37,027	33,814	18,991	156,587
2030	840	12	117	0	37,597	33,920	18,904	156,280
2031	840	12	117	0	38,193	33,920	18,904	156,280
2032	840	12	117	0	38,789	33,920	18,904	156,280
2033	840	12	117	0	39,385	33,920	18,904	156,280
2034	840	12	117	0	39,981	33,920	18,904	156,280
2035	840	12	117	0	40,578	33,920	18,904	156,280
2036	840	12	117	0	41,174	33,920	18,904	156,280
2037	840	12	117	0	41,770	33,920	18,904	156,280
2038	840	12	117	0	42,366	33,920	18,904	156,280
2039	840	12	117	0	42,962	33,920	18,904	156,280
2040	840	12	117	0	43,558	33,920	18,904	156,280
2041	840	12	117	0	43,558	33,920	18,904	156,280
2042	840	12	117	0	43,558	33,920	18,904	156,280
2043	840	12	117	0	43,558	33,920	18,904	156,280
2044	840	12	117	0	43,558	33,920	18,904	156,280
2045	840	12	117	0	43,558	33,920	18,904	156,280
2046	840	12	117	0	43,558	33,920	18,904	156,280
2047	840	12	117	0	43,558	33,920	18,904	156,280
2048	840	12	117	0	43,558	33,920	18,904	156,280
2049	840	12	117	0	43,558	33,920	18,904	156,280
2050	840	12	117	0	43,558	33,920	18,904	156,280
2051	840	12	117	0	43,558	33,920	18,904	156,280
2052	840	12	117	0	43,558	33,920	18,904	156,280
2053	840	12	117	0	43,558	33,920	18,904	156,280
2054	840	12	117	0	43,558	33,920	18,904	156,280
2055	840	12	117	0	43,558	33,920	18,904	156,280
2056	840	12	117	0	43,558	33,920	18,904	156,280
2057	840	12	117	0	43,558	33,920	18,904	156,280
2058	840	12	117	0	43,558	33,920	18,904	156,280
2059	840	12	117	0	43,558	33,920	18,904	156,280
2060	840	12	117	0	43,558	33,920	18,904	156,280

Table D-3k
State of Arizona Users (af)

Calendar Year	Wellton Mohawk IDD	Kaman Inc.	Gila Monster Farms (CRSS)	Gila Monster Farms (Shortage Allocation Model)	Desert Lawn Memorial Park	Alec, Camille	Union Pacific Co.	Ft Mohave Ind. Res.
2008	277,997	0	5,270	5,155	155	60	29	67,800
2009	277,997	0	5,270	5,155	155	60	29	70,400
2010	277,997	0	5,270	5,155	155	60	29	73,000
2011	277,997	0	5,270	5,155	155	60	29	73,000
2012	277,997	0	5,270	5,155	155	60	29	73,000
2013	277,997	0	5,270	5,155	155	60	29	73,000
2014	277,997	0	5,270	5,155	155	60	29	73,000
2015	277,997	0	5,270	5,155	155	60	29	73,000
2016	277,997	0	5,270	5,155	155	60	29	73,000
2017	277,997	0	5,270	5,155	155	60	29	73,000
2018	277,997	0	5,270	5,155	155	60	29	73,000
2019	277,997	0	5,270	5,155	155	60	29	73,000
2020	277,997	0	5,270	5,155	155	60	29	73,000
2021	277,997	0	5,270	5,155	155	60	29	73,000
2022	277,997	0	5,270	5,155	155	60	29	73,000
2023	277,997	0	5,270	5,155	155	60	29	73,000
2024	277,997	0	5,270	5,155	155	60	29	73,000
2025	277,997	0	5,270	5,155	155	60	29	73,000
2026	277,997	0	5,270	5,155	155	60	29	73,000
2027	277,997	0	5,270	5,155	155	60	29	73,000
2028	277,997	0	5,270	5,155	155	60	29	73,000
2029	277,997	0	5,270	5,155	155	60	29	73,000
2030	277,997	0	5,270	5,155	155	60	29	73,000
2031	277,997	0	5,270	5,155	155	60	29	73,000
2032	277,997	0	5,270	5,155	155	60	29	73,000
2033	277,997	0	5,270	5,155	155	60	29	73,000
2034	277,997	0	5,270	5,155	155	60	29	73,000
2035	277,997	0	5,270	5,155	155	60	29	73,000
2036	277,997	0	5,270	5,155	155	60	29	73,000
2037	277,997	0	5,270	5,155	155	60	29	73,000
2038	277,997	0	5,270	5,155	155	60	29	73,000
2039	277,997	0	5,270	5,155	155	60	29	73,000
2040	277,997	0	5,270	5,155	155	60	29	73,000
2041	277,997	0	5,270	5,155	155	60	29	73,000
2042	277,997	0	5,270	5,155	155	60	29	73,000
2043	277,997	0	5,270	5,155	155	60	29	73,000
2044	277,997	0	5,270	5,155	155	60	29	73,000
2045	277,997	0	5,270	5,155	155	60	29	73,000
2046	277,997	0	5,270	5,155	155	60	29	73,000
2047	277,997	0	5,270	5,155	155	60	29	73,000
2048	277,997	0	5,270	5,155	155	60	29	73,000
2049	277,997	0	5,270	5,155	155	60	29	73,000
2050	277,997	0	5,270	5,155	155	60	29	73,000
2051	277,997	0	5,270	5,155	155	60	29	73,000
2052	277,997	0	5,270	5,155	155	60	29	73,000
2053	277,997	0	5,270	5,155	155	60	29	73,000
2054	277,997	0	5,270	5,155	155	60	29	73,000
2055	277,997	0	5,270	5,155	155	60	29	73,000
2056	277,997	0	5,270	5,155	155	60	29	73,000
2057	277,997	0	5,270	5,155	155	60	29	73,000
2058	277,997	0	5,270	5,155	155	60	29	73,000
2059	277,997	0	5,270	5,155	155	60	29	73,000
2060	277,997	0	5,270	5,155	155	60	29	73,000

Table D-3l
State of Arizona Users (af)

Calendar Year	Ft Yuma Res.	CO Riv. Ind. Res.	Mohave Valley IDD	Parker	North Gila Valley IDD	Yuma County WUA	Powers	Molina	Total State of Arizona[1]
2008	1,178	395,200	3,208	684	19,761	228,211	624	0	2,800,000
2009	1,178	404,600	3,208	693	19,761	228,290	624	0	2,800,000
2010	1,178	414,000	3,208	701	19,761	228,368	624	0	2,800,000
2011	1,178	423,800	3,208	717	19,761	228,368	624	0	2,800,000
2012	1,178	433,600	3,208	734	19,761	228,368	624	0	2,800,000
2013	1,178	443,400	3,208	750	19,761	228,368	624	0	2,800,000
2014	1,178	453,200	3,208	766	19,761	228,368	624	0	2,800,000
2015	1,178	463,000	3,208	783	19,761	228,368	624	0	2,800,000
2016	1,178	463,000	3,208	799	19,761	228,368	624	0	2,800,000
2017	1,178	463,000	3,208	815	19,761	228,368	624	0	2,800,000
2018	1,178	463,000	3,208	831	19,761	228,368	624	0	2,800,000
2019	1,178	463,000	3,208	848	19,761	228,368	624	0	2,800,000
2020	1,178	463,000	3,208	864	19,761	228,368	624	0	2,800,000
2021	1,178	463,000	3,208	871	19,827	227,662	624	0	2,800,000
2022	1,178	463,000	3,208	878	19,893	226,955	624	0	2,800,000
2023	1,178	463,000	3,208	886	19,959	226,249	624	0	2,800,000
2024	1,178	463,000	3,208	893	20,025	225,543	624	0	2,800,000
2025	1,178	463,000	3,208	900	20,091	224,837	624	0	2,800,000
2026	1,178	463,000	3,208	907	20,156	224,130	624	0	2,800,000
2027	1,178	463,000	3,208	914	20,222	223,424	624	0	2,800,000
2028	1,178	463,000	3,208	922	20,288	222,718	624	0	2,800,000
2029	1,178	463,000	3,208	929	20,354	222,011	624	0	2,800,000
2030	1,178	463,000	3,208	936	20,420	221,305	624	0	2,800,000
2031	1,178	463,000	3,208	937	20,420	221,305	624	0	2,800,000
2032	1,178	463,000	3,208	938	20,420	221,305	624	0	2,800,000
2033	1,178	463,000	3,208	939	20,420	221,305	624	0	2,800,000
2034	1,178	463,000	3,208	940	20,420	221,305	624	0	2,800,000
2035	1,178	463,000	3,208	941	20,420	221,305	624	0	2,800,000
2036	1,178	463,000	3,208	941	20,420	221,305	624	0	2,800,000
2037	1,178	463,000	3,208	942	20,420	221,305	624	0	2,800,000
2038	1,178	463,000	3,208	943	20,420	221,305	624	0	2,800,000
2039	1,178	463,000	3,208	944	20,420	221,305	624	0	2,800,000
2040	1,178	463,000	3,208	945	20,420	221,305	624	0	2,800,000
2041	1,178	463,000	3,208	946	20,420	221,305	624	0	2,800,000
2042	1,178	463,000	3,208	948	20,420	221,305	624	0	2,800,000
2043	1,178	463,000	3,208	949	20,420	221,305	624	0	2,800,000
2044	1,178	463,000	3,208	950	20,420	221,305	624	0	2,800,000
2045	1,178	463,000	3,208	952	20,420	221,305	624	0	2,800,000
2046	1,178	463,000	3,208	953	20,420	221,305	624	0	2,800,000
2047	1,178	463,000	3,208	954	20,420	221,305	624	0	2,800,000
2048	1,178	463,000	3,208	955	20,420	221,305	624	0	2,800,000
2049	1,178	463,000	3,208	957	20,420	221,305	624	0	2,800,000
2050	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000
2051	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000
2052	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000
2053	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000
2054	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000
2055	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000
2056	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000
2057	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000
2058	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000
2059	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000
2060	1,178	463,000	3,208	958	20,420	221,305	624	0	2,800,000

1. Sum does not include the columns denoted as used by the Shortage Allocation Model.

Table D-4a
State of Arizona CAP 2: M&I Schedules (af)

CAP M&I Schedules	2008	2009	2010	2011	2012	2013	2014
Apache Junction - Arizona Water Company	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Arizona-American Water Company - Agua Fria	10,900	11,093	11,093	11,093	11,093	11,093	11,093
Arizona-American Water Company - Paradise Valley	3,231	3,231	3,231	3,231	3,231	3,231	3,231
Arizona-American Water Company - Sun City	4,189	4,189	4,189	4,189	4,189	4,189	4,189
Arizona-American Water Company - Sun City West	2,372	2,372	2,372	2,372	2,372	2,372	2,372
Arizona State Land Department	700	700	700	700	700	700	700
ASARCO - Hayden/Ray Mine	0	0	0	0	0	0	0
Avondale, City of	4,746	4,746	4,746	4,746	4,746	4,746	4,746
Avra Water Corporation	0	0	0	0	0	0	0
Berneil Water Company	0	0	0	0	0	0	0
Buckeye, Town of	0	0	0	0	0	0	0
Carefree, Town of	400	400	400	400	400	400	400
Casa Grande - Arizona Water Company	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Cave Creek Water Company	1,598	1,648	1,698	1,748	1,798	1,848	1,898
Central Arizona Groundwater Replenishment District	7,746	7,746	7,746	7,746	7,746	7,746	7,746
Chandler, City of	5,305	6,592	7,880	8,289	8,654	8,654	8,654
Chandler Heights Citrus Irrigation District	0	0	0	0	0	0	0
Chaparral City Water Company	4,761	4,838	4,915	5,018	5,120	5,223	5,325
Circle City Water Company	0	0	0	0	0	0	0
Coolidge - Arizona Water Company	0	0	0	0	0	0	0
Community Water Company of Green Valley	0	0	0	0	0	0	0
El Mirage, City of	0	0	0	0	0	0	0
Eloy, City of	2,171	2,171	2,171	2,171	2,171	2,171	2,171
Florence, Town of	2,048	2,048	2,048	2,048	2,048	2,048	2,048
Flowing Wells Irrigation District	0	0	0	0	0	0	0
Gilbert, Town of	7,235	7,235	7,235	7,235	7,235	7,235	7,235
Glendale, City of	14,183	14,183	14,183	14,183	14,183	14,183	14,183
Goodyear, City of	10,742	10,742	10,742	10,742	10,742	10,742	10,742
Green Valley Water Company	500	500	500	500	500	500	500
H20 Water Company, Inc.	0	0	0	0	0	0	0
Marana, Town of	0	0	0	0	0	0	0
Maricopa County Parks	630	630	630	635	635	635	640
Mesa, City of	20,872	21,794	22,716	23,761	24,807	25,853	26,898
Metropolitan Domestic Water Improvement District	10,101	10,152	10,204	10,263	10,321	10,379	10,438
Oro Valley, Town of	0	0	9,541	9,668	9,795	9,922	10,049
Peoria, City of	7,401	7,992	8,583	10,081	11,580	13,078	14,577
Phelps-Dodge Miami	0	0	0	0	0	0	0
Phoenix, City of	117,715	121,416	125,129	131,441	134,120	134,120	134,120
Phoenix Memorial Park	0	0	0	0	0	0	0
Pine Water Company	0	0	0	0	0	0	0
Queen Creek Water Company	348	348	348	348	348	348	348
Rio Verde Utilities, Inc.	812	812	812	812	812	812	812
San Carlos Apache M & I	0	0	0	0	0	0	0
San Tan Irrigation District	0	0	0	0	0	0	0
Scottsdale, City of	46,460	47,724	48,989	50,353	51,718	52,810	52,810
Spanish Trail Water Company	0	0	0	0	0	0	0
Superior - Arizona Water Company	0	0	0	0	0	0	0
Surprise, City of	4,606	5,061	5,516	6,049	6,582	7,115	7,648
Tempe, City of	4,315	4,315	4,315	4,315	4,315	4,315	4,315
Tonto Hills Utility Company	0	0	0	0	0	0	0
Tucson, City of	83,750	90,000	96,250	102,500	109,100	116,096	123,512
Vail Water Company	0	0	0	0	0	0	0
Valley Utility Water Company, Inc.	0	0	0	0	0	0	0
Water Utilities Community Facilities District	50	50	50	50	50	50	50
Water Utility of Greater Buckeye, Inc.	0	0	0	0	0	0	0
Water Utility of Greater Tonopah, Inc.	0	0	0	0	0	0	0
White Tanks - Arizona Water Company	968	968	968	968	968	968	968
CAP M&I Total	388,855	403,697	427,899	445,655	460,078	471,581	482,417

Table D-4b
State of Arizona CAP 2: M&I Schedules (af)

CAP M&I Schedules	2015	2016	2017	2018	2019	2020	2021
Apache Junction - Arizona Water Company	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Arizona-American Water Company - Agua Fria	11,093	11,093	11,093	11,093	11,093	11,093	11,093
Arizona-American Water Company - Paradise Valley	3,231	3,231	3,231	3,231	3,231	3,231	3,231
Arizona-American Water Company - Sun City	4,189	4,189	4,189	4,189	4,189	4,189	4,189
Arizona-American Water Company - Sun City West	2,372	2,372	2,372	2,372	2,372	2,372	2,372
Arizona State Land Department	700	700	700	700	700	1,911	3,122
ASARCO - Hayden/Ray Mine	0	0	0	0	0	1,313	2,625
Avondale, City of	4,746	4,746	4,746	4,746	4,746	4,788	4,830
Avra Water Corporation	0	0	0	0	0	51	101
Berneil Water Company	0	0	0	0	0	13	25
Buckeye, Town of	0	0	0	0	0	2	3
Carefree, Town of	400	400	400	400	400	456	513
Casa Grande - Arizona Water Company	2,000	2,000	2,000	2,000	2,000	2,430	2,861
Cave Creek Water Company	1,948	1,998	2,048	2,098	2,148	2,198	2,248
Central Arizona Groundwater Replenishment District	7,746	7,746	7,746	7,746	7,746	7,746	7,746
Chandler, City of	8,654	8,654	8,654	8,654	8,654	8,654	8,654
Chandler Heights Citrus Irrigation District	0	0	0	0	0	20	39
Chaparral City Water Company	5,428	5,566	5,705	5,844	5,982	6,121	6,306
Circle City Water Company	0	0	0	0	0	246	492
Coolidge - Arizona Water Company	0	0	0	0	0	125	250
Community Water Company of Green Valley	0	0	0	0	0	179	357
El Mirage, City of	0	0	0	0	0	32	64
Eloy, City of	2,171	2,171	2,171	2,171	2,171	2,171	2,171
Florence, Town of	2,048	2,048	2,048	2,048	2,048	2,048	2,048
Flowing Wells Irrigation District	0	0	0	0	0	272	544
Gilbert, Town of	7,235	7,235	7,235	7,235	7,235	7,235	7,235
Glendale, City of	14,183	14,183	14,183	14,183	14,183	14,374	14,565
Goodyear, City of	10,742	10,742	10,742	10,742	10,742	10,742	10,742
Green Valley Water Company	500	500	500	500	500	588	675
H20 Water Company, Inc.	0	0	0	0	0	9	18
Marana, Town of	0	0	0	0	0	3	6
Maricopa County Parks	640	640	645	645	645	650	650
Mesa, City of	27,944	28,987	30,029	31,072	32,115	33,787	34,433
Metropolitan Domestic Water Improvement District	10,496	10,555	10,613	10,671	10,730	10,901	11,071
Oro Valley, Town of	10,176	10,303	10,305	10,305	10,305	10,305	10,305
Peoria, City of	16,075	17,571	19,067	20,564	22,060	23,556	25,236
Phelps-Dodge Miami	0	0	0	0	0	182	363
Phoenix, City of	134,120	134,120	134,120	134,120	134,120	134,120	134,120
Phoenix Memorial Park	0	0	0	0	0	5	11
Pine Water Company	0	0	0	0	0	10	20
Queen Creek Water Company	348	348	348	348	348	348	348
Rio Verde Utilities, Inc.	812	812	812	812	812	812	812
San Carlos Apache M & I	0	0	0	0	0	1,134	2,268
San Tan Irrigation District	0	0	0	0	0	15	30
Scottsdale, City of	52,810	52,810	52,810	52,810	52,810	52,810	52,810
Spanish Trail Water Company	0	0	0	0	0	190	380
Superior - Arizona Water Company	0	0	0	0	0	18	36
Surprise, City of	8,181	9,908	10,249	10,249	10,249	10,249	10,249
Tempe, City of	4,315	4,315	4,315	4,315	4,315	4,315	4,315
Tonto Hills Utility Company	0	0	0	0	0	4	9
Tucson, City of	131,372	134,450	142,672	142,672	142,672	142,766	142,860
Vail Water Company	0	0	0	0	0	116	232
Valley Utility Water Company, Inc.	0	0	0	0	0	16	31
Water Utilities Community Facilities District	50	50	50	50	50	229	409
Water Utility of Greater Buckeye, Inc.	0	0	0	0	0	3	5
Water Utility of Greater Tonopah, Inc.	0	0	0	0	0	4	8
White Tanks - Arizona Water Company	968	968	968	968	968	968	968
CAP M&I Total	493,693	501,412	512,767	515,553	518,339	528,121	537,102

Table D-4c
State of Arizona CAP 2: M&I Schedules (af)

CAP M&I Schedules	2022	2023	2024	2025	2026	2027	2028
Apache Junction - Arizona Water Company	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Arizona-American Water Company - Agua Fria	11,093	11,093	11,093	11,093	11,093	11,093	11,093
Arizona-American Water Company - Paradise Valley	3,231	3,231	3,231	3,231	3,231	3,231	3,231
Arizona-American Water Company - Sun City	4,189	4,189	4,189	4,189	4,189	4,189	4,189
Arizona-American Water Company - Sun City West	2,372	2,372	2,372	2,372	2,372	2,372	2,372
Arizona State Land Department	4,333	5,544	6,755	7,966	9,177	10,388	11,599
ASARCO - Hayden/Ray Mine	3,938	5,250	6,563	7,875	9,188	10,500	11,813
Avondale, City of	4,872	4,914	4,955	4,997	5,039	5,081	5,123
Avra Water Corporation	152	202	253	303	354	404	455
Berneil Water Company	38	50	63	75	88	100	113
Buckeye, Town of	5	6	8	9	11	13	14
Carefree, Town of	569	625	681	738	794	850	906
Casa Grande - Arizona Water Company	3,291	3,721	4,151	4,582	5,012	5,442	5,872
Cave Creek Water Company	2,298	2,348	2,398	2,406	2,406	2,406	2,406
Central Arizona Groundwater Replenishment District	7,746	7,746	7,746	7,746	7,746	7,746	7,746
Chandler, City of	8,654	8,654	8,654	8,654	8,654	8,654	8,654
Chandler Heights Citrus Irrigation District	59	79	98	118	138	158	177
Chaparral City Water Company	6,492	6,677	6,863	7,048	7,235	7,421	7,606
Circle City Water Company	737	983	1,229	1,475	1,720	1,966	2,212
Coolidge - Arizona Water Company	375	500	625	750	875	1,000	1,125
Community Water Company of Green Valley	536	715	893	1,072	1,250	1,429	1,608
El Mirage, City of	95	127	159	191	222	254	286
Eloy, City of	2,171	2,171	2,171	2,171	2,171	2,171	2,171
Florence, Town of	2,048	2,048	2,048	2,048	2,048	2,048	2,048
Flowing Wells Irrigation District	816	1,089	1,361	1,633	1,905	2,177	2,449
Gilbert, Town of	7,235	7,235	7,235	7,235	7,235	7,235	7,235
Glendale, City of	14,755	14,946	15,137	15,328	15,519	15,710	15,900
Goodyear, City of	10,742	10,742	10,742	10,742	10,742	10,742	10,742
Green Valley Water Company	763	850	938	1,025	1,113	1,200	1,288
H20 Water Company, Inc.	28	37	46	55	64	74	83
Marana, Town of	9	12	15	18	21	24	26
Maricopa County Parks	650	655	655	655	660	660	660
Mesa, City of	35,080	35,726	36,372	37,018	37,678	38,338	38,999
Metropolitan Domestic Water Improvement District	11,242	11,412	11,583	11,754	11,924	12,095	12,265
Oro Valley, Town of	10,305	10,305	10,305	10,305	10,305	10,305	10,305
Peoria, City of	25,236	25,236	25,236	25,236	25,236	25,236	25,236
Phelps-Dodge Miami	545	727	908	1,090	1,271	1,453	1,635
Phoenix, City of	134,120	134,120	134,120	134,120	134,120	134,120	134,120
Phoenix Memorial Park	16	21	26	32	37	42	47
Pine Water Company	30	40	50	60	70	81	91
Queen Creek Water Company	348	348	348	348	348	348	348
Rio Verde Utilities, Inc.	812	812	812	812	812	812	812
San Carlos Apache M & I	3,402	4,536	5,670	6,804	7,938	9,073	10,207
San Tan Irrigation District	44	59	74	89	103	118	133
Scottsdale, City of	52,810	52,810	52,810	52,810	52,810	52,810	52,810
Spanish Trail Water Company	569	759	949	1,139	1,329	1,519	1,708
Superior - Arizona Water Company	53	71	89	107	125	143	160
Surprise, City of	10,249	10,249	10,249	10,249	10,249	10,249	10,249
Tempe, City of	4,315	4,315	4,315	4,315	4,315	4,315	4,315
Tonto Hills Utility Company	13	18	22	27	31	36	40
Tucson, City of	142,953	143,047	143,141	143,235	143,328	143,422	143,516
Vail Water Company	348	464	580	696	812	929	1,045
Valley Utility Water Company, Inc.	47	63	78	94	109	125	141
Water Utilities Community Facilities District	588	767	947	1,126	1,305	1,485	1,664
Water Utility of Greater Buckeye, Inc.	8	11	13	16	19	22	24
Water Utility of Greater Tonopah, Inc.	12	16	20	24	28	32	36
White Tanks - Arizona Water Company	968	968	968	968	968	968	968
CAP M&I Total	544,403	551,709	559,011	566,270	573,541	580,808	588,073

Table D-4d
State of Arizona CAP 2: M&I Schedules (af)

CAP M&I Schedules	2029	2030	2031	2032	2033	2034	2035
Apache Junction - Arizona Water Company	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Arizona-American Water Company - Agua Fria	11,093	11,093	11,093	11,093	11,093	11,093	11,093
Arizona-American Water Company - Paradise Valley	3,231	3,231	3,231	3,231	3,231	3,231	3,231
Arizona-American Water Company - Sun City	4,189	4,189	4,189	4,189	4,189	4,189	4,189
Arizona-American Water Company - Sun City West	2,372	2,372	2,372	2,372	2,372	2,372	2,372
Arizona State Land Department	12,810	14,021	15,232	16,443	17,654	18,865	20,076
ASARCO - Hayden/Ray Mine	13,125	14,438	15,750	17,063	18,375	19,688	21,000
Avondale, City of	5,165	5,207	5,249	5,290	5,332	5,374	5,416
Avra Water Corporation	505	556	606	657	707	758	808
Berneil Water Company	125	138	150	163	175	188	200
Buckeye, Town of	16	17	19	20	22	23	25
Carefree, Town of	963	1,019	1,075	1,131	1,188	1,244	1,300
Casa Grande - Arizona Water Company	6,303	6,733	7,163	7,593	8,024	8,454	8,884
Cave Creek Water Company	2,406	2,406	2,406	2,406	2,406	2,406	2,406
Central Arizona Groundwater Replenishment District	7,746	7,746	7,746	7,746	7,746	7,746	7,746
Chandler, City of	8,654	8,654	8,654	8,654	8,654	8,654	8,654
Chandler Heights Citrus Irrigation District	197	217	236	256	276	295	315
Chaparral City Water Company	7,793	7,979	8,166	8,351	8,537	8,724	8,909
Circle City Water Company	2,458	2,703	2,949	3,195	3,441	3,686	3,932
Coolidge - Arizona Water Company	1,250	1,375	1,500	1,625	1,750	1,875	2,000
Community Water Company of Green Valley	1,786	1,965	2,144	2,322	2,501	2,679	2,858
El Mirage, City of	318	349	381	413	445	476	508
Eloy, City of	2,171	2,171	2,171	2,171	2,171	2,171	2,171
Florence, Town of	2,048	2,048	2,048	2,048	2,048	2,048	2,048
Flowing Wells Irrigation District	2,721	2,993	3,266	3,538	3,810	4,082	4,354
Gilbert, Town of	7,235	7,235	7,235	7,235	7,235	7,235	7,235
Glendale, City of	16,091	16,282	16,473	16,664	16,854	17,045	17,236
Goodyear, City of	10,742	10,742	10,742	10,742	10,742	10,742	10,742
Green Valley Water Company	1,375	1,463	1,550	1,638	1,725	1,813	1,900
H20 Water Company, Inc.	92	101	110	119	129	138	147
Marana, Town of	29	32	35	38	41	44	47
Maricopa County Parks	665	665	665	665	665	665	665
Mesa, City of	39,659	40,319	40,956	41,593	42,230	42,866	43,503
Metropolitan Domestic Water Improvement District	12,436	12,607	12,777	12,948	13,118	13,289	13,460
Oro Valley, Town of	10,305	10,305	10,305	10,305	10,305	10,305	10,305
Peoria, City of	25,236	25,236	25,236	25,236	25,236	25,236	25,236
Phelps-Dodge Miami	1,816	1,998	2,180	2,361	2,543	2,724	2,906
Phoenix, City of	134,120	134,120	134,120	134,120	134,120	134,120	134,120
Phoenix Memorial Park	53	58	63	68	74	79	84
Pine Water Company	101	111	121	131	141	151	161
Queen Creek Water Company	348	348	348	348	348	348	348
Rio Verde Utilities, Inc.	812	812	812	812	812	812	812
San Carlos Apache M & I	11,341	12,475	13,609	14,743	15,877	17,011	18,145
San Tan Irrigation District	148	162	177	192	207	221	236
Scottsdale, City of	52,810	52,810	52,810	52,810	52,810	52,810	52,810
Spanish Trail Water Company	1,898	2,088	2,278	2,468	2,657	2,847	3,037
Superior - Arizona Water Company	178	196	214	232	249	267	285
Surprise, City of	10,249	10,249	10,249	10,249	10,249	10,249	10,249
Tempe, City of	4,315	4,315	4,315	4,315	4,315	4,315	4,315
Tonto Hills Utility Company	44	49	53	58	62	67	71
Tucson, City of	143,610	143,703	143,797	143,891	143,985	144,078	144,172
Vail Water Company	1,161	1,277	1,393	1,509	1,625	1,741	1,857
Valley Utility Water Company, Inc.	156	172	188	203	219	234	250
Water Utilities Community Facilities District	1,843	2,022	2,202	2,381	2,560	2,740	2,919
Water Utility of Greater Buckeye, Inc.	27	30	32	35	38	40	43
Water Utility of Greater Tonopah, Inc.	40	44	48	52	56	60	64
White Tanks - Arizona Water Company	968	968	968	968	968	968	968
CAP M&I Total	595,344	602,610	609,853	617,095	624,338	631,581	638,823

Table D-5a
State of Arizona CAP 2: Indian Schedules (af)

Year	Camp Verde	Tonto Apache	Fort McDowell	San Carlos Apache	Salt River Pima-Maricopa	Gila River	Ak-Chin/ San Carlos[1]
2008		128		2,847	13,300	56,605	38,903
2009	1,200	128	800	4,817	13,300	73,430	43,683
2010	1,200	128	1,718	6,788	13,300	90,254	48,462
2011	1,200	128	2,635	8,759	13,300	107,078	53,241
2012	1,200	128	3,553	10,729	13,300	123,903	58,021
2013	1,200	128	4,470	12,700	13,300	140,727	58,300
2014	1,200	128	5,388	12,700	13,300	157,551	58,300
2015	1,200	128	6,305	12,700	13,300	174,376	58,300
2016	1,200	128	7,223	12,700	13,300	191,200	58,300
2017	1,200	128	8,140	12,700	13,300	191,200	58,300
2018	1,200	128	9,058	12,700	13,300	191,200	58,300
2019	1,200	128	9,975	12,700	13,300	191,200	58,300
2020	1,200	128	10,893	12,700	13,300	191,200	58,300
2021	1,200	128	11,810	12,700	13,300	191,200	58,300
2022	1,200	128	12,728	12,700	13,300	191,200	58,300
2023	1,200	128	13,645	12,700	13,300	191,200	58,300
2024	1,200	128	14,563	12,700	13,300	191,200	58,300
2025	1,200	128	15,480	12,700	13,300	191,200	58,300
2026	1,200	128	16,398	12,700	13,300	191,200	58,300
2027	1,200	128	17,315	12,700	13,300	191,200	58,300
2028	1,200	128	18,233	12,700	13,300	191,200	58,300
2029	1,200	128	18,233	12,700	13,300	191,200	58,300
2030	1,200	128	18,233	12,700	13,300	191,200	58,300
2031	1,200	128	18,233	12,700	13,300	191,200	58,300
2032	1,200	128	18,233	12,700	13,300	191,200	58,300
2033	1,200	128	18,233	12,700	13,300	191,200	58,300
2034	1,200	128	18,233	12,700	13,300	191,200	58,300
2035	1,200	128	18,233	12,700	13,300	191,200	58,300
2036	1,200	128	18,233	12,700	13,300	191,200	58,300
2037	1,200	128	18,233	12,700	13,300	191,200	58,300
2038	1,200	128	18,233	12,700	13,300	191,200	58,300
2039	1,200	128	18,233	12,700	13,300	191,200	58,300
2040	1,200	128	18,233	12,700	13,300	191,200	58,300
2041	1,200	128	18,233	12,700	13,300	191,200	58,300
2042	1,200	128	18,233	12,700	13,300	191,200	58,300
2043	1,200	128	18,233	12,700	13,300	191,200	58,300
2044	1,200	128	18,233	12,700	13,300	191,200	58,300
2045	1,200	128	18,233	12,700	13,300	191,200	58,300
2046	1,200	128	18,233	12,700	13,300	191,200	58,300
2047	1,200	128	18,233	12,700	13,300	191,200	58,300
2048	1,200	128	18,233	12,700	13,300	191,200	58,300
2049	1,200	128	18,233	12,700	13,300	191,200	58,300
2050	1,200	128	18,233	12,700	13,300	191,200	58,300
2051	1,200	128	18,233	12,700	13,300	191,200	58,300
2052	1,200	128	18,233	12,700	13,300	191,200	58,300
2053	1,200	128	18,233	12,700	13,300	191,200	58,300
2054	1,200	128	18,233	12,700	13,300	191,200	58,300
2055	1,200	128	18,233	12,700	13,300	191,200	58,300
2056	1,200	128	18,233	12,700	13,300	191,200	58,300
2057	1,200	128	18,233	12,700	13,300	191,200	58,300
2058	1,200	128	18,233	12,700	13,300	191,200	58,300
2059	1,200	128	18,233	12,700	13,300	191,200	58,300
2060	1,200	128	18,233	12,700	13,300	191,200	58,300

1. Schedule was increased by 4,500 af to cover losses on the Santa Rosa Canal.

Table D-5b
State of Arizona CAP 2: Indian Schedules (af)

Year	Chui-Chu	Shuk Toak	Pasua-Yaqui	San Xavier	Yavapai-Prescott	Future Indian Settlements	Total CAP Indian Schedules
2008	2,000	10,800	500	11,000	500		136,583
2009	4,000	10,800	500	16,000	500		169,158
2010	6,000	10,800	500	23,500	500		203,149
2011	8,000	10,800	500	26,000	500		232,141
2012	8,000	10,800	500	27,000	500	1,218	258,851
2013	8,000	10,800	500	27,000	500	1,218	278,843
2014	8,000	10,800	500	27,000	500	1,218	296,585
2015	8,000	10,800	500	27,000	500	1,218	314,327
2016	8,000	10,800	500	27,000	500	1,218	332,069
2017	8,000	10,800	500	27,000	500	1,218	332,986
2018	8,000	10,800	500	27,000	500	1,218	333,904
2019	8,000	10,800	500	27,000	500	1,218	334,821
2020	8,000	10,800	500	27,000	500	1,218	335,739
2021	8,000	10,800	500	27,000	500	1,218	336,656
2022	8,000	10,800	500	27,000	500	1,218	337,574
2023	8,000	10,800	500	27,000	500	1,218	338,491
2024	8,000	10,800	500	27,000	500	1,218	339,409
2025	8,000	10,800	500	27,000	500	1,218	340,326
2026	8,000	10,800	500	27,000	500	1,218	341,244
2027	8,000	10,800	500	27,000	500	1,218	342,161
2028	8,000	10,800	500	27,000	500	1,218	343,079
2029	8,000	10,800	500	27,000	500	1,218	343,079
2030	8,000	10,800	500	27,000	500	1,218	343,079
2031	8,000	10,800	500	27,000	500	1,218	343,079
2032	8,000	10,800	500	27,000	500	1,218	343,079
2033	8,000	10,800	500	27,000	500	1,218	343,079
2034	8,000	10,800	500	27,000	500	1,218	343,079
2035	8,000	10,800	500	27,000	500	1,218	343,079
2036	8,000	10,800	500	27,000	500	1,218	343,079
2037	8,000	10,800	500	27,000	500	1,218	343,079
2038	8,000	10,800	500	27,000	500	1,218	343,079
2039	8,000	10,800	500	27,000	500	1,218	343,079
2040	8,000	10,800	500	27,000	500	1,218	343,079
2041	8,000	10,800	500	27,000	500	1,218	343,079
2042	8,000	10,800	500	27,000	500	1,218	343,079
2043	8,000	10,800	500	27,000	500	1,218	343,079
2044	8,000	10,800	500	27,000	500	1,218	343,079
2045	8,000	10,800	500	27,000	500	1,218	343,079
2046	8,000	10,800	500	27,000	500	1,218	343,079
2047	8,000	10,800	500	27,000	500	1,218	343,079
2048	8,000	10,800	500	27,000	500	1,218	343,079
2049	8,000	10,800	500	27,000	500	1,218	343,079
2050	8,000	10,800	500	27,000	500	1,218	343,079
2051	8,000	10,800	500	27,000	500	1,218	343,079
2052	8,000	10,800	500	27,000	500	1,218	343,079
2053	8,000	10,800	500	27,000	500	1,218	343,079
2054	8,000	10,800	500	27,000	500	1,218	343,079
2055	8,000	10,800	500	27,000	500	1,218	343,079
2056	8,000	10,800	500	27,000	500	1,218	343,079
2057	8,000	10,800	500	27,000	500	1,218	343,079
2058	8,000	10,800	500	27,000	500	1,218	343,079
2059	8,000	10,800	500	27,000	500	1,218	343,079
2060	8,000	10,800	500	27,000	500	1,218	343,079

Table D-6a
State of Arizona CAP 3: NIA Schedules (af)

Year	ASLD	Chandler	Glendale	Scottsdale	Tempe	Mesa	Phoenix
2008	9,026	3,924	682	3,306	23	5,551	37,280
2009	9,026	3,924	682	3,306	23	5,551	37,280
2010	9,026	3,924	682	3,306	23	5,551	37,280
2011	9,026	3,924	682	3,306	23	5,551	37,280
2012	9,026	3,924	682	3,306	23	5,551	37,280
2013	9,026	3,924	682	3,306	23	5,551	37,280
2014	9,026	3,924	682	3,306	23	5,551	37,280
2015	9,026	3,924	682	3,306	23	5,551	37,280
2016	9,026	3,924	682	3,306	23	5,551	37,280
2017	9,026	3,924	682	3,306	23	5,551	37,280
2018	9,026	3,924	682	3,306	23	5,551	37,280
2019	9,026	3,924	682	3,306	23	5,551	37,280
2020	9,026	3,924	682	3,306	23	5,551	37,280
2021	9,026	3,924	682	3,306	23	5,551	37,280
2022	9,026	3,924	682	3,306	23	5,551	37,280
2023	9,026	3,924	682	3,306	23	5,551	37,280
2024	9,026	3,924	682	3,306	23	5,551	37,280
2025	9,026	3,924	682	3,306	23	5,551	37,280
2026	9,026	3,924	682	3,306	23	5,551	37,280
2027	9,026	3,924	682	3,306	23	5,551	37,280
2028	8,856	3,850	669	3,244	23	5,448	36,579
2029	7,970	3,465	602	2,919	20	4,903	32,920
2030	7,130	3,100	539	2,611	18	4,386	29,448
2031	6,907	3,003	522	2,530	18	4,249	28,530
2032	6,687	2,907	505	2,449	17	4,113	27,617
2033	6,467	2,811	489	2,369	16	3,978	26,710
2034	6,245	2,715	472	2,287	16	3,841	25,793
2035	6,044	2,628	457	2,214	15	3,718	24,964
2036	6,023	2,618	455	2,206	15	3,705	24,875
2037	6,001	2,609	453	2,198	15	3,691	24,787
2038	5,980	2,600	452	2,190	15	3,678	24,698
2039	5,958	2,590	450	2,182	15	3,665	24,610
2040	5,937	2,581	449	2,175	15	3,652	24,521
2041	5,929	2,578	448	2,172	15	3,647	24,489
2042	5,922	2,574	447	2,169	15	3,642	24,458
2043	5,914	2,571	447	2,166	15	3,638	24,426
2044	5,441	586	411	14	14	378	685
2045	5,433	586	410	14	14	378	685
2046	5,424	586	410	14	14	378	685
2047	5,415	586	409	14	14	378	685
2048	5,406	586	408	14	14	378	685
2049	5,397	586	408	14	14	378	685
2050	5,389	586	407	14	14	378	685
2051	5,382	586	407	14	14	378	685
2052	5,375	586	406	14	14	378	685
2053	5,368	586	406	14	14	378	685
2054	5,362	586	405	14	14	378	685
2055	5,359	586	405	14	14	378	685
2056	5,359	586	405	14	14	378	685
2057	5,359	586	405	14	14	378	685
2058	5,359	586	405	14	14	378	685
2059	5,359	586	405	14	14	378	685
2060	5,359	586	405	14	14	378	685

Table D-6b
State of Arizona CAP 3: NIA Schedules (af)

Year	Gilbert	GRIC	San Xavier	Schuk Toak	Reserved Federal	State Reserved	Total
2008	1,537	0	1,631	369		2,974	66,303
2009	1,537	0	2,447	553		2,974	67,303
2010	1,537	0	3,262	738		31,072	96,401
2011	1,537	0	4,078	922		31,072	97,401
2012	1,537	0	4,894	1,106		31,072	98,401
2013	1,537	0	5,709	1,291		31,072	99,401
2014	1,537	0	6,525	1,475		31,072	100,401
2015	1,537	0	7,340	1,660	2,300	31,072	103,701
2016	1,537	0	8,156	1,844	7,300	31,072	109,701
2017	1,537	0	8,972	2,028	12,300	31,072	115,701
2018	1,537	0	9,787	2,213	17,300	31,072	121,701
2019	1,537	0	10,603	2,397	22,300	31,072	127,701
2020	1,537	0	11,418	2,582	27,300	59,171	161,800
2021	1,537	0	12,234	2,766	32,300	59,171	167,800
2022	1,537	0	13,050	2,950	37,300	59,171	173,800
2023	1,537	0	13,865	3,135	42,300	59,171	179,800
2024	1,537	0	14,681	3,319	47,300	59,171	185,800
2025	1,537	24,120	15,496	3,504	52,300	59,171	215,920
2026	1,537	48,240	16,312	3,688	57,300	59,171	246,040
2027	1,537	72,360	17,128	3,872	62,300	59,171	276,160
2028	1,508	94,666	17,606	3,980	66,035	58,059	300,524
2029	1,357	106,494	16,565	3,745	59,428	52,250	292,640
2030	1,214	95,263	15,462	3,496	53,161	68,934	284,761
2031	1,176	92,294	15,604	3,528	51,504	66,786	276,651
2032	1,139	89,342	15,709	3,552	49,856	64,650	268,543
2033	1,101	86,405	15,777	3,567	48,218	62,525	260,433
2034	1,063	83,439	15,800	3,572	46,563	60,379	252,185
2035	1,029	80,758	15,402	3,482	45,066	58,438	244,215
2036	1,026	80,471	15,347	3,470	44,906	58,231	243,348
2037	1,022	80,185	15,292	3,457	44,746	58,023	242,481
2038	1,018	79,898	15,238	3,445	44,586	57,816	241,614
2039	1,015	79,611	15,183	3,433	44,427	57,609	240,748
2040	1,011	79,325	15,128	3,420	44,267	57,401	239,881
2041	1,010	79,222	15,109	3,416	44,210	57,327	239,572
2042	1,008	79,120	15,089	3,411	44,153	57,253	239,263
2043	1,007	79,018	15,070	3,407	44,095	57,179	238,954
2044	927	72,704	13,866	3,135	40,572	52,610	191,342
2045	925	72,586	13,843	3,130	40,506	52,525	191,035
2046	924	72,469	13,821	3,125	40,441	52,440	190,729
2047	922	72,351	13,798	3,120	40,375	52,355	190,422
2048	921	72,234	13,776	3,115	40,310	52,270	190,116
2049	919	72,117	13,754	3,110	40,244	52,185	189,810
2050	918	71,999	13,731	3,104	40,179	52,100	189,503
2051	916	71,909	13,714	3,101	40,128	52,035	189,269
2052	915	71,819	13,697	3,097	40,078	51,970	189,034
2053	914	71,730	13,680	3,093	40,028	51,905	188,800
2054	913	71,640	13,663	3,089	39,978	51,840	188,566
2055	913	71,608	13,657	3,088	39,960	51,817	188,482
2056	913	71,608	13,657	3,088	39,960	51,817	188,482
2057	913	71,608	13,657	3,088	39,960	51,817	188,482
2058	913	71,608	13,657	3,088	39,960	51,817	188,482
2059	913	71,608	13,657	3,088	39,960	51,817	188,482
2060	913	71,608	13,657	3,088	39,960	51,817	188,482

Table D-7
State of Arizona CAP Summary Schedules (af)

Year	Priority 1 - Priority 3 Mainstream Total	Priority 4 Mainstream Total	Priority 1 - Priority 4 Mainstream Total	Central Arizona Project Schedule (before losses)	Central Arizona Project Schedule (after 5% loss)	CAP 2: M&I & Indian Schedule (after 5% loss)	CAP 3: NIA Priority Schedule (after 5% loss)	CAP 4: Excess Water (after 5% loss)	CAP 5: Arizona Water Banking Authority (after 5% loss)
2008	1,337,954	72,175	1,410,129	1,389,871	1,320,377	525,438	66,304	400,000	328,635
2009	1,350,703	73,298	1,424,001	1,375,999	1,307,199	572,855	67,304	400,000	267,040
2010	1,363,452	74,421	1,437,873	1,362,127	1,294,020	631,048	96,402	400,000	166,570
2011	1,373,770	75,139	1,448,909	1,351,091	1,283,537	677,796	97,402	400,000	108,338
2012	1,384,087	75,857	1,459,944	1,340,056	1,273,053	718,929	98,402	400,000	55,722
2013	1,394,405	76,574	1,470,979	1,329,021	1,262,570	750,424	99,402	400,000	12,743
2014	1,404,722	77,292	1,482,014	1,317,986	1,252,086	779,002	100,402	372,682	0
2015	1,415,040	78,010	1,493,049	1,306,951	1,241,603	808,019	103,702	329,882	0
2016	1,415,557	78,719	1,494,276	1,305,724	1,240,438	833,480	109,702	297,256	0
2017	1,416,075	79,350	1,495,425	1,304,575	1,239,346	845,753	115,702	277,891	0
2018	1,416,592	79,817	1,496,409	1,303,591	1,238,411	849,457	121,702	267,252	0
2019	1,417,110	80,284	1,497,394	1,302,606	1,237,476	853,161	127,702	256,614	0
2020	1,417,627	80,713	1,498,340	1,301,660	1,236,577	863,860	161,801	210,916	0
2021	1,418,119	80,865	1,498,985	1,301,015	1,235,964	873,758	167,801	194,405	0
2022	1,418,612	81,018	1,499,630	1,300,370	1,235,352	881,977	173,801	179,574	0
2023	1,419,104	81,171	1,500,275	1,299,725	1,234,739	890,201	179,801	164,737	0
2024	1,419,596	81,324	1,500,920	1,299,080	1,234,126	898,420	185,801	149,906	0
2025	1,420,088	81,476	1,501,565	1,298,435	1,233,514	906,596	215,921	110,996	0
2026	1,420,580	81,629	1,502,209	1,297,791	1,232,901	914,785	246,041	72,075	0
2027	1,421,073	81,782	1,502,854	1,297,146	1,232,288	922,969	276,161	33,158	0
2028	1,421,565	81,934	1,503,499	1,296,501	1,231,676	931,152	300,524	0	0
2029	1,422,057	82,087	1,504,144	1,295,856	1,231,063	938,423	292,640	0	0
2030	1,422,549	82,240	1,504,789	1,295,211	1,230,450	945,689	284,761	0	0
2031	1,423,145	82,556	1,505,701	1,294,299	1,229,584	952,932	276,651	0	0
2032	1,423,741	82,872	1,506,614	1,293,386	1,228,717	960,174	268,543	0	0
2033	1,424,338	83,189	1,507,526	1,292,474	1,227,850	967,417	260,433	0	0
2034	1,424,934	83,505	1,508,439	1,291,561	1,226,983	974,660	252,323	0	0
2035	1,425,530	83,821	1,509,351	1,290,649	1,226,117	981,902	244,215	0	0
2036	1,426,126	84,138	1,510,263	1,289,737	1,225,250	981,902	243,348	0	0
2037	1,426,722	84,454	1,511,176	1,288,824	1,224,383	981,902	242,481	0	0
2038	1,427,318	84,770	1,512,088	1,287,912	1,223,516	981,902	241,614	0	0
2039	1,427,914	85,086	1,513,000	1,287,000	1,222,650	981,902	240,748	0	0
2040	1,428,510	85,403	1,513,913	1,286,087	1,221,783	981,902	239,881	0	0
2041	1,428,510	85,728	1,514,238	1,285,762	1,221,474	981,902	239,572	0	0
2042	1,428,510	86,053	1,514,564	1,285,436	1,221,165	981,902	239,263	0	0
2043	1,428,510	86,379	1,514,889	1,285,111	1,220,856	981,902	238,954	0	0
2044	1,428,510	86,704	1,515,214	1,284,786	1,220,547	1,029,205	191,342	0	0
2045	1,428,510	87,029	1,515,540	1,284,460	1,220,237	1,029,205	191,033	0	0
2046	1,428,510	87,355	1,515,865	1,284,135	1,219,928	1,029,205	190,723	0	0
2047	1,428,510	87,680	1,516,190	1,283,810	1,219,619	1,029,205	190,414	0	0
2048	1,428,510	88,005	1,516,516	1,283,484	1,219,310	1,029,205	190,105	0	0
2049	1,428,510	88,331	1,516,841	1,283,159	1,219,001	1,029,205	189,796	0	0
2050	1,428,510	88,656	1,517,166	1,282,834	1,218,692	1,029,205	189,487	0	0
2051	1,428,510	88,905	1,517,415	1,282,585	1,218,456	1,029,205	189,251	0	0
2052	1,428,510	89,154	1,517,664	1,282,336	1,218,219	1,029,205	189,014	0	0
2053	1,428,510	89,403	1,517,913	1,282,087	1,217,983	1,029,205	188,778	0	0
2054	1,428,510	89,652	1,518,162	1,281,838	1,217,746	1,029,205	188,541	0	0
2055	1,428,510	89,740	1,518,250	1,281,750	1,217,662	1,029,205	188,457	0	0
2056	1,428,510	89,740	1,518,250	1,281,750	1,217,662	1,029,205	188,457	0	0
2057	1,428,510	89,740	1,518,250	1,281,750	1,217,662	1,029,205	188,457	0	0
2058	1,428,510	89,740	1,518,250	1,281,750	1,217,662	1,029,205	188,457	0	0
2059	1,428,510	89,740	1,518,250	1,281,750	1,217,662	1,029,205	188,457	0	0
2060	1,428,510	89,740	1,518,250	1,281,750	1,217,662	1,029,205	188,457	0	0

D.2 Surplus Condition Depletion Schedules

The depletion schedules for the various Surplus conditions under each alternative are presented in Tables D-9 through D-13. The modeling for all alternatives assumed that surplus would be delivered to MWD, IID, and CVWD in California, CAP in Arizona, and SNWA in Nevada.[1]

Table D-8 presents the effective dates that each type of surplus is in effect for each alternative. The details for each alternative are discussed below.

Table D-8
Type of Surplus In Effect For Each Alternative

Action Alternative	Tables	Applicable Surplus Condition and Modeling Period				
		Flood Control	70R[1]	Quantified (70R)	Full Domestic	Partial Domestic
No Action	D-9 and D-13	2008-2060	2017-2060	2008-2016	2008-2016	2008-2016
Basin States	D-10 and D-13	2008-2060	2027-2060	2008-2026	2008-2026	-
Conservation Before Shortage	D-10 and D-13	2008-2060	2027-2060	2008-2026	2008-2026	-
Water Supply	D-11 and D-13	2008-2060	2027-2060	2008-2026	2008-2026	2008-2026
Reservoir Storage	D-12 and D-13	2008-2060	2008-2060	-	-	-
Preferred Alternative	D-10 and D-13	2008-2060	2027-2060	2008-2026	2008-2026	-

1. Deliveries under a 70R Surplus Condition are assumed to follow the Flood Control Surplus Schedules.

D.2.1 No Action Alternative

Under the No Action Alternative, the existing ISG are assumed to be in place through 2016. Depletion schedules under Flood Control, Quantified (70R), Full Domestic, and Partial Domestic Surplus conditions are shown in Table D-9. After 2016, the modeled operation is assumed to revert back to the assumptions used for Flood Control Surplus and 70R Surplus conditions, as shown in Table D-9 and D-13.

D.2.2 Basin States Alternative

The Basin States Alternative includes both a modification and an extension of the ISG. The existing ISG would be extended through 2026 and be modified by eliminating the Partial Domestic Surplus condition, beginning in 2008, and limiting the amount of water available under the Full Domestic Surplus conditions during the period 2017 through 2026 (Section 2.4). Depletion schedules under Flood Control, Quantified (70R) and Domestic Surplus conditions are shown in Table D-10. After 2026, the modeled operation is assumed to revert back to the assumptions used for the No Action Alternative (Flood Control Surplus and 70R Surplus) as shown in Table D-13.

[1] Other entities currently, or may in the future, have contracts for surplus deliveries. However, for modeling purposes, the entities listed were assumed to receive the surplus deliveries in their respective states.

D.2.3 Conservation Before Shortage Alternative

The Conservation Before Shortage Alternative assumes the same modifications to and extension of the term of the ISG as described under the Basin States Alternative. These schedules are also shown in Table D-10. After 2026, the modeled operation is assumed to revert back to the assumptions used for the No Action Alternative (Flood Control Surplus and 70R Surplus) as shown in Table D-13.

D.2.4 Water Supply Alternative

The Water Supply Alternative assumes the ISG would be extended through 2026. Depletion schedules under Flood Control, Quantified (70R), Full Domestic and Partial Domestic Surplus conditions are shown in Table D-11. After 2026, the modeled operation is assumed to revert back to the assumptions used for the No Action Alternative (Flood Control Surplus and 70R Surplus) as shown in Table D-13.

D.2.5 Reservoir Storage Alternative

Under the Reservoir Storage Alternative, the permissive provisions of the ISG are terminated beginning in 2008 and the modeled operations revert to the assumptions used for the No Action Alternative (Flood Control and 70R Surplus) from 2008 through 2026. Depletion schedules under Flood Control and 70R Surplus conditions are shown in Table D-12. After 2026, the modeled operation continues using the assumptions for the No Action Alternative (Flood Control Surplus and 70R Surplus) as shown in Table D-13.

D.2.6 Preferred Alternative

The Preferred Alternative assumes the same modifications to and extension of the term of the ISG as described under the Basin States and Conservation Before Shortage alternatives. These schedules are also shown in Table D-10. After 2026, the modeled operation is assumed to revert back to the assumptions used for the No Action Alternative (Flood Control Surplus and 70R Surplus) as shown in Table D-13.

Table D-9
Lower Division States
Surplus Condition Depletion Schedules for the No Action Alternative
2008 through 2026

	Flood Control					Quantified (70R)[1]					Full Domestic		Partial Domestic	
Year	MWD	IID	CVWD	SNWA	CAP	MWD	IID	CVWD	SNWA	CAP	MWD	SNWA	MWD	SNWA
2008	1,250,000	3,010,800	584,533	330,000	1,715,000	1,250,000	2,932,267	494,533	330,000	1,715,000	1,250,000	279,000	952,000	275,000
2009	1,250,000	2,985,800	584,533	334,000	1,750,000	1,250,000	2,907,267	499,533	334,000	1,750,000	1,250,000	283,000	972,000	277,000
2010	1,250,000	2,960,800	584,533	338,000	1,787,000	1,250,000	2,882,267	504,533	338,000	1,787,000	1,250,000	287,000	992,000	279,000
2011	1,250,000	2,935,800	584,533	342,000	1,812,000	1,250,000	2,857,267	509,533	342,000	1,812,000	1,250,000	291,000	1,012,000	281,000
2012	1,250,000	2,930,800	584,533	345,000	1,835,000	1,250,000	2,852,267	514,533	345,000	1,835,000	1,250,000	295,000	1,032,000	283,000
2013	1,250,000	2,925,800	584,533	349,000	1,835,000	1,250,000	2,847,267	519,533	349,000	1,835,000	1,250,000	299,000	1,052,000	285,000
2014	1,250,000	2,920,800	584,533	353,000	1,835,000	1,250,000	2,842,267	524,533	353,000	1,835,000	1,250,000	302,000	1,072,000	287,000
2015	1,250,000	2,915,800	584,533	357,000	1,835,000	1,250,000	2,837,267	529,533	357,000	1,835,000	1,250,000	303,000	1,092,000	287,000
2016	1,250,000	2,910,800	584,533	361,000	1,835,000	1,250,000	2,832,267	534,533	361,000	1,835,000	1,250,000	307,000	1,112,000	289,000
2017	1,250,000	2,905,800	584,533	365,000	1,835,000	1,250,000	2,905,800	584,533	365,000	1,835,000	-	-	-	-
2018	1,250,000	2,900,800	584,533	369,000	1,835,000	1,250,000	2,900,800	584,533	369,000	1,835,000	-	-	-	-
2019	1,250,000	2,895,800	584,533	373,000	1,835,000	1,250,000	2,895,800	584,533	373,000	1,835,000	-	-	-	-
2020	1,250,000	2,890,800	584,533	378,000	1,835,000	1,250,000	2,890,800	584,533	378,000	1,835,000	-	-	-	-
2021	1,250,000	2,885,800	584,533	382,000	1,835,000	1,250,000	2,885,800	584,533	382,000	1,835,000	-	-	-	-
2022	1,250,000	2,880,800	584,533	387,000	1,835,000	1,250,000	2,880,800	584,533	387,000	1,835,000	-	-	-	-
2023	1,250,000	2,875,800	584,533	391,000	1,835,000	1,250,000	2,875,800	584,533	391,000	1,835,000	-	-	-	-
2024	1,250,000	2,870,800	584,533	395,000	1,835,000	1,250,000	2,870,800	584,533	395,000	1,835,000	-	-	-	-
2025	1,250,000	2,865,800	584,533	400,000	1,835,000	1,250,000	2,865,800	584,533	400,000	1,835,000	-	-	-	-
2026	1,250,000	2,860,800	584,533	404,000	1,835,000	1,250,000	2,860,800	584,533	404,000	1,835,000	-	-	-	-

1. After 2016, deliveries to California agricultural uses under a Quantified (70R) Surplus condition are assumed to follow the Flood Control Surplus schedules.

Table D-10
Lower Division States
Surplus Condition Depletion Schedules for the Basin States and Conservation Before Shortage Alternatives and the Preferred Alternative
2008 through 2026

	Flood Control					Quantified (70R)					Domestic[1]		Partial Domestic	
Year	MWD	IID	CVWD	SNWA	CAP	MWD	IID	CVWD	SNWA	CAP	MWD	SNWA	MWD	SNWA
2008	1,250,000	3,010,800	584,533	330,000	1,715,000	1,250,000	2,932,267	494,533	330,000	1,715,000	1,250,000	279,000	-	-
2009	1,250,000	2,985,800	584,533	334,000	1,750,000	1,250,000	2,907,267	499,533	334,000	1,750,000	1,250,000	283,000	-	-
2010	1,250,000	2,960,800	584,533	338,000	1,787,000	1,250,000	2,882,267	504,533	338,000	1,787,000	1,250,000	287,000	-	-
2011	1,250,000	2,935,800	584,533	342,000	1,812,000	1,250,000	2,857,267	509,533	342,000	1,812,000	1,250,000	291,000	-	-
2012	1,250,000	2,930,800	584,533	345,000	1,835,000	1,250,000	2,852,267	514,533	345,000	1,835,000	1,250,000	295,000	-	-
2013	1,250,000	2,925,800	584,533	349,000	1,835,000	1,250,000	2,847,267	519,533	349,000	1,835,000	1,250,000	299,000	-	-
2014	1,250,000	2,920,800	584,533	353,000	1,835,000	1,250,000	2,842,267	524,533	353,000	1,835,000	1,250,000	302,000	-	-
2015	1,250,000	2,915,800	584,533	357,000	1,835,000	1,250,000	2,837,267	529,533	357,000	1,835,000	1,250,000	303,000	-	-
2016	1,250,000	2,910,800	584,533	361,000	1,835,000	1,250,000	2,832,267	534,533	361,000	1,835,000	1,250,000	307,000	-	-
2017	1,250,000	2,905,800	584,533	365,000	1,835,000	1,250,000	2,827,267	539,533	365,000	1,835,000	1,036,648	371,000	-	-
2018	1,250,000	2,900,800	584,533	369,000	1,835,000	1,250,000	2,822,267	544,533	369,000	1,835,000	1,066,648	371,000	-	-
2019	1,250,000	2,895,800	584,533	373,000	1,835,000	1,250,000	2,817,267	549,533	373,000	1,835,000	1,096,648	371,000	-	-
2020	1,250,000	2,890,800	584,533	378,000	1,835,000	1,250,000	2,812,267	554,533	378,000	1,835,000	1,129,148	371,000	-	-
2021	1,250,000	2,885,800	584,533	382,000	1,835,000	1,250,000	2,807,267	559,533	382,000	1,835,000	1,141,648	371,000	-	-
2022	1,250,000	2,880,800	584,533	387,000	1,835,000	1,250,000	2,802,267	564,533	387,000	1,835,000	1,139,148	371,000	-	-
2023	1,250,000	2,875,800	584,533	391,000	1,835,000	1,250,000	2,797,267	569,533	391,000	1,835,000	1,136,648	371,000	-	-
2024	1,250,000	2,870,800	584,533	395,000	1,835,000	1,250,000	2,792,267	574,533	395,000	1,835,000	1,136,648	371,000	-	-
2025	1,250,000	2,865,800	584,533	400,000	1,835,000	1,250,000	2,787,267	579,533	400,000	1,835,000	1,136,648	371,000	-	-
2026	1,250,000	2,860,800	584,533	404,000	1,835,000	1,250,000	2,782,267	584,533	404,000	1,835,000	1,136,648	371,000	-	-

1. During 2017 through 2026, the distribution of Domestic Surplus water is assumed to be limited as follows: 1) for use by MWD, 250 kafy in addition to the amount of California's basic apportionment available to MWD; 2) for use by SNWA, 100 kafy in addition to the amount of Nevada's basic apportionment available to SNWA; and 3) for use in Arizona, 100 kafy in addition to the amount of Arizona's basic apportionment available to Arizona contractors. Based on input received from the Arizona Department of Water Resources, a Domestic Surplus to Arizona was not modeled.

Table D-11
Lower Division States
Surplus Condition Depletion Schedules for the Water Supply Alternative
2008 through 2026

	Flood Control					Quantified (70R)					Full Domestic[1]		Partial Domestic	
Year	MWD	IID	CVWD	SNWA	CAP	MWD	IID	CVWD	SNWA	CAP	MWD	SNWA	MWD	SNWA
2008	1,250,000	3,010,800	584,533	330,000	1,715,000	1,250,000	2,932,267	494,533	330,000	1,715,000	1,250,000	279,000	952,000	275,000
2009	1,250,000	2,985,800	584,533	334,000	1,750,000	1,250,000	2,907,267	499,533	334,000	1,750,000	1,250,000	283,000	972,000	277,000
2010	1,250,000	2,960,800	584,533	338,000	1,787,000	1,250,000	2,882,267	504,533	338,000	1,787,000	1,250,000	287,000	992,000	279,000
2011	1,250,000	2,935,800	584,533	342,000	1,812,000	1,250,000	2,857,267	509,533	342,000	1,812,000	1,250,000	291,000	1,012,000	281,000
2012	1,250,000	2,930,800	584,533	345,000	1,835,000	1,250,000	2,852,267	514,533	345,000	1,835,000	1,250,000	295,000	1,032,000	283,000
2013	1,250,000	2,925,800	584,533	349,000	1,835,000	1,250,000	2,847,267	519,533	349,000	1,835,000	1,250,000	299,000	1,052,000	285,000
2014	1,250,000	2,920,800	584,533	353,000	1,835,000	1,250,000	2,842,267	524,533	353,000	1,835,000	1,250,000	302,000	1,072,000	287,000
2015	1,250,000	2,915,800	584,533	357,000	1,835,000	1,250,000	2,837,267	529,533	357,000	1,835,000	1,250,000	303,000	1,092,000	287,000
2016	1,250,000	2,910,800	584,533	361,000	1,835,000	1,250,000	2,832,267	534,533	361,000	1,835,000	1,250,000	307,000	1,112,000	289,000
2017	1,250,000	2,905,800	584,533	365,000	1,835,000	1,250,000	2,827,267	539,533	365,000	1,835,000	1,036,648	371,000	1,132,000	291,000
2018	1,250,000	2,900,800	584,533	369,000	1,835,000	1,250,000	2,822,267	544,533	369,000	1,835,000	1,066,648	371,000	1,152,000	293,000
2019	1,250,000	2,895,800	584,533	373,000	1,835,000	1,250,000	2,817,267	549,533	373,000	1,835,000	1,096,648	371,000	1,172,000	295,000
2020	1,250,000	2,890,800	584,533	378,000	1,835,000	1,250,000	2,812,267	554,533	378,000	1,835,000	1,129,148	371,000	1,192,000	297,000
2021	1,250,000	2,885,800	584,533	382,000	1,835,000	1,250,000	2,807,267	559,533	382,000	1,835,000	1,141,648	371,000	1,212,000	299,000
2022	1,250,000	2,880,800	584,533	387,000	1,835,000	1,250,000	2,802,267	564,533	387,000	1,835,000	1,139,148	371,000	1,232,000	301,000
2023	1,250,000	2,875,800	584,533	391,000	1,835,000	1,250,000	2,797,267	569,533	391,000	1,835,000	1,136,648	371,000	1,250,000	303,000
2024	1,250,000	2,870,800	584,533	395,000	1,835,000	1,250,000	2,792,267	574,533	395,000	1,835,000	1,136,648	371,000	1,250,000	305,000
2025	1,250,000	2,865,800	584,533	400,000	1,835,000	1,250,000	2,787,267	579,533	400,000	1,835,000	1,136,648	371,000	1,250,000	307,000
2026	1,250,000	2,860,800	584,533	404,000	1,835,000	1,250,000	2,782,267	584,533	404,000	1,835,000	1,136,648	371,000	1,250,000	313,000

1. During 2017 through 2026, the distribution of Full Domestic Surplus water is assumed to be limited as follows: 1) for use by MWD, 250 kafy in addition to the amount of California's basic apportionment available to MWD; 2) for use by SNWA, 100 kafy in addition to the amount of Nevada's basic apportionment available to SNWA; and 3) for use in Arizona, 100 kafy in addition to the amount of Arizona's basic apportionment available to Arizona contractors. Full Domestic Surplus to Arizona was not modeled.

Table D-12
Lower Division States
Surplus Condition Depletion Schedules for the Reservoir Storage Alternative
2008 through 2026

	Flood Control					70R					Full Domestic		Partial Domestic	
Year	MWD	IID	CVWD	SNWA	CAP	MWD	IID	CVWD	SNWA	CAP	MWD	SNWA	MWD	SNWA
2008	1,250,000	3,010,800	584,533	330,000	1,715,000	1,250,000	3,010,800	584,533	330,000	1,715,000	-	-	-	-
2009	1,250,000	2,985,800	584,533	334,000	1,750,000	1,250,000	2,985,800	584,533	334,000	1,750,000	-	-	-	-
2010	1,250,000	2,960,800	584,533	338,000	1,787,000	1,250,000	2,960,800	584,533	338,000	1,787,000	-	-	-	-
2011	1,250,000	2,935,800	584,533	342,000	1,812,000	1,250,000	2,935,800	584,533	342,000	1,812,000	-	-	-	-
2012	1,250,000	2,930,800	584,533	345,000	1,835,000	1,250,000	2,930,800	584,533	345,000	1,835,000	-	-	-	-
2013	1,250,000	2,925,800	584,533	349,000	1,835,000	1,250,000	2,925,800	584,533	349,000	1,835,000	-	-	-	-
2014	1,250,000	2,920,800	584,533	353,000	1,835,000	1,250,000	2,920,800	584,533	353,000	1,835,000	-	-	-	-
2015	1,250,000	2,915,800	584,533	357,000	1,835,000	1,250,000	2,915,800	584,533	357,000	1,835,000	-	-	-	-
2016	1,250,000	2,910,800	584,533	361,000	1,835,000	1,250,000	2,910,800	584,533	361,000	1,835,000	-	-	-	-
2017	1,250,000	2,905,800	584,533	365,000	1,835,000	1,250,000	2,905,800	584,533	365,000	1,835,000	-	-	-	-
2018	1,250,000	2,900,800	584,533	369,000	1,835,000	1,250,000	2,900,800	584,533	369,000	1,835,000	-	-	-	-
2019	1,250,000	2,895,800	584,533	373,000	1,835,000	1,250,000	2,895,800	584,533	373,000	1,835,000	-	-	-	-
2020	1,250,000	2,890,800	584,533	378,000	1,835,000	1,250,000	2,890,800	584,533	378,000	1,835,000	-	-	-	-
2021	1,250,000	2,885,800	584,533	382,000	1,835,000	1,250,000	2,885,800	584,533	382,000	1,835,000	-	-	-	-
2022	1,250,000	2,880,800	584,533	387,000	1,835,000	1,250,000	2,880,800	584,533	387,000	1,835,000	-	-	-	-
2023	1,250,000	2,875,800	584,533	391,000	1,835,000	1,250,000	2,875,800	584,533	391,000	1,835,000	-	-	-	-
2024	1,250,000	2,870,800	584,533	395,000	1,835,000	1,250,000	2,870,800	584,533	395,000	1,835,000	-	-	-	-
2025	1,250,000	2,865,800	584,533	400,000	1,835,000	1,250,000	2,865,800	584,533	400,000	1,835,000	-	-	-	-
2026	1,250,000	2,860,800	584,533	404,000	1,835,000	1,250,000	2,860,800	584,533	404,000	1,835,000	-	-	-	-

Table D-13
Lower Division States
Surplus Condition Depletion Schedules for No Action and All Action Alternatives
2027 through 2060

	Flood Control					70R					Full Domestic		Partial Domestic	
Year	MWD	IID	CVWD	SNWA	CAP	MWD	IID	CVWD	SNWA	CAP	MWD	SNWA	MWD	SNWA
2027	1,250,000	2,860,800	584,533	408,000	1,835,000	1,250,000	2,860,800	584,533	408,000	1,835,000	-	-	-	-
2028	1,250,000	2,860,800	584,533	412,000	1,835,000	1,250,000	2,860,800	584,533	412,000	1,835,000	-	-	-	-
2029	1,250,000	2,860,800	584,533	415,000	1,835,000	1,250,000	2,860,800	584,533	415,000	1,835,000	-	-	-	-
2030	1,250,000	2,860,800	584,533	418,000	1,835,000	1,250,000	2,860,800	584,533	418,000	1,835,000	-	-	-	-
2031	1,250,000	2,860,800	584,533	423,000	1,835,000	1,250,000	2,860,800	584,533	423,000	1,835,000	-	-	-	-
2032	1,250,000	2,860,800	584,533	427,000	1,835,000	1,250,000	2,860,800	584,533	427,000	1,835,000	-	-	-	-
2033	1,250,000	2,860,800	584,533	431,000	1,835,000	1,250,000	2,860,800	584,533	431,000	1,835,000	-	-	-	-
2034	1,250,000	2,860,800	584,533	435,000	1,835,000	1,250,000	2,860,800	584,533	435,000	1,835,000	-	-	-	-
2035	1,250,000	2,860,800	584,533	439,000	1,835,000	1,250,000	2,860,800	584,533	439,000	1,835,000	-	-	-	-
2036	1,250,000	2,860,800	584,533	443,000	1,835,000	1,250,000	2,860,800	584,533	443,000	1,835,000	-	-	-	-
2037	1,250,000	2,860,800	584,533	448,000	1,835,000	1,250,000	2,860,800	584,533	448,000	1,835,000	-	-	-	-
2038	1,250,000	2,860,800	584,533	452,000	1,835,000	1,250,000	2,860,800	584,533	452,000	1,835,000	-	-	-	-
2039	1,250,000	2,860,800	584,533	456,000	1,835,000	1,250,000	2,860,800	584,533	456,000	1,835,000	-	-	-	-
2040	1,250,000	2,860,800	584,533	460,000	1,835,000	1,250,000	2,860,800	584,533	460,000	1,835,000	-	-	-	-
2041	1,250,000	2,860,800	584,533	464,000	1,835,000	1,250,000	2,860,800	584,533	464,000	1,835,000	-	-	-	-
2042	1,250,000	2,860,800	584,533	468,000	1,835,000	1,250,000	2,860,800	584,533	468,000	1,835,000	-	-	-	-
2043	1,250,000	2,860,800	584,533	472,000	1,835,000	1,250,000	2,860,800	584,533	472,000	1,835,000	-	-	-	-
2044	1,250,000	2,860,800	584,533	476,000	1,835,000	1,250,000	2,860,800	584,533	476,000	1,835,000	-	-	-	-
2045	1,250,000	2,860,800	584,533	480,000	1,835,000	1,250,000	2,860,800	584,533	480,000	1,835,000	-	-	-	-
2046	1,250,000	2,910,800	584,533	485,000	1,835,000	1,250,000	2,910,800	584,533	485,000	1,835,000	-	-	-	-
2047	1,250,000	2,910,800	584,533	489,000	1,835,000	1,250,000	2,910,800	584,533	489,000	1,835,000	-	-	-	-

Table D-13
Lower Division States
Surplus Condition Depletion Schedules for No Action and All Action Alternatives
2027 through 2060

	Flood Control					70R					Full Domestic		Partial Domestic	
Year	MWD	IID	CVWD	SNWA	CAP	MWD	IID	CVWD	SNWA	CAP	MWD	SNWA	MWD	SNWA
2048	1,250,000	2,910,800	584,533	493,000	1,835,000	1,250,000	2,910,800	584,533	493,000	1,835,000	-	-	-	-
2049	1,250,000	2,910,800	584,533	497,000	1,835,000	1,250,000	2,910,800	584,533	497,000	1,835,000	-	-	-	-
2050	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-
2051	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-
2052	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-
2053	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-
2054	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-
2055	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-
2056	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-
2057	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-
2058	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-
2059	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-
2060	1,250,000	2,910,800	584,533	501,000	1,835,000	1,250,000	2,910,800	584,533	501,000	1,835,000	-	-	-	-

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Appendix E

Colorado River Water Entitlements and Priority Systems within Arizona, California, and Nevada

This appendix contains tables that list the Colorado River water entitlement holders within Arizona, California, and Nevada. One table is provided for each state. The entitlement priority system for each of the three Lower Division states is also shown in each respective table. The priorities presented in this appendix are based on contractual arrangements between each entity and Reclamation, as well as key provisions of the Law of the River, including the Consolidated Decree.

Table E-1
State of Arizona Colorado River Water Entitlement Holders and Priorities

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement (afy) Diversion	Entitlement (afy) Consumptive Use
1st (PPRs)[1]	Molina	PPR No. 15	1928	Agriculture	318	
	Gila Monster Farms (formerly Sturges)	PPR No. 16	1925	Agriculture	780	
	Cocopah Indian Reservation	PPR No. 1	9/27/1917	Indian	7,681	
	Cocopah Indian Reservation	PPR No. 8	1915	Indian	1,140	
	Powers (Power, R.E. & P.)	PPR No. 7	1915	Agriculture	960	
	Zozaya (in MVIDD)	PPR No. 17	1912	Agriculture	720	
	Fort Mohave Indian Reservation	PPR No. 3	2/2/1911	Indian	75,566	
	Brooke Water Company (formerly Graham)	PPR No. 9	1910	M&I[2]	360	
	North Gila Valley Irrigation District	PPR No. 6	7/8/1905	Agriculture	24,500	
	Yuma Auxiliary Project (Unit B)	PPR No. 5 & Certificates	7/8/1905	Agriculture	6,800	
	City of Parker	PPR No. 20	1905	M&I	630	or if less, 400
	Hulet (in MVIDD)	PPR No. 10	1902	Agriculture	1,080	
	Hoover (in MVIDD/formerly Hopal)	4-07-30-W0052/PPR 11	1902	Agriculture	1,050	
	Miller (in MVIDD)	PPR No. 12	1902	M&I	240	
	McKellips and Granite Reef Farms (in MVIDD)	PPR No. 13	1902	Agriculture	810	
	Sherill & Lafollette (in MVIDD)	PPR No. 14	1902	Agriculture	1,080	
	Swan (in MVIDD)	PPR No 18	1902	M&I	960	
	Yuma County Water Users' Association	PPR No. 4 & Certificates	1901	Agriculture	254,200	
	Phillips, Milton and Jean	PPR No. 19	1900	Agriculture	42	
	City of Yuma	PPR No. 21	1893	M&I	2,333	or if less,1,478
	Fort Mohave Indian Reservation	PPR No. 3	9/18/1890	Indian	27,969	
	Fort Yuma Indian Reservation (new entitlement)	PPR No. 3a	1/9/1884	Indian	6,350	
	Colorado River Indian Reservation	PPR No. 2	11/16/1874	Indian	51,986	
	Colorado River Indian Reservation	PPR No. 2	11/22/1873	Indian	252,016	
	Colorado River Indian Reservation	PPR No. 2	3/3/1865	Indian	358,400	
2nd & 3rd (co-equal)	Cibola National Wildlife Refuge (2nd Priority)	Secretarial Reservation	8/21/1964	M&I	34,500	or if less, 16,793
	Yuma Irrigation District (5,000 af M&I) (2nd Priority)	14-06-300-1270	1962	M&I/Agriculture		67,278
	National Park Service (2nd Priority)	1964 Decree	1961	M&I	unquantified	

Table E-1
State of Arizona Colorado River Water Entitlement Holders and Priorities

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement (afy)	
					Diversion	Consumptive Use
2nd & 3rd (co-equal)	Yuma Union High School (3rd Priority)	14-06-303-179	1960	M&I	200	
	Union Pacific Railroad (formerly Southern Pacific Co.) (3rd Priority)	14-06-303-1524	12/21/1959	M&I	48	
	Kaman, Inc. (3rd Priority)	14-06-303-1555	12/2/1959	M&I	2	
	City of Yuma (3rd Priority)	14-06-W-106	11/12/1959	M&I		48,522
	Department of Navy MCAS (2nd Priority)	14-06-300-937	1/1/1959	M&I	3,000	
	Yuma County Water Users' Association (14,701af M&I) (2nd Priority)	14-06-300-621 & Certificates	1957	M&I/Agriculture	unquantified	
	Yuma Area Office (489.95 af M&I Conversion)				490	
	City of Yuma (cemetery) (3rd Priority)	14-06-303-1078	11/12/1956	M&I	60	
	Yuma Mesa Fruit Growers (3rd Priority)	14-06-303-1196	10/1/1956	Agriculture	15	
	Yuma Mesa Irrigation & Drainage District (10,000 af M&I) (2nd Priority)	14-06-W102	5/26/1956	M&I/Agriculture		141,519
	Desert Lawn Memorial Park (3rd Priority)	14-06-300-1079	5/1/1956	M&I	200	
	Ak-Chin Indian Community[4] (2nd Priority)	AK-CHIN121180A	1/1/1956	Indian	50,000	
	University of Arizona (3rd Priority)	14-06-300-144	1954	Agriculture	1,088	
	Yuma Mesa Grapefruit Company (Camille Allec Jr.) (3rd Priority)	14-06-303-528	12/23/1953	Agriculture	120	
	North Gila Valley Irrigation District (2,500 af M&I) (2nd Priority)	14-06-W-54	5/12/1953	M&I/Agriculture		41,203
	Yuma Auxiliary Project (Unit B) (2nd Priority)	14-06-300-44	12/22/1962	Agriculture	unquantified	
	Wellton-Mohawk Irrigation and Drainage District (5,000 af M&I) (2nd Priority)	1-07-30-W0021	3/4/1952	M&I/Agriculture		278,000
	Chandler (Salt River Pima-Maricopa Exchange)[4] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	4,278	
	Gilbert (Salt River Pima-Maricopa Exchange)[4] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	6,762	
	Glendale (Salt River Pima-Maricopa Exchange)[4] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	3,000	
	Mesa (Salt River Pima-Maricopa Exchange)[4] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	2,760	
	Phoenix (Salt River Pima-Maricopa Exchange)[4] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	5,000	
	Scottsdale (Salt River Pima-Maricopa Exchange)[4] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	100	
	Tempe (Salt River Pima-Maricopa Exchange)[4] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	100	
	Gila Monster Farms (formerly Sturges) (3rd Priority)	6-07-30-W0337	1/1/1952	Agriculture	6,285	
	Sturges, Harold (2nd Priority)	I76R-733	1/1/1952	Agriculture	0	
	Sturges, Irma (2nd Priority)	I76R-735	1/1/1952	Agriculture	0	
	Department of Army – Yuma Proving Ground (2nd Priority)	I76r-696	1951	M&I	1,129	
	Bureau of Reclamation - Davis Dam (2nd Priority)	Secretarial Reservation	4/26/1941	M&I	100	

Table E-1
State of Arizona Colorado River Water Entitlement Holders and Priorities

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement (afy) Diversion	Entitlement (afy) Consumptive Use
2nd & 3rd(co-equal)	Imperial National Wildlife Refuge (2nd Priority)	1964 Decree	2/14/1941	M&I	28,000	or if less, 23,000
	Havasu Lake National Wildlife Refuge (2nd Priority)	1964 Decree	1/22/1941	M&I	41,839	or if less, 37,399
4th (River Users)	Arizona State Land Department	7-07-30-W0358	2004	M&I	1,534	
	Arizona State Land Department	4-07-30-W0317	1999	Agriculture	6,607	
	Arizona State Parks Board - Contact Point	(Recommendation)[5]		M&I	20	
	Arizona State Parks Board - Windsor Beach	7-07-30-W0364	1998	M&I	90	
	Arizona-American Water Company	00-XX-30-W0391	2001	M&I	1,420	
	Beattie Farms Southwest	06-XX-30-W0446	2006	Agriculture	1,110	
	Brooke Water Company (formerly Graham)	4-07-30-W0444	1983/2007	M&I	440	
	Bullhead City (includes subcontract w/MCWA of 6,000 af)	2-07-30-W0273	1982	M&I	21,210	
	Bureau of Land Management[3] (estimated diversion entitlement of 6,171 af)	8-07-30-W0373	1973/81/87	M&I	6,171	4,010
	CHACHA, LLC (formerly Curtis Family Trust)	(Recommendation)		Agriculture	2,100	
	B&F Investment, LLC	06-XX-30-W0453	1983	M&I	60	
	Cibola Valley Irrigation & Drainage District	2-07-30-W0028	1983	M&I	300	
	Cibola Valley Irrigation & Drainage District	2-07-30-W0028	1983	Agriculture	11,766	
	City of Somerton	03-XX-30-W0419	2006	M&I	750	
	City of Yuma (Smucker Park)	14-06-303-2702	1969	M&I	33	
	Cocopah Indian Reservation	1974 Decree	1974	Indian	2,026	
	Crystal Beach Water Conservation District	6-07-30-W0352	1997	M&I	132	
	Curtis, Armon (Curry Family LTD)	3-07-30-W0037	1983	Agriculture	300	
	Desert Lawn Memorial Park Association, Inc.	14-06-300-2587	1975	M&I	360	
	Ehrenburg Improvement District	8-07-30-W0006	1977	M&I	500	
	Fisher's Landing Water and Sewer Works, LLC	6-XX-30-W0450	2007	M&I	53	
	Gila Monster Farms (formerly Sturges Farms Inc.)	6-07-30-W0337	1997	Agriculture	1,435	
	Gold Dome Mining Corporation	0-07-030-W0250	1990	M&I	7	
	Gold Standard Mines Corporation	3-07-30-W0038	1983	M&I	75	
	Golden Shores Water Conservation District	9-07-30-W0203	1989	M&I	2,000	
	Hillcrest Water Company	5-07-30-W0078	1985	M&I	84	
	Hopi Tribe	04-XX-30-W0432	1983	Indian	5,997	

Table E-1
State of Arizona Colorado River Water Entitlement Holders and Priorities

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement (afy)	
					Diversion	Consumptive Use
4th (River Users)	JRJ Partners LLC (formerly Jessen Family Limited)	06-XX-30-W0448	2007	Agriculture	1,080	
	Lake Havasu City (includes subcontract w/ MCWA of 6,000 af)	3-07-30-W0039	1995	M&I	25,180	
	Marble Canyon Company, Inc.	5-07-30-W0322	1996	M&I	70	
	Martinez Lake Cabin Sites	(Recommendation)		M&I	23	
	McAlister, Maurice L.	7-07-30-W0355	1998	M&I	40	
	Mohave County Water Authority	04-XX-30-W0431	1983	Agriculture	5,997	
	Mohave County Water Authority	5-07-30-W0320	1968	M&I	3,500	
	Subcontracts to Arizona-American Water Co. (900 af)					
	Subcontracts to MVIDD (380 & 600 af)					
	Mohave Valley Irrigation and Drainage District	14-06-W-204	1968	M&I	8,000	
	Mohave Valley Irrigation and Drainage District	14-06-W-204	1968	Agriculture	27,060	
	Mohave Water Conservation District (includes subcontract w/ MCWA of 3,000 af)	9-07-30-W0012	1968	M&I	4,800	
	North Baja LLC (formerly Jamar Produce)	5-07-30-W0066	1984	M&I	72	
	North Baja LLC (formerly Jamar Produce)	5-07-30-W0066	1984	Agriculture	408	
	Ogram Boys Enterprises	1-XX-30-W0402	2005	Agriculture	924	
	Ogram, George	01-XX-30-W0398	2003	Agriculture	480	
	Pasquinelli, Gary and Barbara (formerly Ansel Hall)	5-07-30-W0065	1986	Agriculture	486	
	Peach, John	(Recommendation)		Agriculture	456	
	Phillips, Milton and Jean	(Recommendation)		Agriculture	18	
	Rayner Ranches	5-07-30-W0064	1984	Agriculture	4,500	
	Reserved Secretary Water for Indian Settlements				3,500	
	Roy, Edward P. & Anna R.	6-07-30-W0124	1986	M&I	1	
	Shepard Water Company	(Recommendation)		M&I	50	
	City of Parker	2-07-30-W0025	1998	M&I	1,030	
	Town of Quartzsite	7-07-30-W0353	1999	M&I	1,070	
	Verizon (formerly Continental Telephone)	14-06-300-2506	1974	M&I	1	
	Unallocated Priority 4 Water			M&I	9,326	
	Total River Users				164,652	

Table E-1
State of Arizona Colorado River Water Entitlement Holders and Priorities

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement (afy) Diversion	Entitlement (afy) Consumptive Use
4th (CAP)	Central Arizona Water Conservation District (CAP)[4]	14-06-W-245	1972	M&I/Agriculture/Indian	AZ Balance	AZ Balance
5th - Unused Apportionment	Arizona Public Service Company (formerly Yucca Power Plant)	6-07-30-W0336	2000		1,500	
	Arizona State Land Department	4-07-30-W0317	1999		9,067.2	
	Cibola Valley Irrigation & Drainage District	2-07-30-W0028	1983		1,500	
	Gila Monster Farms	6-07-30-W0337	1997		656	
	Hopi Tribe	04-XX-30-W0432	2004		750	
	Lake Havasu City	3-07-30-W0039	1995		Not Specified	
	Marble Canyon Company, Inc.	5-07-30-W0322	1996		Not Specified	
	Mohave County Water Authority	04-XX-30-W0431	1983		750	
	Mohave County Water Authority	5-07-30-W0320	1995		Upon Request	
	City of Parker	2-07-30-W0025	1998		2,000	
6th - Surplus	Cibola Valley Irrigation & Drainage District	2-07-30-W0028	1983		2,000	
	Gila Monster Farms	6-07-30-W0337	1997		Upon Request	
	Hopi Tribe	04-XX-30-W0432	2004		1,000	
	Mohave County Water Authority	04-XX-30-W0431	2004		1,000	

Note: All units are in afy (acre-feet per year).

Subcontracts are displayed below the Entitlement Holder and indented five spaces.

[1]In a shortage, PPRs are delivered water in order of priority date regardless of state lines.

[2]Municipal and Industrial.

[3]BLM diversion entitlement is estimated from consumptive use entitlement based on 2004 Decree Accounting ratios.

[4]These CAP users are subject to CAP conveyance losses which are assumed to be 5 percent.

[5]Recommended Contracts.

Table E-2
State of California Colorado River Water Entitlement Holders and Priorities

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement (afy)	
					Diversion	Consumptive Use
PPR's[1]	Miscellaneous PPRs	PPR's 45-80	1895-1928	M&I	36	21.6
	Sonny Gowan (Grannis)	PPR 32 & 7-07-30-W0158	1928	Agriculture	180	
	Chagnon	PPR No. 41	1925	Agriculture	120	
	Stephenson	PPR No. 30	1923	Agriculture	240	
	Colorado River Sportsmen's League	PPR No. 36	1921	Agriculture	96	
	Andrade (AKA Andrade, Andrews, Bly, Brown, Carney, Daniel, Fairbanks, Glynn, Lindeman, Leon, Schroeder, Sherman, Perrett, Wetmore, Wetmore, Williams)	PPR No. 38	1921	M&I/ Agriculture	66	
	Milpitas	PPR No. 34	1918	Agriculture	108	
	Lawrence	PPR No. 42	1915	Agriculture	120	
	Milpitas	PPR No. 37	1914	Agriculture	69	
	Morgan	PPR No. 33	1913	Agriculture	150	
	Chemehuevi Indian Reservation	PPR No. 22	2/2/1907	Indian	11,340	or if less, irrigation for 1,900 acres
	Cooper	PPR No. 40	1905	Agriculture	60	
	Yuma Project, Reservation Division (non-Indian portion)	PPR 28 & Water Cert.	7/8/1905	Indian/ Agriculture	38,270	or if less, irrigation for 6,294 acres
	Reynolds	PPR No. 39	1904	Agriculture	36	
	Imperial Irrigation District (includes lands in CVWD)	PPR No. 27	1901	Agriculture	2,600,000	or if less, irrigation for 424,145 acres
	Needles (formerly Atchison, Topeka, and Santa Fe Railway Co.)	PPR No. 44	1896	M&I	1,260	273
	Picacho Development Corp and CA Department of Parks and Recreation	PPR 31 & 8-07-30-W0187	1893	Agriculture	120	

Table E-2
State of California Colorado River Water Entitlement Holders and Priorities

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement (afy) Diversion	Entitlement (afy) Consumptive Use
	Fort Mohave Indian Reservation	PPR No. 25	9/18/1890	Indian	16,720	or if less, irrigation for 2,587 acres
PPRs[1]	Simons	PPR No. 35	1889	Agriculture	60	
	City of Needles	PPR No. 43/5-XX-30-W0445	1885	M&I	1,500	950
	Fort Yuma Indian Reservation	PPR No. 23	1/9/1884	Indian	71,616	or if less, irrigation for 10,742 acres
	Palo Verde Irrigation District	PPR No. 26	1877	Agriculture	219,780	or if less, irrigation for 33,604 acres
	Colorado River Indian Reservation	PPR No. 24	5/15/1876	Indian	5,860	or if less, irrigation for 879 acres
	Colorado River Indian Reservation	PPR No. 24	11/16/1874	Indian	40,241	or if less, irrigation for 6,037 acres
	Colorado River Indian Reservation	PPR No. 24	10/22/1873	Indian	10,745	or if less, irrigation for 1,612 acres
	Yuma Associates LTD and Winterhaven Water District (262.8 M&I)	PPR 29 & 4-07-30-W0053	1856	M&I/ Agriculture	780	
1st	Palo Verde Irrigation District - Valley Lands (1)[2]	PVID20733C_P2	1933	Agriculture	≤104,500 acres	Unquantified
2nd	Yuma Project, Reservation Division[3] (includes Bard, Indian, Island[4])	Water Certificates4	1905	Indian/ Agriculture	≤25,000 acres	
3rd	Palo Verde Irrigation District (3b) - Lower Palo Verde Mesa Lands	PVID20733C_P5	1933	Agriculture	≤16,000 acres	Unquantified
	Coachella Valley Water District (3a)[5]	I1r-781	1934	Agriculture		327,000
	Imperial Irrigation Districts (3a)[6]	I1r-747	1932	Agriculture		488,500
4th	Metropolitan Water District of Southern California (4)	I1r-645	1930, 1931	M&I		550,000
5th - Unused	San Diego County Water Authority (5b) (transferred right to MET)					

Table E-2
State of California Colorado River Water Entitlement Holders and Priorities

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement (afy)	
					Diversion	Consumptive Use
& Surplus	Metropolitan Water District of Southern California (5a) (Annexed 5b's Entitlement)	I1r-645	1930, 1931	M&I		662,000
6th - Unused & Surplus	Palo Verde Irrigation District (6b) – Mesa Lands	PVID20733C	1933	Agriculture		300,000
	Coachella Valley Water District (6a)	I1r-781	1934	Agriculture		
	Imperial Irrigation District (6a)	I1r-747	1932	Agriculture		
7th	All remaining water within California available for agricultural use					Unquantified
Surplus	Bureau of Land Management	8-07-30-W0374	1973	M&I		1,000
	City of Needles	5-07-30-W0091	1985	M&I	10,000	
	Coachella Valley Water District	7-07-30-W0150	1987	M&I/ Agriculture	100,000	
	Department of the Navy	6-07-30-W0351	1999	M&I	25	23
	Metropolitan Water District of Southern California	7-07-30-W0171	1987	M&I	180,000	

Note: All units are in afy (acre-feet per year).

M&I: Municipal and Industrial.

These priorities are based on the California Seven Party Agreement, modified to include the PPRs identified by the Consolidated Decree.

Forbearances and transfers are displayed in Appendix G, Attachment 6, Table G-42.

[1]In a shortage, PPRs are delivered water in order of priority date regardless of state lines. It is assumed that each PPR holder would divert and consumptively use all of its entitlement by 2017.

[2]PVID's PPR protects 219,780 af of its Seven Party 1st priority diversion entitlement, which is consumptively estimated to be 93,601 af. Dependent upon call, PVID will fallow a minimum of 25,000 af for the Metropolitan Water District of Southern California.

[3]A portion of this Seven Party Agreement entitlement is protected by two separate PPR entitlements, the Fort Yuma Indian Reservation (PPR 23) and the Yuma Project, Reservation Division (PPR 28).

[4]Incorporation of Yuma Island pumpers' use within this priority does not represent either a final approval of this use by Reclamation or a final determination of the appropriate Decree accounting for this use; and is not an admission by any Colorado River contractor as to the legality of this use or diversion of Colorado River water. No Water Certificates have been issued for use of water on Yuma Island in California.

[5]Coachella Valley Water District's quantified entitlement of 330,000 af is reduced by 3,000 af to permit the Secretary of the Interior to satisfy PPR use not covered by the Seven Party Agreement.

[6]IID's PPR protects 2,600,000 af of its Seven Party 3rd priority diversion entitlement. IID's 3rd priority quantified entitlement of 3,100,000 af is reduced by the estimated PPR consumptive use of 2,527,341 af and 11,500 af to permit the Secretary of the Interior to satisfy PPR use not covered by the Seven Party Agreement.

Table E-3
State of Nevada Colorado River Water Entitlement Holders and Priorities

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement (afy) Diversion	Entitlement (afy) Consumptive Use
1st[1]	Lake Mead National Recreation Area	PPR 82/1979 Decree	1926	M&I	500	or if less, 300
	Fort Mohave Indian Reservation	PPR 81	1890	Indian	12,534	
2nd	Lake Mead National Recreation Area[2]	1964 Decree	1930	M&I	unlimited	
3rd	Boulder City	14-06-300-978	1931	M&I	5,876	
4th	Basic Management, Inc.	14-06-300-2083	1969	M&I	8,608	
	City of Henderson	0-07-30-W0246	1967	M&I	15,878	
5th	Lakeview Company (Hacienda Casino)	14-06-300-1523	1965	M&I	0	
	Pacific Coast Building Products, Inc. (PABCO)	5-07-30-W0089	1965	M&I	928	
6th	Las Vegas Valley Water District	14-06-300-2130	1969	M&I	15,407	
7th	Boy Scouts of America (annexed by SNWA)	9-07-30-W0011	1978	M&I	10	
	Bureau of Reclamation (includes Sportsman Park)	Secretarial Res.	1998	M&I	300	
	Nevada Department of Wildlife (formerly Nevada Dept. of Game and Fish)	14-06-300-2405	1972	M&I		25
	U.S. Air Force (4,000 af) (Delivery from SNWA)				4,000	
8th	Big Bend Water District	2-07-30-W0269	1992	M&I	10,000	
	Robert B. Griffith Project	7-07-30-W0004	1992	M&I	304,000	
	Sub. to City of Boulder City (8,918 af)			M&I		
	Sub. to City Henderson (27,021 af)			M&I		
	Sub. to City of North Las Vegas (26635 af)			M&I		
	Sub. to Las Vegas Valley Water District (232,426 af)			M&I		
8th - Balance & Surplus	Southern Nevada Water Authority (includes banking)	2-07-30-W0266	1992	M&I	balance + surplus	

Note: All units are in afy (acre-feet per year).
M&I: Municipal and Industrial.
Subcontracts are displayed below the Entitlement Holder and indented five spaces.
[1]In a shortage, PPRs are delivered water in order of priority date regardless of state lines.
[2]This unlimited entitlement is estimated based on 2004 use.

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Appendix F

Water Quality Modeling Documentation

This appendix contains the documentation for the modeling and analyses performed to analyze the potential effects on water quality constituents of concern. Three different models were used to analyze different water quality parameters and each is described in this appendix. The salinity module of the CRSS RiverWare™ model was used to analyze changes in salinity concentrations for all alternatives. The CRSS RiverWare™ model is described in Appendix A. The CE-QUAL-W2 model and the GEMSS model were used to analyze potential changes in temperature and water quality corresponding with reservoir drawdown and respective reservoir releases. The results of the modeling and analysis of these water quality parameters are described in Section 4.5 of this Final EIS.

Table of Contents

List of Figures

List of Tables

F.1 Salinity Modeling Using the Salinity Module of the CRSS RiverWare™ Model - Model and Approach Description

F.1.1 Model Description (Salinity Module of the CRSS RiverWare™ Model)

Salinity is the only water quality parameter modeled in CRSS. It is modeled as a conservative substance; therefore, dissolution and precipitation are not modeled. As with the hydrology component, salinity is modeled at a monthly time-step and both reservoir and river reach objects are assumed fully mixed over the month; thereby, requiring no lagging algorithms to route salinity.

Seven of the twelve reservoirs (Flaming Gorge, Starvation, Navajo, Lake Powell, Lake Mead, Lake Mohave, and Lake Havasu) are represented in the CRSS salinity module. The reservoirs Flaming Gorge, Navajo, Lake Powell, Lake Mead, and Lake Mohave use a Huen or Predictor-Corrector numerical method to route salinity through the reservoirs. The reservoirs Starvation and Lake Havasu use a weighting method developed by Reclamation that facilitates routing salinity in a reservoir that has a small storage to inflow ratio. Under this scenario, standard numeric methods, such as the Huen method, can become numerically unstable. Both methods assume the reservoirs are fully mixed at a monthly time-step. Flaming Gorge, Lake Powell, and Lake Mead reservoirs include salinity in their bank storage computation. Water flows into the bank at the current time-step concentration and fully mixes with the bank water. Water flows out of the bank at the current time-step bank concentration.

Salt can enter the river system from either a natural source, salt loading resulting from irrigated agriculture return flows, or from flows imported into the system. Salt can leave the system with flows exported out of the system. Additionally, water quality improvement projects represent salt prevented from entering the system as the result of salinity control measures.

F.1.2 Input data

The CRSS salinity component requires several salinity specific data inputs. These include natural salinity at 24 nodes throughout the Colorado River system, future levels of salt loading resulting from agriculture, the concentration of exported and imported flows, future levels of salinity control, and initial reservoir salinity concentrations.

Salinity associated with the available natural flow data (described in Section 3.3 of this Final EIS) is computed with a single site salinity model presented in Prairie et al. (2005). This model uses a nonparametric regression method based on local polynomial estimation, which describes the variability of salt mass as a function of flow. The model is defined as: natural salt mass = f (natural streamflow). The main feature is that the function f is estimated locally (Loader 1999). The implementation steps are as follows.

a) At any value of the streamflow, say x*, K-nearest neighbors (K-NN) are identified from the observations.

b) To the K-NN a polynomial of order p is fit.

c) The fitted polynomial is then used to estimate the salt mass corresponding to the streamflow x*.

The number of nearest neighbors (K) and the order of polynomial p are estimated for the observed data using objective criteria, Generalized Cross Validation (GCV). The local estimation of the function f provides the capability to capture any arbitrary features (linear or nonlinear) that might be present in the data; besides, this obviates making any assumptions as to the underlying form of the function f (linear in the case of traditional linear regression approach). Prairie et al. (2005) provides details on the methodology and its development for salinity modeling.

Natural salt mass, required to compute the flow-salt regressions, is computed by removing anthropogenic influences (upstream reservoir regulation, salt loading from agriculture return flows, and salt removed with exports) affecting salt from observed historic data. Natural salt mass data from 1971 to 1995 were used for the 15 Upper Basin gages, matching the time period used in the 2005 Triennial Review. The nine Lower Basin gages were modeled based on 1971 to 2005 natural salt mass data. Once the monthly regression relationships were determined for each gage the associated natural salt for the natural flows from 1906 to 2004 are computed.

Salt loading resulting from agriculture is available at an annual time-step and disaggregated to monthly values for modeling purposes. The concentrations of exported and imported flows are developed from available historic data at each export location and held constant through time. Future levels of salinity control are estimated from hydro-salinity studies performed for each salinity control project. Initial reservoir salinity concentrations were set based on the latest historic values available. These are the December 2005 values reported by the United States Geographical Survey (USGS) with the exception of Davis Dam and Parker Dam, which were assumed to be equivalent to Lake Mead concentration since a December 2005 value is not available.

F.1.3 Calibration

To ensure the regressions properly capture the flow-salt relationship, the regressions used to determine natural salt based on the 1971 to 1995 natural flows is input in a CRSS-based model. The model is run with historic data representing salt loading from agriculture, concentration of exported flows, levels of salinity control, and initial reservoir salinity concentrations for the time period 1971 to 1995. If the simulated historic salinity concentrations downstream of Lake Powell and upstream of Imperial Dam compare well with the actual historic salinity at these locations the model is properly calibrated. An example of this is shown in Prairie and Callejo (2005).

F.1.4 Limitations

Since the regression relationship between flow and salt is based on post-1971 values future projections are limited to simulating the post-1971 flow and salt relationship. A changing relationship cannot be modeled.

Limited data is available describing the monthly salt loading resulting from agriculture. Annual estimates are disaggregated for modeling purposes and monthly salinity results are typically aggregated to an annual time-step before analysis of results. The variability of annual salt loading resulting from agriculture is not well understood; therefore, the annual estimate is held constant over all years. This assumption forces the variability in agricultural salt loading to be back-computed into the natural salt mass. Therefore, it is important to recognize that the natural salt mass, as well as the natural flow, is not only what would naturally have occurred throughout the basin without anthropogenic effects. It also incorporates the error in any assumptions or in the accuracy of the estimates of the anthropogenic effects that were removed from the historic gage records.

Lastly, the CRSS salinity component is generally intended for long-term modeling (15 to 20 years) and reservoir salinity is highly sensitive to initial reservoir conditions for the first ten to 12 years. More accurately determining initial reservoir conditions will greatly improve the accuracy of the first ten to 12 years of results. After these first ten to 12 years the initial conditions have minimal impact on model results.

F.2 Reservoir Modeling Using CE-QUAL-W2 Water Quality Model - Model and Approach Description

F.2.1 Model Description (CE-QUAL-W2 Model)

CE-QUAL-W2 is a two dimensional, longitudinal/vertical, hydrodynamic, and water quality model. Because the model assumes lateral homogeneity, it is best suited for relatively long and narrow waterbodies exhibiting longitudinal and vertical water quality gradients (Cole 2003). Development and evolution of CE-QUAL-W2 has spanned three decades. The United States Army Corps of Engineers (USACE), J.E. Edinger and Associates (Edinger), and Dr. Scott Wells at Portland State University working with Mr. Tom Cole (USACE) have been the major developers in recent years. Edinger was contracted by Reclamation’s Upper and Lower Regions to test the earliest version of this model (LARM) in 1980 on Lake Powell and Lake Mead. All of the above have been helpful and provided some insight on the development of this application.

F.2.2 Model Capabilities & Limitations

The CE-QUAL-W2 model is capable of predicting water surface elevations, velocities, temperatures, and a number of water quality constituents. Water is routed through cells in a computational grid where each cell acts as a completely mixed reactor for each time-step. Geometrically complex waterbodies can be represented through multiple branches and cells. Multiple inflows and outflows to the waterbody are represented through point/nonpoint sources, branches, precipitation, and other methods. Tools for modeling hydraulic structures such as spillways and pipes are available. Output from the model provides options for detailed and convenient analyses.

The model uses several assumptions and approximations to simulate hydrodynamics, transport, and water quality processes. The model solves for gradients in the longitudinal and vertical directions and assumes lateral gradients are negligible. This assumption may be inappropriate for waterbodies with significant lateral variations. Turbulence is modeled through eddy coefficients of which the user must decide which scheme is most appropriate for an application. An algorithm for vertical momentum is not included and results may be inaccurate in waterbodies with significant vertical acceleration. Water quality processes are extremely complex and the model uses simplified approaches to reach solutions. Several water quality processes are not simulated including zooplankton, macrophytes, and a dynamic sediment oxygen demand.

F.2.3 Input Data
The model is limited by the quality and availability of input data. This includes meteorological, inflow and outflow, water temperature, water quality, and calibration data. These data most often determine the accuracy and usefulness of the application.

F.2.4 Bathymetry
The bathymetry file of a CE-QUAL-W2 model is the two-dimensional numeric representation of a waterbody and is also referred to as the computational grid. The two dimensions represented are the longitudinal and vertical dimensions, or the length and depth of a waterbody which are divided into longitudinal segments and vertical layers. The lateral dimension, or width, is not represented in the grid but an average width is computed and used to determine volume. Since the model grid is two-dimensional all modeled parameters such as temperature, velocity, and water quality constituents can only vary in the longitudinal and vertical directions. This assumes that modeled parameters do not vary significantly in the lateral direction. This assumption has been found appropriate in relatively long and narrow waterbodies.

The components of the grid are, from smallest to largest, cells, segments, branches, and waterbodies. The cell is a single vertical layer within a single segment. Segments consist of one or more cells, branches are one or more longitudinal segments, and a waterbody is one or more branches. Bathymetry files are dimensions from a single waterbody.

The volume of the grid is computed by multiplying a cell's length, thickness, and width. The sum of all cells within the grid is then the total storage for the waterbody. The computational grid storage is compared to actual storage-capacity charts to verify the model bathymetry accuracy.

F.2.5 Model Calibration
Model calibration involves comparing observed data to modeled, or predicted, results. The observed values are typically vertical profile and reservoir discharge observations for temperature and other water quality parameters. Calibration statistics are generated by computing the absolute mean error (AME). This computation is the sum of the absolute value of the predicted value minus the observed value, which is then divided by the total number of observations. This describes, on average, the difference between predicted and observed values.

F.2.6 Code Modifications

The unique chemical fingerprinting in Lake Powell with the build up of saline water, reservoir turn over and routing of the salt presents a unique data base to test the mixing algorithms of various models. The original WRE one-dimensional model, LARM, and earlier versions of CE-QUAL-W2 all completely mixed the reservoir each year, and thus multi-year runs were not possible. These models all fairly represented temperatures of the releases from the dam to test selective withdrawal alternatives. The version of CE-QUAL-W2 being utilized for this analysis is version 3.2; however, Reclamation has contracted Environmental Resources Management (ERM) to assist in peer review and in code modification specific to this system. Since hydrodynamic mixing is critical to maintaining long term salinity profiles in this reservoir, a modification in the code was made for this modeling to improve seasonal mixing. Evaporation is one of the primary variables affecting vertical mixing in the reservoir. The code has been modified to allow the evaporation coefficients to be changed to a fixed value at any frequency. For the Lake Powell application monthly coefficients are used. By setting monthly evaporation coefficients the model calibration has been significantly improved for the test period in both heat and salinity budgets. Evaporation totals were compared with Reclamation computed monthly evaporation values as a calibration check.

F.2.7 Lake Powell Model

F.2.7.1 General Description

The Lake Powell model simulates hydrodynamics, temperature, salinity, dissolved oxygen, phytoplankton and organic matter decay. The model uses a geometric, computational grid and various input data to simulate these processes. The grid is discussed below. Input data describe meteorological conditions, inflows, outflows, and water quality parameters. Meteorological data are collected from Page, Arizona and Hanksville, Utah. Inflow records are used for the Colorado River (combination of the Colorado, Green, and San Rafael Rivers), San Juan River, and the Dirty Devil River. For inflows where little or no data is available estimates are made. These include:

- North Wash
- Trachyte Creek
- Hansen Creek
- Bullfrog Creek
- Halls Creek
- Escalante River
- Cha Creek
- Rock Creek
- Last Chance Creek

- Warm Creek
- Navajo Canyon
- Wahweap Creek

Outflow is for all releases made through Glen Canyon dam. Data for water quality parameters are from major tributaries where available. These data sets have been collected from Reclamation, United States Geological Survey, National Climatic Data Center, and Utah and Arizona state and local agency records.

F.2.7.2 Lake Powell Bathymetry

The Lake Powell CE-QUAL-W2 bathymetry consists of 9 branches, 90 segments, and 97 layers. All layers are 1.75 meters thick. The branches represent the following channels and/or bays:

- Main (Colorado River) channel – Branch 1 (Br 1)
- Bullfrog Bay – Branch 2 (Br 2)
- Escalante River channel – Branch 3 (Br 3)
- San Juan River channel – Branch 4 (Br 4)
- Rock Creek Bay – Branch 5 (Br 5)
- Last Chance Bay – Branch 6 (Br 6)
- Warm Creek Bay – Branch 7 (Br 7)
- Navajo Canyon – Branch 8 (Br 8)
- Wahweap Bay – Branch 9 (Br 9)

Figure F-1 is a diagram of the Lake Powell model bathymetry with top, front, and side views of the grid.

Figure F-1
Lake Powell Bathymetry[1]

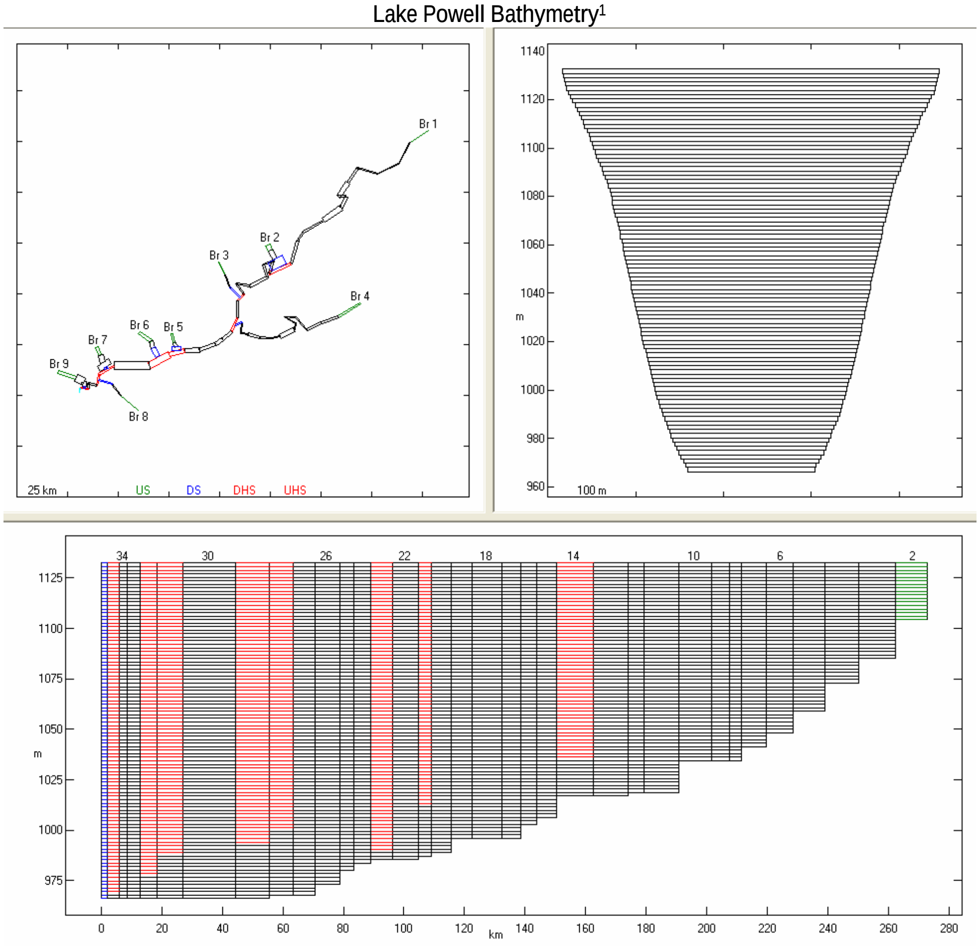


Figure Notes:
[1] Br # indicates the different branches in the Lake Powell Bathymetry two-dimensional model grid. The list of branches can be found in Section F.2.7.2
Blue: indicates a downstream boundary condition
Red: indicates the connection of tributary branches
Green: indicates an upstream boundary condition

F.2.7.3 Lake Powell Model Assumptions

The input data used in the model are the best available and are assumed to be accurate representations of meteorology, flow, and water quality parameters. Additional assumptions, described below, may also affect model accuracy and reliability.

F.2.7.4 Meteorological Conditions

Meteorological conditions are represented in the model by one dataset. Data from the Page, Arizona airport is used to represent meteorological conditions on Lake Powell, mainly because it is the most complete dataset in the region. Page is located at the southernmost end of the reservoir and conditions there are not always representative of conditions on the rest of the lake, especially near the major inflows and northern end. The errors that result, however, are considered acceptable.

F.2.7.5 Water Balance

The model is calibrated to reproduce observed water surface elevations. An additional input referred to as the distributed tributary is created. This input includes flows that are required to balance the water budget, positive or negative. This represents precipitation, ungaged flow, bank storage, and other source/sinks. CE-QUAL-W2 distributes this flow evenly over the water surface in a simulation. Large flows can have water quality impacts. Reasonable assumptions are made for assigning water quality constituent concentrations to these flows.

F.2.7.6 Sediment Delta Interactions

Sediment deltas have built up near the mouth of major and minor inflows. Deposition and scour of these deltas creates interactions that impact several water quality parameters. The CE-QUAL-W2 model does not simulate sediment delta scouring, sediment digenesis of dissolved phosphorus, or chemical and biological oxygen demand release. This is on the edge of modeling and data gathering technology at this time. These processes are either not represented or an alternate approach is used to model them. The impact of these processes is not insignificant and until the approaches used are studied further the dissolved oxygen and nutrient analyses are largely qualitative.

F.2.7.7 Lake Powell Model Calibration

The Lake Powell CE-QUAL-W2 model is considered calibrated for temperature and total dissolved solids for the period 1990-2005. Predicted results are compared to observed data from 13 locations including the tailwater. Calibration efforts for other water quality parameters such as dissolved oxygen, nutrients, and algae are ongoing and considered qualitative at this stage.

F.2.7.8 Temperature Calibration

Calibration statistics for temperature are shown for each station in Table F-1. The number of profiles at each station is also given in the table. The AME of the temperature profiles is 0.8°C. The AME of the dam release temperatures is 0.45°C.

There are hundreds of individual profiles over the 15 year run period within the model. Three select vertical profiles with AME statistics are shown below for Wahweap (Figure F-2), Bullfrog (Figure F-3), and Cha (Figure F-4). A graph of the observed and predicted reservoir discharge temperatures is also shown (Figure F-5).

Table F-1
Lake Powell Temperature Calibration Statistics

Station	Years	AME	# of Profiles
Hite	1991 to 2005	1.39	52
Good Hope	1991 to 2005	1.11	52
Bullfrog	1991 to 2005	0.84	53
Escalante Confluence	1991 to 2005	0.69	54
San Juan Confluence	1991 to 2005	0.59	38
Oak Canyon	1991 to 2005	0.62	58
Crossing of the Fathers	1991 to 2005	0.58	60
Lower Zahn	1991 to 2005	1.21	38
Upper Piute	1991 to 2005	0.97	49
Lower Piute	1991 to 2005	0.80	44
Cha Canyon	1991 to 2005	0.69	51
Wahweap	1991 to 2005	0.65	179
Release Temperature	1991 to 2005	0.45	
Average		0.80	

Figure F-2
Temperature Profile at Wahweap Station, 2.4 kilometers from Glen Canyon Dam (AME = 0.39°C)

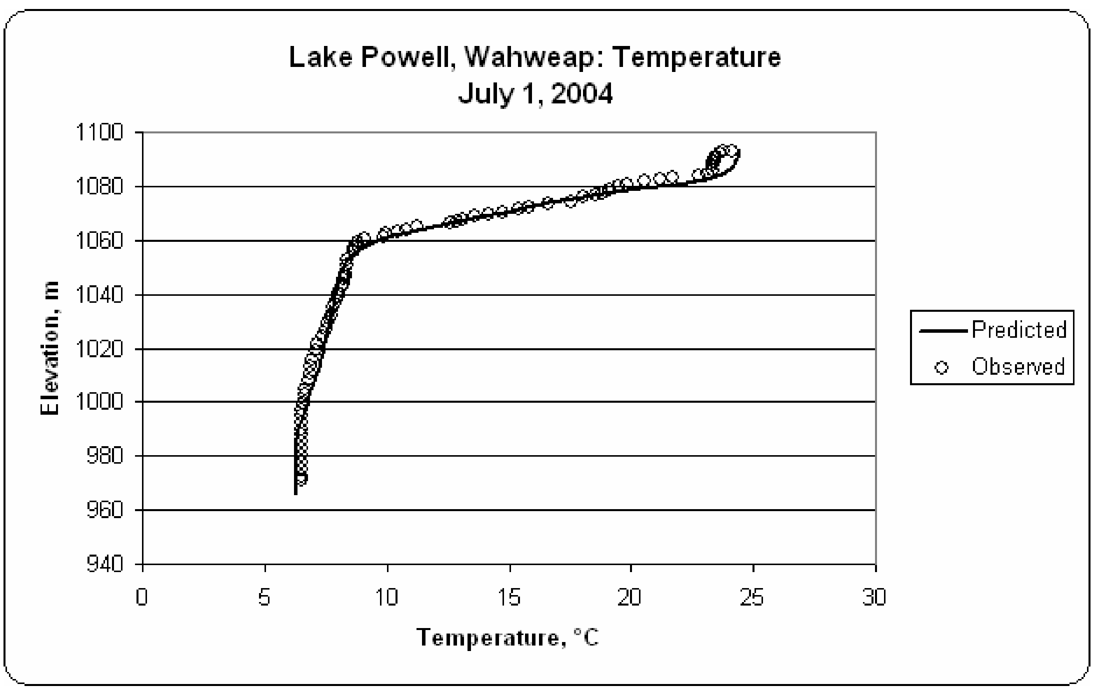


Figure F-3
Temperature Profile at Bullfrog Station, 169.2 kilometers from Glen Canyon Dam

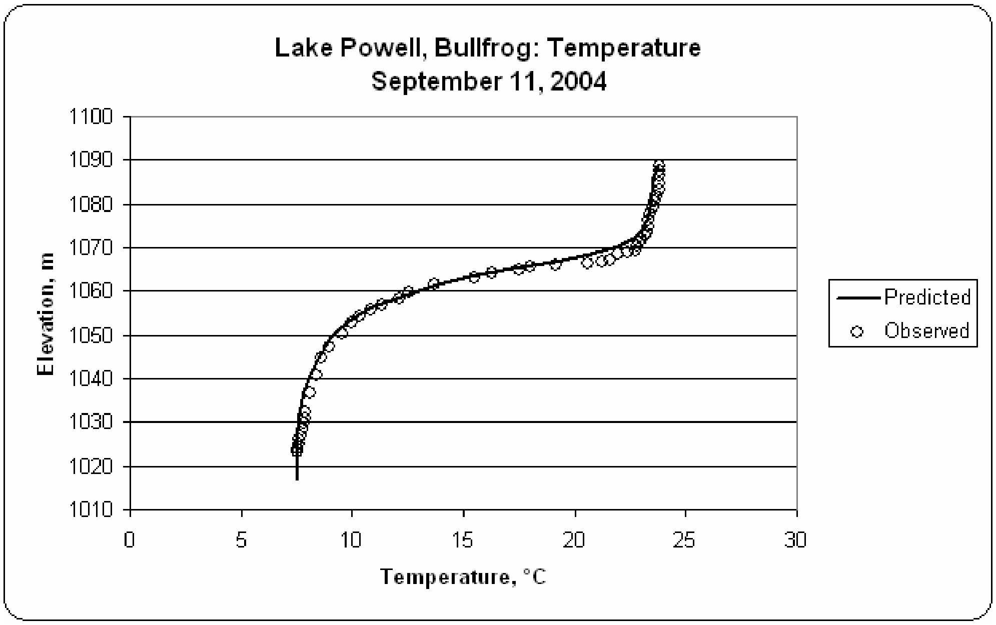


Figure F-4
Temperature Profile at Cha Station, 19.3 kilometers from the Confluence of the
San Juan River and Colorado River Channels (AME = 0.32°C)

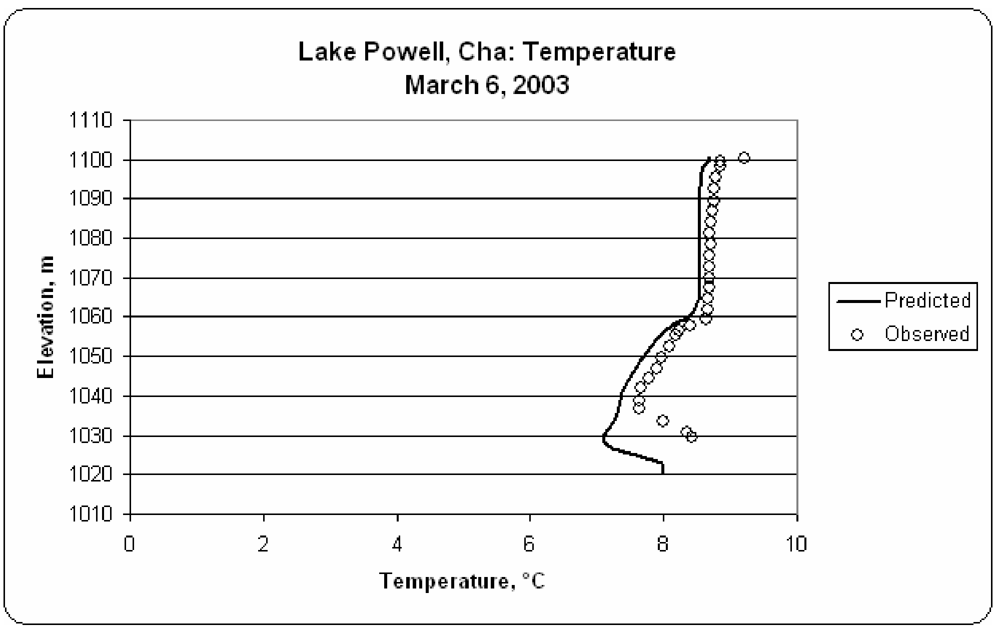
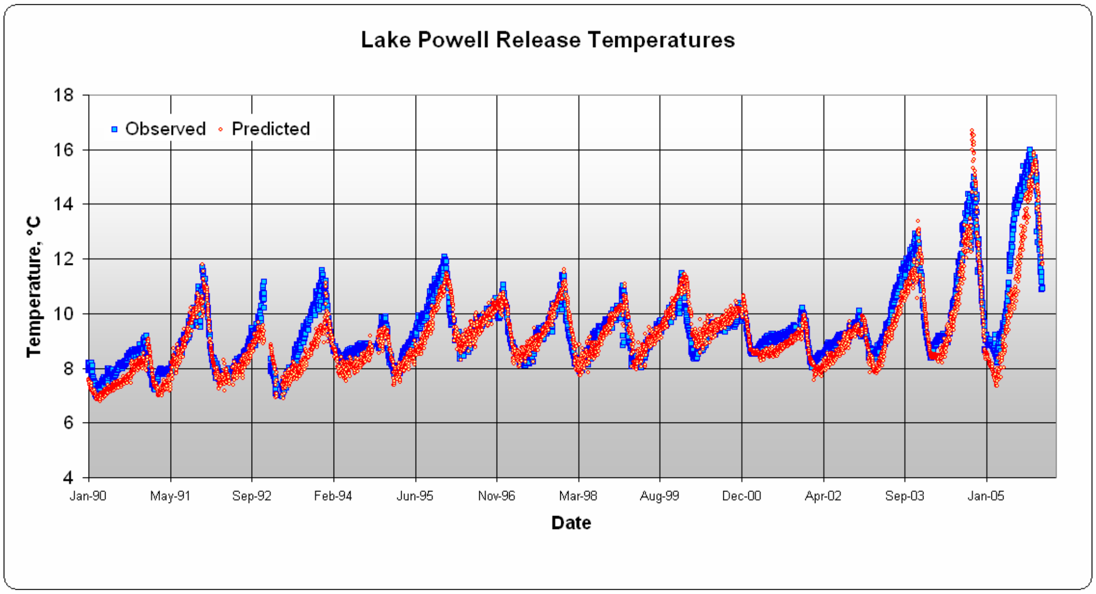


Figure F-5
Glen Canyon Dam Discharge Temperature Calibration



F.2.7.9 Total Dissolved Solids Calibration

Total dissolved solids (TDS) are assumed to be a conservative parameter and, therefore, act as a tracer and help verify the hydrodynamic calibration. Calibration statistics and the number of profiles for TDS at each station are shown in Table F-2. The AME of the TDS profiles is 32.6 mg/L. The AME of the tailwater TDS is 14.1 mg/L.

Table F-2
Lake Powell TDS Calibration Statistics

Station	Years	AME	# of Profiles
Hite	1991 to 2005	54.98	52
Good Hope	1991 to 2005	41.61	42
Bullfrog	1991 to 2005	31.04	53
Escalante Confluence	1991 to 2005	27.88	54
San Juan Confluence	1991 to 2005	26.65	38
Oak Canyon	1991 to 2005	25.99	58
Crossing of the Fathers	1991 to 2005	25.42	60
Lower Zahn	1991 to 2005	40.43	38
Upper Piute	1991 to 2005	29.22	49
Lower Piute	1991 to 2005	24.25	44
Cha Canyon	1991 to 2005	27.01	51
Wahweap	1991 to 2005	34.71	179
Release TDS	1991 to 2005	14.1	
Average		32.63	

Three TDS vertical profiles with AME statistics, for the same stations and dates as the temperature profiles, are shown in Figure F-6 through Figure F-9.

Figure F-6
TDS Profile at Wahweap Station, 2.4 kilometers from Glen Canyon Dam (AME = 19.5 mg/L)

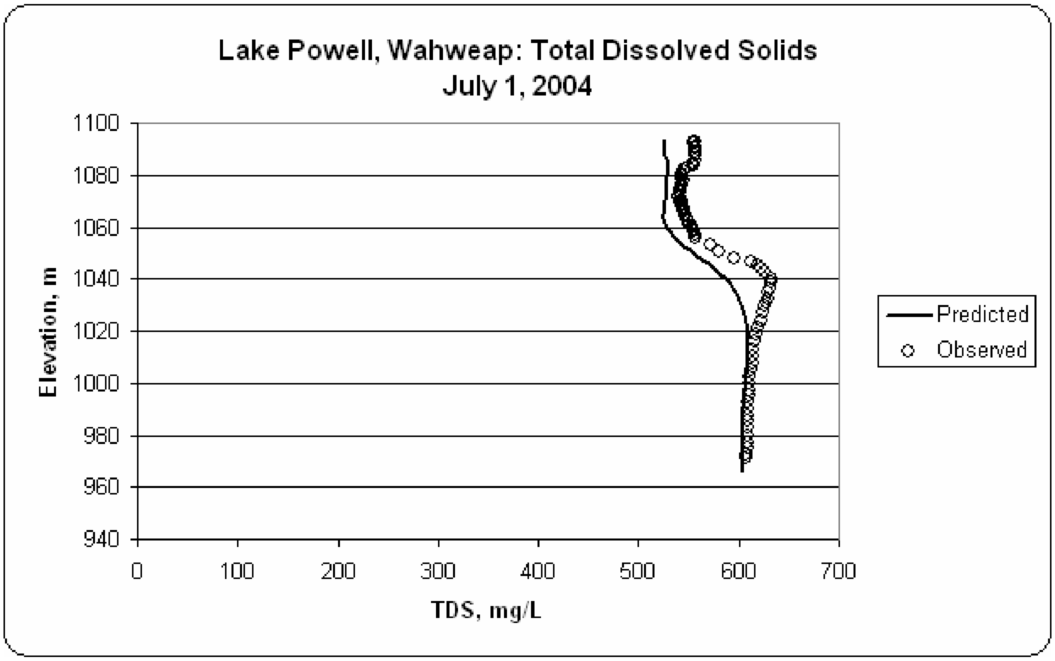


Figure F-7
TDS Profile at Bullfrog Station, 169.2 kilometers from Glen Canyon Dam (AME = 30.2 mg/L)

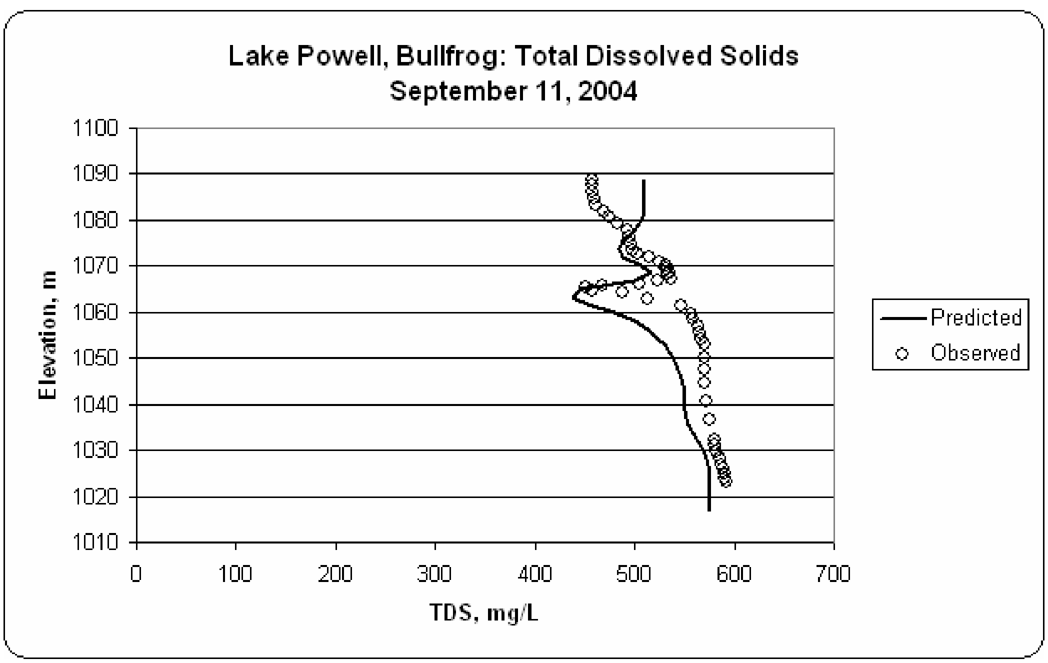


Figure F-8
TDS Profile at Cha Station, 19.3 kilometers from the Confluence of the San Juan River and Colorado River Channels (AME = 30.8 mg/L)

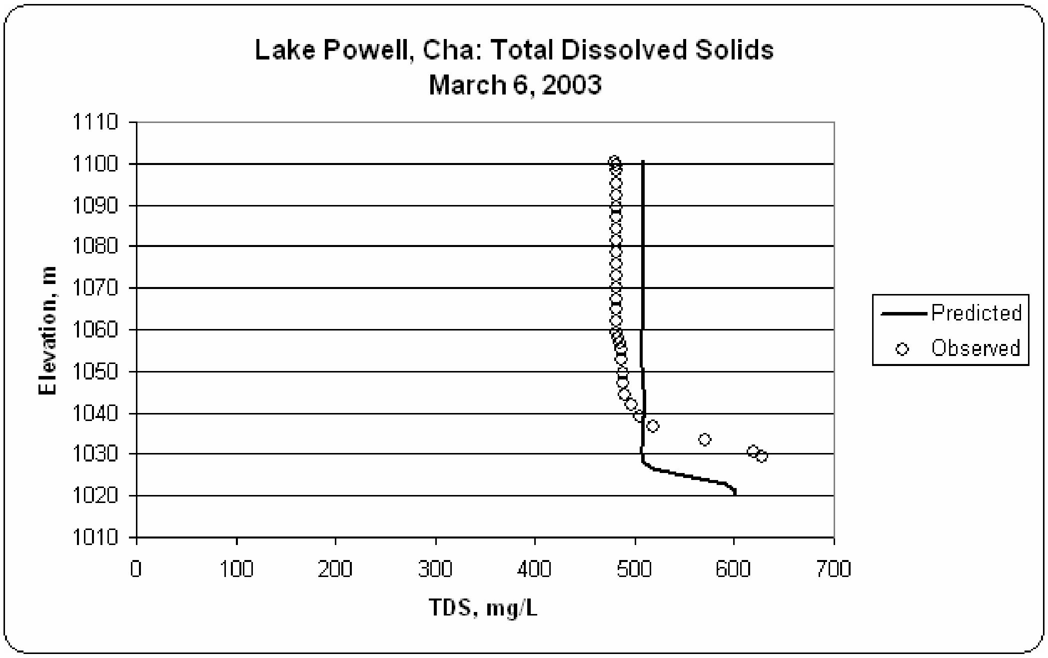
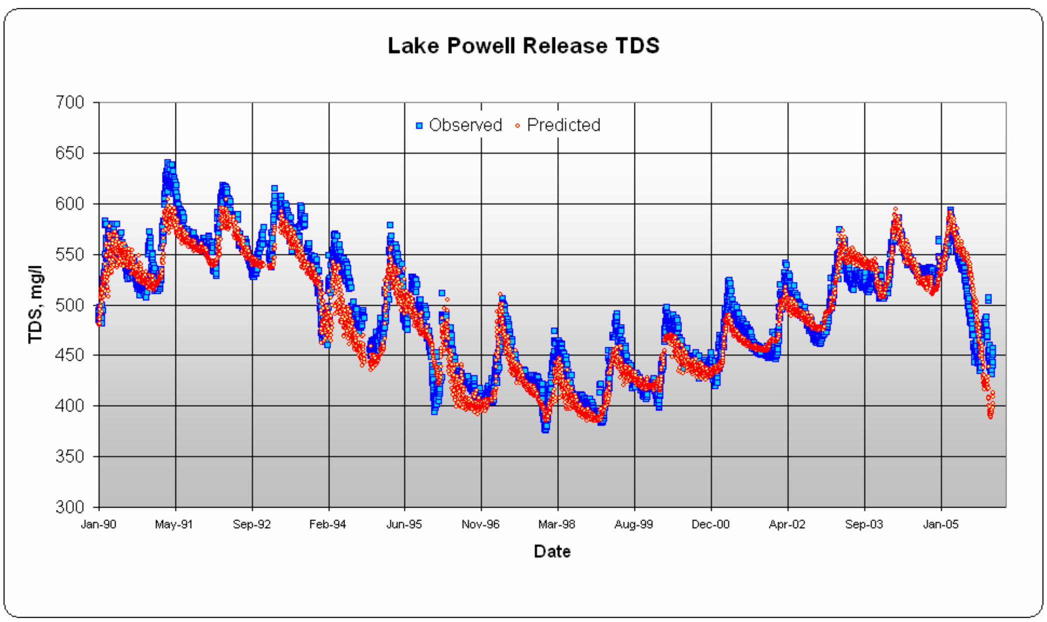


Figure F-9
Glen Canyon Dam Discharge TDS Calibration



F.2.7.10 Dissolved Oxygen Calibration

The dissolved oxygen calibration is still in its initial stages of development and is of limited value for use in the Final EIS. It is affected by temperature, wind and wave mixing, plankton production and respiration, organic matter decay, and other chemical and biological oxygen demands. Many of these are complex and not extensively monitored. A qualitative/semi-quantitative analysis using an empirical method is being developed, a summary of which is given below.

Dissolved oxygen trends and cycles appear to be related to hydrology and reservoir drawdown. Based on these two parameters two CBOD compartments in the CE-QUAL-W2 model are being utilized to represent the sum total oxygen demand. They are loaded as part of the parameters in the inflow constituent file. The loading values in these two inflow CBOD boxes are being calculated by a set of rules and relationships based on changes in reservoir elevation, inflow volume, and water temperature. One box is used to represent chemical oxygen demand processes predominating cold water inflow conditions, while the other is used more to represent summer time carbonate biological oxygen demand processes associated with bacteriological decay of organic matter. Calibration is accomplished by iterative runs (trial and error) and comparison with downstream segment oxygen, phosphorus, carbon, and phytoplankton profile numbers. The overall DO calibration has an AME of 1.2 mg/L for vertical profiles and 0.9 mg/L for reservoir discharge DO (see Table F-3). Vertical profiles of the dissolved oxygen calibration at Wahweap (Figure F-10 and Figure F-11), Bullfrog (Figure F-12), and Cha Canyon (Figure F-13) are shown below as well as the discharge concentrations (Figure F-14). Calibration is expected to be further improved with additional iterative runs and refinement to the method.

Table F-3
Lake Powell DO Calibration Statistics

Station	Years	AME	# of Profiles
Hite	1991 to 2005	1.11	52
Good Hope	1991 to 2005	0.96	51
Bullfrog	1991 to 2005	1.00	54
Escalante Confluence	1991 to 2005	1.04	54
San Juan Confluence	1991 to 2005	1.13	38
Oak Canyon	1991 to 2005	1.00	58
Crossing of the Fathers	1991 to 2005	1.21	60
Lower Zahn	1991 to 2005	1.45	38
Upper Piute	1991 to 2005	1.23	49
Lower Piute	1991 to 2005	1.11	44
Cha Canyon	1991 to 2005	1.19	51
Wahweap	1991 to 2005	1.40	182
Release DO	1991 to 2005	0.86	
Average		1.19	

Figure F-10
DO Profile at Wahweap Station, 2.4 kilometers from Glen Canyon Dam (AME = 1.3 mg/L)

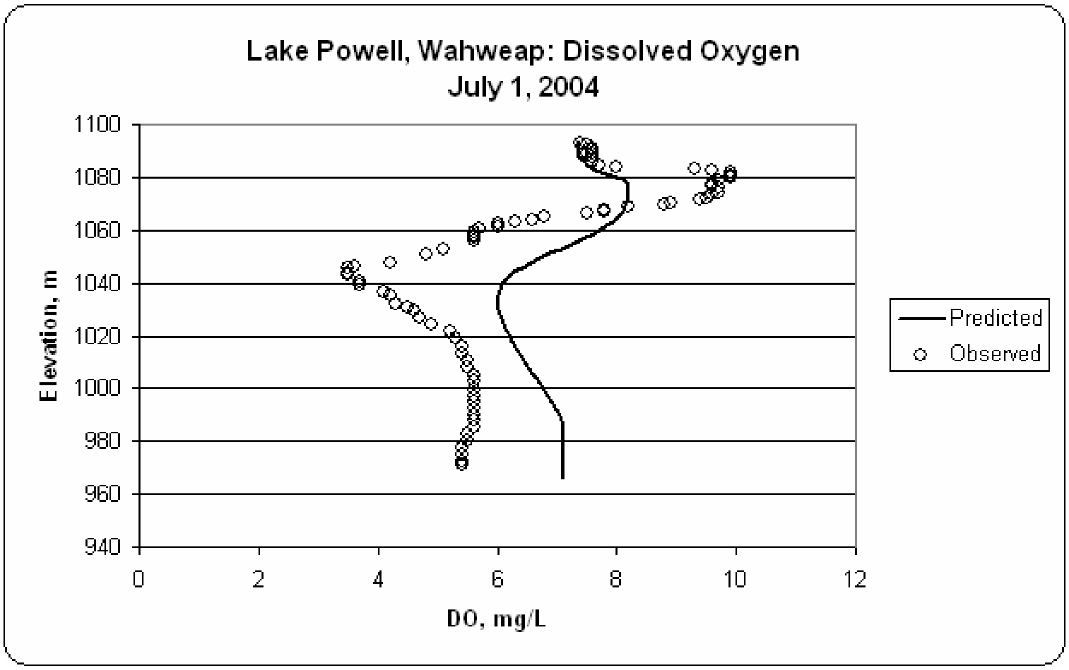


Figure F-11
DO Profile at Wahweap Station, 2.4 kilometers from Glen Canyon Dam (AME = 0.6 mg/L)

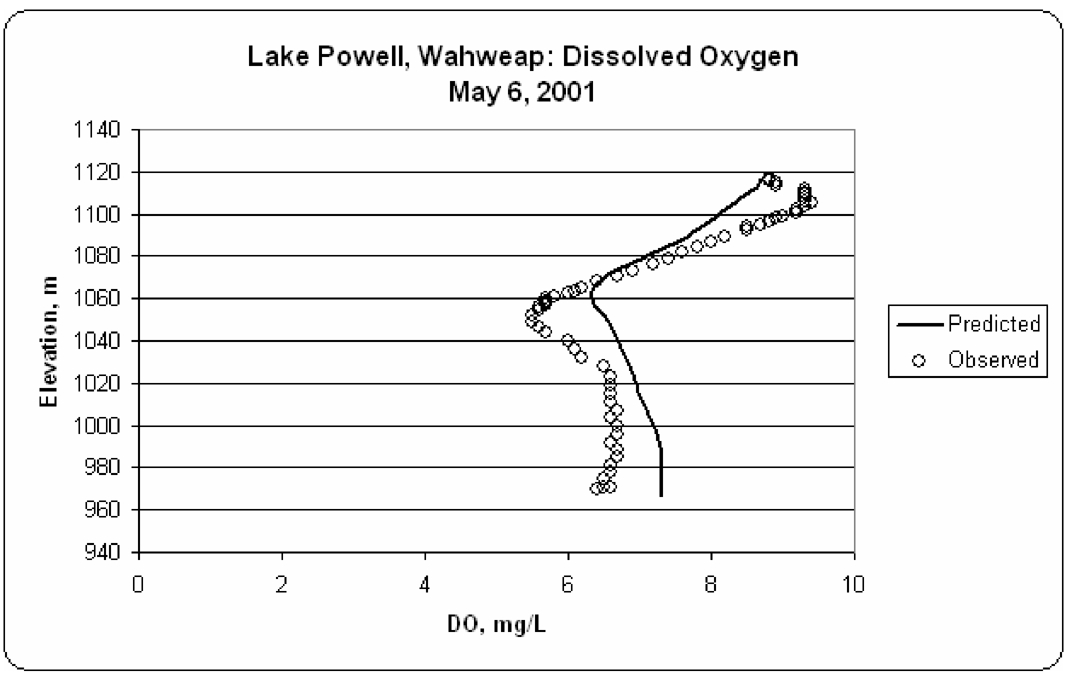


Figure F-12
DO Profile at Bullfrog Station, 169.2 kilometers from Glen Canyon Dam (AME = 0.9 mg/L)

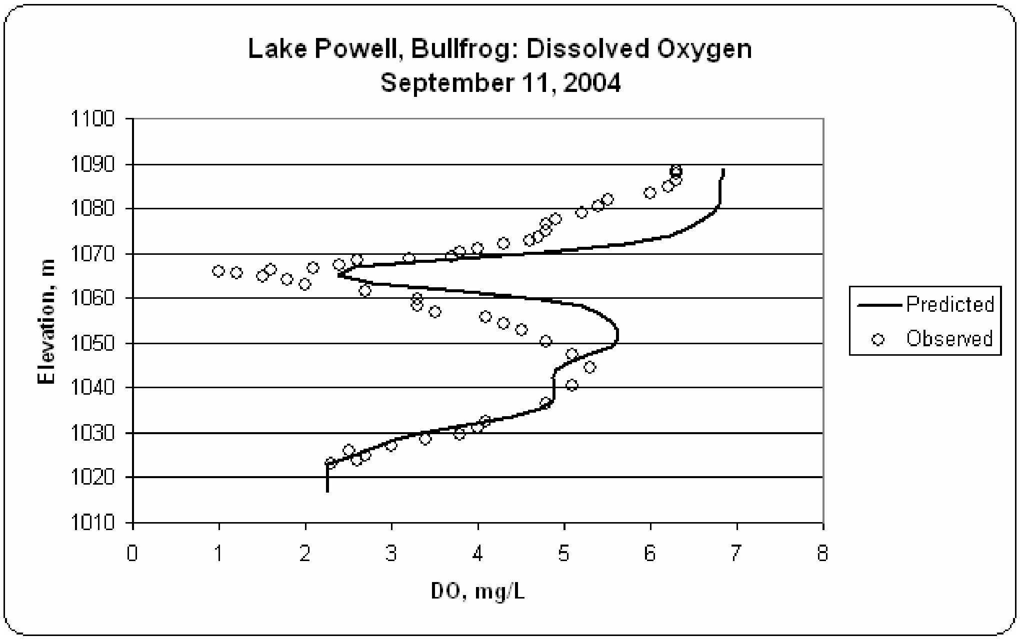


Figure F-13
DO Profile at Cha Station, 19.3 kilometers from the Confluence of the
San Juan River and Colorado River Channels (AME = 0.8 mg/L)

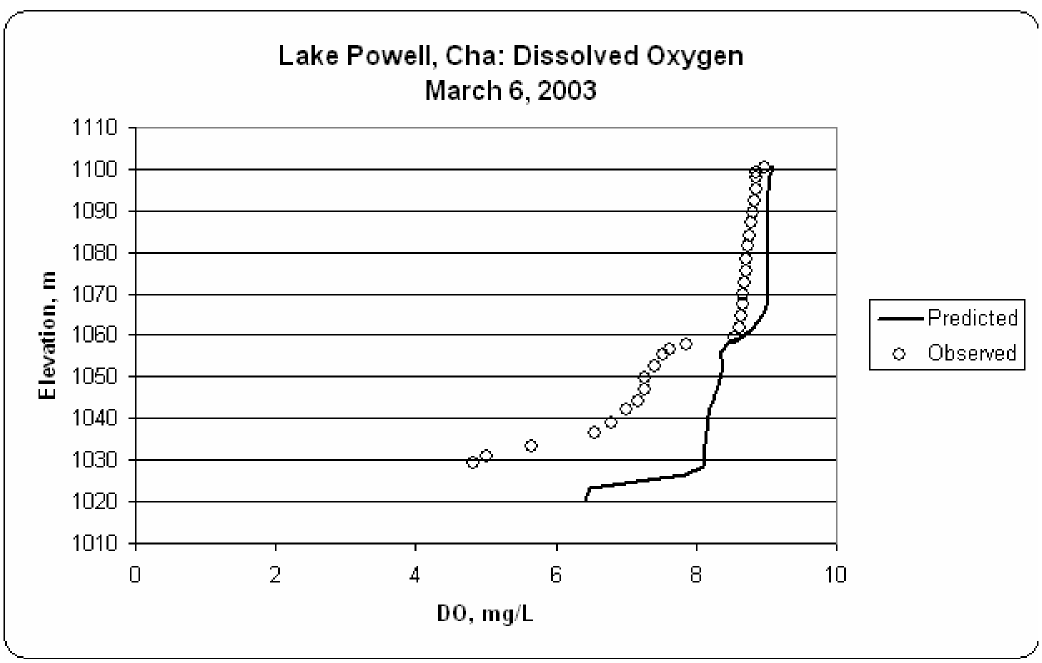
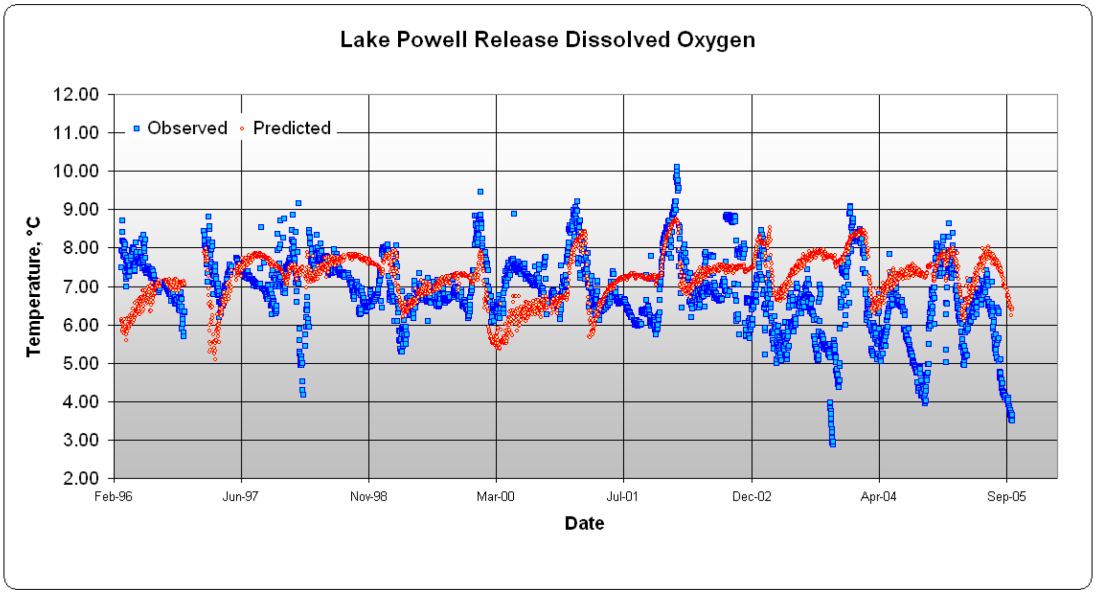


Figure F-14
Glen Canyon Dam Discharge DO Calibration



F.3 Temperature Modeling of Colorado River Flows Between Glen Canyon Dam and Lake Mead Using the GEMSS Water Quality Model - Model and Approach Description

F.3.1 Model Description (GEMSS Model)

The 1-D hydrodynamic and water quality model GEMSS was developed by Edinger. The transport equations for this model were similar to W2 which was based on the Generalized Longitudinal Hydrodynamic and Transport (GLHT) computation derived from the three-dimensional equations of fluid motion and continuity (Edinger and Buchak 1980). This model was selected because of its successful applications of the 1-D water quality/hydrodynamic module in TMDL studies. Like the CE-QUAL-W2 model it can model numerous water quality parameters; however, only water temperature was modeled for this study.

F.3.2 Model Geometry

The model's geometry data downstream of Glen Canyon Dam to Lake Mead was based upon GIS spatial information and river cross sections available from USGS Grand Canyon Monitoring and Research Center (GCMRC). This information was used to generate a simplified geometry grid covering 280 miles of the Colorado River using 102 segments with averaged length of 7,000 m (23,000 ft) each and 234 slope points.

F.3.3 Model Time-varying Data

The model's time-varying data sets included flow rates, water temperatures, downstream water surface elevation, and meteorological data which were used to compute surface heat exchange. The boundary hydrology included daily average release data from Lake Powell and daily inflows of an average year (1947 to 2004) from the Little Colorado River. These data came from USGS gaging stations and Reclamation database. The water temperature boundary conditions included daily measured temperatures at Lees Ferry and daily temperature of an average year from the Little Colorado River. Meteorological data from Page, Arizona was required to compute surface wind shear and heat exchange and consisted of hourly air and dew point temperature, wind speed, wind direction, cloud cover, solar radiation, and atmospheric pressure.

F.3.4 Temperature Calibrations

The GEMSS model was calibrated to observed Diamond Creek hydrology and observed water temperature at three locations (Lees Ferry, Little Colorado River confluence, and Diamond Creek) that were provided by GCMRC. The calibration period was based on the same period used in CE-QUAL-W2 (1990 to 2005); however observed data for these three locations were sporadic for this time period.

To verify the mass balance calculation of the model, the modeled flows were compared with actual flows at Diamond Creek. The modeled flows at Diamond Creek were consistently lower than observed flows by about six percent due to tributary inflows and assumed average daily flows from the Little Colorado River. The average errors for comparison between modeled and observed water temperatures were -0.08 °C at Lees Ferry, 0.09 °C below the Little Colorado River, and -1.1 °C at Diamond Creek (Figures F-15, F-16, and F-17 respectively). The modeled water temperatures at the Diamond Creek station were consistently lower than the observed data. This was likely caused by the difference in meteorological data between Diamond Creek and Page.

Figure F-15
GEMSS Modeled and Observed Temperatures at Lees Ferry (a sample period of 1995 to 2002)

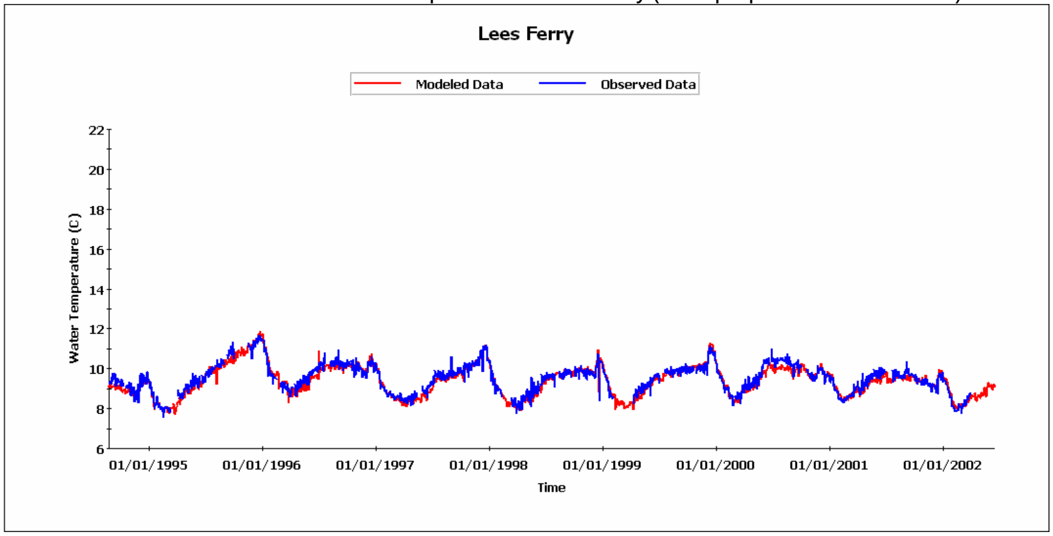


Figure F-16
GEMSS Modeled and Observed Temperatures at Diamond Creek (a sample period of 1999 to 2002)

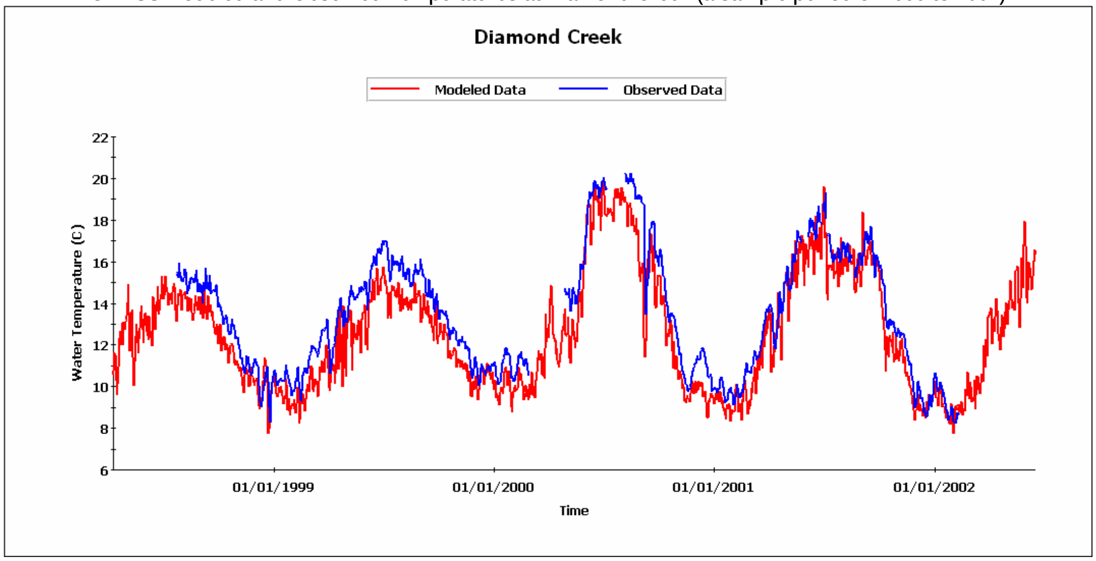
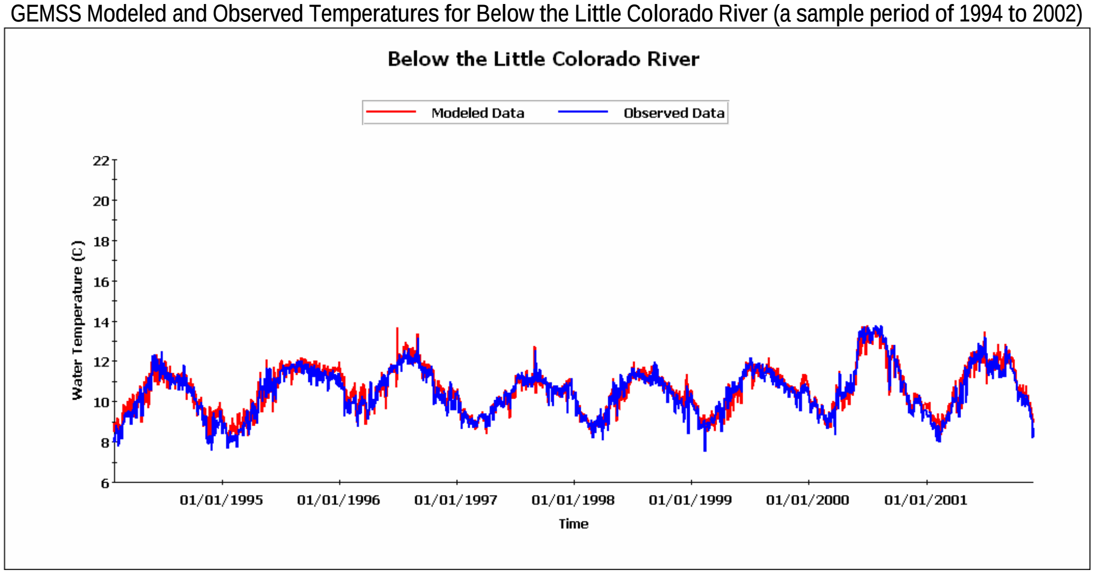


Figure F-17
GEMSS Modeled and Observed Temperatures for Below the Little Colorado River (a sample period of 1994 to 2002)



F.3.5 Analysis of Alternatives

The calibrated GEMSS model was used to analyze downstream temperature regimes for the Shortage alternatives. Release water temperatures from the CE-QUAL-W2 model and the flows from the CRSS model were used as inputs to the GEMSS model. The following assumptions were made in analyzing water temperatures downstream of Glen Canyon Dam:

- monthly average reservoir release volumes were used for each of the CRSS 90th, 50th, and 10th percentile Lake Powell elevations;
- minimum and maximum release volumes based on each of the alternatives (including the No Action Alternative) were used for each of the CRSS percentiles as mentioned above;
- minimum and maximum release temperatures from CE-QUAL-W2 for all shortage alternatives were used for each of the CRSS percentiles;
- a warm and a cool meteorological year (i.e. warmer or cooler air and dew point temperatures) were applied across alternatives and CRSS percentiles; and
- the Basin States Alternative and Conservation Before Shortage Alternative were analyzed as one alternative.

The outcome from combination of variable release volume, temperature, and meteorological conditions resulted in an average and a range of temperatures at any given location and time of year.

F.4 References

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Appendix G

Shortage Allocation Model Documentation

This appendix describes the Shortage Allocation Model and assumptions that were used to allocate shortages to water users in the states of Arizona, California, and Nevada (Lower Division states) as part of the analysis of water deliveries in this Final EIS.

Table of Contents

List of Tables

List of Attachments

G.1 Introduction

In order to assess the potential shortages and socioeconomic effects to users under each of the alternatives, specific modeling assumptions were made and these are documented in this appendix. The proposed federal action is for the purpose of adopting additional operational guidelines to improve the Department of the Interior's (Department) annual management and operation of key Colorado River reservoirs for an interim period through 2026. However, in order to assess the potential effects of the proposed federal action in this Final EIS, certain modeling assumptions are used that display projected water deliveries to Mexico. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico.

The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the International Boundary and Water Commission in consultation with the Department of State.

G.2 Background and Purpose

The Shortage Allocation Model was created to calculate the quantity of Colorado River water that would be available to water entitlement holders under shortage conditions on the mainstream of the lower Colorado River. A shortage condition would exist during a year when the Secretary of the Department of the Interior (Secretary), as part of the Annual Operating Plan (AOP), determines that there is less than 7.5 million acre-feet (maf) of water available to the Lower Division states.

The Shortage Allocation Model simulates shortage allocations and adjusts deliveries of Colorado River water in accordance with the apportionment to the Lower Division states prescribed in the Boulder Canyon Project Act of 1928, as confirmed by the Consolidated Decree. Certain modeling assumptions were made with regard to how shortages may be allocated. Reclamation acknowledges that there may be other interpretations of how shortages should be distributed. Reclamation's modeling assumptions are not intended to represent current or future policy with respect to shortage sharing or to limit Secretarial discretion to distribute shortages.

The Shortage Allocation Model simulates shortage allocations to individual Colorado River entitlement holders within each state. Entitlement holders are all persons or entities authorized to beneficially use Colorado River water pursuant to: 1) a right decreed by the United States Supreme Court, 2) a contract for the delivery of Colorado River water through the Secretary, or 3) a Secretarial reservation. For a list of each State's Colorado River water entitlement holders, please see Attachment A, Table Att. A-2 through Att. A-4.

Under the Colorado River Basin Project Act of 1968 (CRBPA) (Section 301(b)), the Central Arizona Project (CAP) incurs most of any initial shortage to the Lower Division states. Consequently, there is great interest in how shortages are allocated among the individual CAP users. The distribution of CAP water during a time of shortage is complex, and the Shortage Allocation Model has been developed to accommodate the unique shortage provisions of the Arizona Water Settlements Act (Public Law 108-451 dated December 10, 2004) and the CAP shortage framework as defined in various CAP water delivery contracts.

G.3 Description of the Shortage Allocation Model

The Shortage Allocation Model was developed as worksheets in Microsoft Office 2003 Excel software using the Excel Visual Basic Editor. The Shortage Allocation Model contains 18 worksheets, which are summarized in Table G-1.

Table G-1
Relationship Between Worksheets in the Shortage Allocation Model

	Worksheet	Function	Retrieves Data from:	Sends Data to:
1	Region Worksheet	Calculates Stage I and Stage II Shortages to Nevada, California, Arizona, and Mexico	Arizona worksheets & Projected Use Schedules	Arizona, California, & Nevada worksheets
2	Nevada Worksheet	Calculates shortages to Nevada Entitlement Holders	Region Worksheet	
3	California Worksheet	Calculates shortages to California Entitlement Holders	Region Worksheet & Quantification Settlement Agreement (QSA) Worksheet	
4	Arizona Worksheet	Calculates shortages to Arizona Entitlement Holders	Region Worksheet & Arizona Projected Consumptive Use (CU) Schedules	CAP Worksheet
5	CAP Worksheet	Calculates shortages to CAP Entitlement Holders	Arizona Worksheet & CAP Projected CU Schedules	CAP Summary Worksheet
6	CAP Summary Worksheet	Displays all CAP Entitlements, Scheduled CU, Adjusted Delivery, and Reductions	CAP Worksheet & CAP Projected CU Schedules	
7	Present Perfected Rights (PPRs) Worksheet	Displays PPRs in date order regardless of state lines		
8	QSA Worksheet	Displays Exhibit B of the QSA		California Worksheet
9	Arizona CU Schedules for Priorities 1-3	Projected Consumptive Use Schedules Provided to model Stage I and II Shortages and shortages to Arizona Entitlement Holders		Arizona and Region Worksheet
10	Arizona CU Schedules for Fourth Priority	Projected Consumptive Use Schedules Provided to model Stage I and II Shortages and shortages to Arizona Entitlement Holders		Arizona and Region Worksheet
11	Summary of Arizona State and CAP Schedules	Shows that all Arizona Projected CU does not exceed 2.8 maf		CAP Non-Indian Agricultural (NIA) and Excess Agricultural Schedules

Table G-1
Relationship Between Worksheets in the Shortage Allocation Model

	Worksheet	Function	Retrieves Data from:	Sends Data to:
12 13 14 15	CAP Municipal & Industrial (M&I), Tribal, NIA, and Excess Agricultural Schedules	Used to show CAP water availability and capture simulated shortage impacts in future years		CAP Worksheet
16 17 18	Decree Worksheets	Shows how Diversion and CU ratios are calculated to estimate full CU Entitlements in Nevada and California, and ratios between Diversion and CU for all users		

The purpose and function of each worksheet is described as follows.

The Region worksheet (see Attachment A, Table Att. A-1) is the key worksheet for operating the Shortage Allocation Model. Once the Shortage Allocation Model is open, the user may enter any shortage volume in the “total reduction” yellow box of the Region tab. Next, to the left of the yellow box a shortage year must be selected by clicking on the “process” button, which provides various years that may be chosen. Each year is associated with different schedules for Colorado River entitlement holders, which the shortages will be based on. Once a year has been selected, the model will operate by selecting “process single shortage volume”. The Shortage Allocation Model calculates the amount of Stage 1 and Stage 2 Shortages (discussed in next section), and the amount of the shortage allocated to each of the Lower Division states, and to Mexico.[1] For purposes of discussion on this Appendix G, assumed water delivery reductions to Mexico will be referred to as “shortages”. The shortages to individual Colorado River entitlement holders are displayed on the State worksheets (Attachment A, Table Att. A-2 through A-4) and the CAP worksheet (Attachment A, Table Att. A-5). The links between the schedules, the Region worksheet, State worksheets, and CAP worksheet operate the Shortage Allocation Model.

The Shortage Allocation Model contains three State worksheets (Attachment A, Tables Att. A-2 through Att. A-4). Given any shortage volume, the State worksheets calculate the portion of the shortage amount that is allocated to the individual entitlement holders within each State. On the Arizona State worksheet, the adjusted delivery is calculated as a reduction to the scheduled use for each entitlement holder. On the California and Nevada State worksheets the reduced delivery

[1] Reclamation’s modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

Appendix M and Appendix Q describe additional modeling assumptions used in the CRSS model for projected water reductions to Mexico, and Section G.6 in Appendix G describes the relationship between the Shortage Allocation Model and CRSS.

is calculated based upon an estimated full entitlement use schedule from 2004 water accounting data.

The Arizona State worksheet calculates the aggregate quantity of fourth priority water available to river users and CAP. In the Draft EIS, shortages were distributed between river users and CAP pro-rata based on scheduled use. The method used to distribute water delivery reductions within Arizona was modified to reflect the Arizona Department of Water Resources (ADWR) Director's Shortage Sharing Work Recommendations. This change basically related to the water delivery reductions to the Arizona Water Banking Authority (i.e. the unused apportionment in Arizona). Originally, in the modeling for the Draft EIS, the deliveries to the Arizona Water Banking Authority (AWBA) were reduced to zero before deliveries to any other water user in Arizona would occur. For the modeling used in the Final EIS, the Arizona water delivery reductions are distributed proportionally between the fourth priority mainstream river users and the CAP. However, for the portion of the water delivery reduction that is assigned to the CAP, the water deliveries to the AWBA are reduced to zero before the deliveries to any other CAP water user are reduced. Both ADWR's and Central Arizona Water Conservation District (CAWCD)'s recommendations were incorporated in the modeling assumptions for the Final EIS. Examples of how the water delivery reductions to Arizona were distributed in the Draft EIS and Final EIS are provided in Table Att. F-3 in Attachment F to this appendix.

The CAP worksheet imports the quantity of available water that is distributed to CAP on the Arizona worksheet, and distributes available water to CAP entitlement holders. The primary changes in the distribution of shortages within the CAP affected the Ak-Chin Indian Community and San Carlos Apache Tribe. Based on comments received on the Draft EIS, the Ak-Chin Indian Community was allocated up to 10,000 af annually of excess CAP water. For years in which water is available for banking by the ABWA, up to an additional 10,000 af is available for the Ak-Chin Indian Community pursuant to Section 2(b) of the Ak-Chin Indian Water Rights Settlement Act (Settlement). After the Secretary has met the water delivery obligation to the Ak-Chin Indian Community under the Ak-Chin Water Rights Settlement, any excess water is available for delivery to the San Carlos Apache Tribe. Estimated delivery losses of 4,500 af on the Santa Rosa Canal, incurred in the delivery of water to the Ak-Chin Indian Community, are charged to the Ak-Chin Indian Community's CAP Settlement. The resulting differences between the shortages modeled in the Draft EIS and Final EIS is provided in Attachment F, Table Att. F-3. Additionally, the Final EIS results of the CAP worksheet are displayed in the "Operational Worksheet: CAP" in Attachment A, Table Att. A-5.

Seven consumptive use schedules were provided by ADWR for use in the Shortage Allocation Model, for the period 2008 through 2060. The consumptive use schedules are listed below:

1) Arizona first through third priorities;

2) Arizona fourth priority;

3) CAP 2: municipal and industrial (M&I) priority user schedules (only provided to year 2035);

4) CAP 2: Tribal schedules;

5) CAP 3: Non-Indian Agricultural (NIA) priority schedules;

6) CAP 4: excess agricultural water schedules (only provided to year 2030); and

7) Arizona Summary Schedules.

The ADWR consumptive use schedules are shown in Appendix D.

Three water accounting spreadsheets are provided for each state: Arizona, California, and Nevada. The water accounting spreadsheets provide historical water accounting information which is used to calculate diversion to consumptive use ratios for entitlement holders in the Shortage Allocation Model.

The Shortage Allocation Model also includes two supporting worksheets which are Exhibit B of the Quantification Settlement Agreement (QSA) (Exhibit B) and a full list of Present Perfected Rights (PPRs). Exhibit B (Attachment F, Table Att. F-2) displays the quantification of certain Colorado River water entitlements and transfers of Colorado River water in the State of California in thousands of acre-feet. The quantified entitlements are incorporated in the Shortage Allocation Model, while the transfers are referenced in Exhibit B. The PPR worksheet displays a complete list of the PPRs in the Lower Division states in date order from lowest to highest priority without regard to state lines (Attachment F, Table Att. F-1). PPR diversion entitlements amount to approximately 4.1 maf and an estimated consumptive use entitlement of 3.4 maf in the Lower Basin. In the event of a severe shortage, where there is insufficient Colorado River water to satisfy the needs of the PPR entitlement holders, the PPR worksheet shows the order in which the limited water supply would be delivered to the PPR holders.

The Shortage Allocation Model may be used to simulate any future shortage allocation for any year based on projected water use, water orders, historical use, or average historical use. In a normal year, the Shortage Allocation Model may be used to simulate the amount of excess water that may be available for banking in any state.

G.4 Assumptions in the Shortage Allocation Model

G.4.1 Introduction

In accordance with Section II (B)(3) of the Consolidated Decree and Section 301(b) of the CRBPA, the Secretary has the authority to declare and allocate shortages to the Lower Division states. Although some guidance is given with regard to how shortages would be allocated (i.e., PPRs must be met first without regard to state lines and California does not incur shortages until water use under Arizona post-1968 water delivery contracts is eliminated), no further guidance exists for the Secretary’s shortage allocation decisions.

To determine the hydrologic impacts of the shortage alternatives, assumptions were made with regard to how shortages might be shared. These assumptions are made to facilitate analysis of the full range of potential impacts of each alternative and are not intended to represent current or future policy with respect to shortage sharing.

G.4.2 Stage 1 and Stage 2 Shortage Assumptions

In the Shortage Allocation Model, shortages in the Lower Basin are categorized as Stage 1 and Stage 2 Shortages. Shortages are first imposed under Stage 1 and would be applied to the most junior users within Arizona (those with post-1968 water rights, i.e., 4th and 5th priority rights within Arizona) and Nevada (primarily the Southern Nevada Water Agency [SNWA]). Stage 1 shortages continue until the deliveries to the post-1968 water rights holders in Arizona (including the CAP) are reduced to zero. The maximum amount of Stage 1 shortages during the period of analysis is dependent on the scheduled depletions for the post-1968 water rights holders and decreases over time from approximately 1.8 maf in 2008 to 1.7 maf in 2040. The post-1968 use decreases due to increasing water use of higher priorities.

After deliveries to the 4th and 5th priority rights within Arizona are reduced to zero, additional reductions are applied to Arizona, California, and Nevada. These shortages, referred to as Stage 2 shortages, continue to the shortage amount determined by the alternative.

The shortage sharing percentages are computed as follows:

- Shortage sharing for Stage 1: Arizona, Nevada, and Mexico take a water supply reduction.
  - Mexico: 16.67 percent reduction of the total shortage
    - computed as a ratio of Mexico’s 1944 Treaty allotment to the sum of the apportionments of the Lower Division states and Mexico’s 1944 Treaty allotment
    - 1.5 maf / 9.0 maf = 0.1667
  - Nevada: 3.33 percent reduction of the total shortage
    - computed as a ratio of Nevada’s apportionment to the sum of the apportionments of the Lower Division states and Mexico’s 1944 Treaty allotment
    - 0.3 maf / 9.0 maf = 0.0333
  - Arizona: 80 percent of the total shortage
    - computed as a ratio of Arizona and California’s apportionment to the sum of the apportionments of the Lower Division states and Mexico’s 1944 Treaty allotment
    - (2.8 maf + 4.4 maf) / 9.0maf = 0.80

- ♦ Shortage Sharing for Stage 2 Reductions (severe shortage after Arizona fourth and fifth priority use is reduced to zero and California shares in remaining shortage).
  - Mexico: 16.67 percent of the Stage 2 Shortage in addition to Stage 1 reductions
    - computed as a ratio of Mexico's 1944 Treaty allotment less the amount of shortage applied to Mexico under Stage 1, to the sum of the apportionments of the Lower Division states and Mexico's 1944 Treaty allotment less the total amount shorted to users under Stage 1
    - (1.5 maf - Mexico Stage 1 shortage) / (9.0 maf – total Stage 1 shortage) = 0.1667
  - Nevada: 3.33 percent of the Stage 2 Shortage in addition to Stage 1 Shortages
    - computed as a ratio of Nevada's apportionment less the amount of shortage applied to Nevada under Stage 1, to the sum of the apportionments of the Lower Division states and Mexico's 1944 Treaty allotment less the total amount shorted to users under Stage 1 Shortage
    - (0.3 maf - Nevada Stage 1 Shortage) / (9.0 maf – total Stage 1 Shortage) = 0.0333
  - Arizona: Arizona's Stage 2 shortage is approximately 20 percent and varies due to Arizona's one through three priority scheduled use
    - computed as a ratio of Arizona's apportionment less the amount of shortage applied to Arizona under Stage 1, to the sum of the apportionments of the Lower Division states and Mexico's 1944 Treaty allotment less the total amount shorted to users under Stage 1 Shortage
    - (2.8 maf - Arizona Stage 1 Shortage) / (9.0 maf – total Stage 1 Shortage)
  - California: California's Stage 2 Shortage is approximately 60 percent and varies due to Arizona's priority one through three scheduled use
    - computed as a ratio of California's apportionment, to the sum of the apportionments of the Lower Division states and Mexico's 1944 Treaty allotment less the total amount shorted to users under Stage 1 Shortage
    - (4.4 maf) / (9.0 maf – total Stage 1 Shortage)

G.4.3 Operations of Stage 1 and 2 Shortages

The Region worksheet, provided in Attachment A, Table Att. A-1, displays the calculations discussed above.

- listed along the left side of Attachment A, Table Att. A-1 are Stage 1 and 2 Shortages, and their respective entities: Mexico, Arizona, Nevada, and California. Along the top of the table are the corresponding consumptive use apportionments to each state and the 1944 Treaty allotment to Mexico, the available consumptive use, and the respective shortages;

- in Attachment A, Table Att. A-1, a 500,000 af shortage in year 2017 was not large enough to trigger a Stage 2 Shortage; therefore only Stage 1 consumptive use adjustments and reductions are calculated. In this example, consumptive use in Arizona is reduced by 400,000 af, consumptive use in Nevada is reduced by 16,667 af, and the delivery to Mexico is reduced by 83,333 af;

- in 2008, the first year of the proposed interim period, the maximum potential Stage 1 Shortage to the Lower Division states and Mexico is 1,827,557 af. The potential Stage 1 Shortage in 2008 is based on the projected use of 1,462,046 af for Arizona fourth priority, and a corresponding potential shortage for Nevada and Mexico based on their shortage sharing percentages;

- as Arizona priority one through priority three use increases over time to their respective full entitlement amount, Arizona fourth priority use decreases as does the volume of the Stage 1 Shortage volume. For example, in 2040, when Arizona reaches full entitlement use, priorities one through three are projected to use 1,428,510 af. The remainder of Arizona’s apportionment, 1,371,490 af, is subject to a Stage 1 Shortage, in addition to Nevada and Mexico’s corresponding potential shortage of 342,872 af. Therefore, the maximum potential Stage 1 Shortage to the Lower Division states and Mexico is 1,714,362 af in 2040. As compared to 2008, the total potential Stage 1 Shortage decreased by over 100,000 af.

G.4.4 General State Assumptions

- each State is assumed to be using its entire apportionment each year. Because State apportionments are based on consumptive use, all Lower Basin diversion entitlements had to be converted to estimated consumptive use entitlements, adjusted delivery, and shortages. For informational purposes the diversion values are calculated and displayed as well. The conversion ratios are based on actual 2004 Decree Accounting diversion and consumptive use ratios for each Lower Basin entitlement holder;

- entitlement holders with multiple priorities divert water by their highest (oldest) priority first;

- the Shortage Allocation Model uses the quantity of water projected to be ordered in a shortage year as a basis for distributing the available water supply to individual users;

- with the exception of PPRs, all entitlement holders within a priority class share in shortages on a pro-rata basis. Therefore, within any priority class other then PPRs, the Shortage Allocation Model does not consider entitlement dates;

- PPR holders are assumed to be diverting their full entitlement; and

- the Shortage Allocation Model does not address current and future paybacks of overruns or underruns under the Inadvertent Overrun and Payback Policy.

G.4.5 Nevada Assumptions

- the Shortage Allocation Model reflects that Nevada has eight water delivery priorities (see Attachment A, Table Att. A-2), as established in the Robert B. Griffith Water Project Contract No. 7-07-30-W0004 for delivery of Colorado River water signed by the United States and State of Nevada; and

- in the above contract, it is stated that SNWA is entitled to divert the balance of any remaining un-allocated, unused, and surplus water in Nevada.

G.4.6 California Assumptions

- the PPRs within California are displayed as having the highest priority in the state relative to the priorities contained in the Seven Party Agreement. The priorities within the Seven Party Agreement do not consider PPRs in California's allocation of 4.4 maf. Reclamation recognizes that the QSA helps California parties to meet the water needs of PPRs by agreeing that certain parties to the Seven Party Agreement would make water available to satisfy the requirements of the PPR holders while keeping the priorities within the Seven Party Agreement intact. In addition, the QSA helped quantify entitlements in the Seven Party Agreement, which is necessary to model shortages. Therefore the Shortage Allocation Model displays the quantified entitlements in the QSA for the Imperial Irrigation District and the Coachella Valley Water District, minus the amount specified for PPR use;

- additionally, while the Seven Party Agreement is recognized in the Shortage Allocation Model, protection is provided to Seven Party Agreement members with PPRs by making these the highest priority within the state;

- QSA transfers and exchanges are not modeled in the Shortage Allocation Model, however they are provided in Exhibit B of the QSA (see Attachment F, Table Att. F-2);

- although the Metropolitan Water District of Southern California (MWD) shows a Seven Party Agreement entitlement of 550,000 af in the Shortage Allocation Model, MWD's "Full Entitlement Use" is assumed to be the calculated entitlement resulting from the balance of California's State apportionment and full entitlement use of higher priorities. During shortage, MWD may acquire a minimum of 25,000 af from the Palo Verde Irrigation District; and

- to see the estimated entitlements associated with each California entitlement holder, please see Attachment A, Table Att. A-3.

G.4.7 Arizona Assumptions

- the ADWR Director's Shortage Sharing Workshop Recommendation was submitted to Reclamation in April 2007, and was modeled to show a redistribution of shortages to Arizona fourth priority users in accordance with the preference of Arizona cities, CAWCD, and ADWR;

- the ADWR Director's Shortage Sharing Workshop Recommendation provides that the fourth priority mainstream shortage water supply be calculated by determining the percentage derived by dividing the total fourth priority mainstream diversion entitlement by the available fourth priority consumptive use water supply (absent a shortage), and then multiplying this percentage by the quantity of fourth priority water available in that shortage year. The remaining fourth priority water supply, after the mainstream amount is subtracted, would be available for diversion by the CAP. Based on further telephone conversations with ADWR representatives, the adjusted delivery quantity to mainstream users would be proportionately distributed based on entitlements. If a user is allocated more than it can use under the scheduled use, the remaining balance flows to the CAP, rather than being available to other fourth priority mainstream users. The modeling and distribution of reductions in water deliveries to Arizona and Colorado River water users within Arizona in this Final EIS considers Arizona's shortage strategy; and

- all Arizona projected water use schedules in the Shortage Allocation Model were supplied by ADWR (see Appendix D). However, in accordance with ADWR, some of the original schedules were adjusted. The agreed upon changes are as follows:

  - the Cibola Valley Irrigation and Drainage District water contract has recently been split into three separate contracts: Hopi Tribe, Mohave County Water Authority, and Cibola Valley Irrigation and Drainage District. Reclamation developed a separate schedule for each of the three entities rather than showing one schedule for the district;

  - a projected water use schedule for Fort Yuma Indian Reservation in Arizona was added to allow for first priority use in accordance with the Consolidated Decree;

  - some projected water use schedules for entitlement holders were divided among their more specific contract entitlements or water rights;

  - other projected water use schedules for Lake Havasu City, Bullhead City, and the Mohave Water Conservation District were combined with their subcontracted water from the Mohave County Water Authority, so that impacts to these cities may be better assessed; and

  - schedules for Arizona fourth priority entitlement holders were reduced at the advice of ADWR, if they exceeded Reclamation's estimated entitlement computed from the diversion and consumptive use ratios used in the 2004 Decree Accounting.

G.4.8 CAP Framework and Assumptions:

The Shortage Allocation Model considers five priorities within the CAP. Within the Shortage Allocation Model, the most senior CAP priorities are the Ak-Chin Indian Community and several central Arizona cities who receive water secured by the Salt River Pima-Maricopa Indian Community Water Rights Settlement Act of 1988 (CAP 1). The second CAP priority is Municipal and Industrial (M&I) and Indian Priority Water (CAP 2). Next in priority within CAP is non-Indian Agriculture (NIA) Priority Water, which is available to specific M&I, Agricultural, and Indian entitlement holders (CAP 3). CAP excess water that is available to non-Indian agricultural entitlement holders is the next priority (CAP 4). The lowest priority within CAP is the AWBA which receives the balance of unused water in CAP (CAP 5).
A diagram of CAP entitlement classes, quantified in units of acre-feet is provided in Table G-2.

Table G-2
CAP Priorities Before and After 2044

<table>
<tr><th colspan="4">Cap Priorities Before 2044 (After Losses)</th><th>Total Entitlement by Priority (af)</th></tr>
<tr><td>CAP 5</td><td colspan="3">Arizona Water Bank</td><td>Balance</td></tr>
<tr><td>CAP 4</td><td colspan="3">Excess Water for Agriculture</td><td>Available</td></tr>
<tr><td>CAP 3</td><td>M&I: 148,598 af</td><td colspan="2">Indian: 216,100 af</td><td>364,698</td></tr>
<tr><td rowspan="4">CAP 2</td><td rowspan="4">M&I: 638,823 af</td><td rowspan="4">Indian: 343,079af</td><td>Indian 4: 32,770 af
31,970 af (GRIC)
800 af (Tohono O'Odham Nation)</td><td>981,902</td></tr>
<tr><td>Indian 3: 11,305 af (GRIC)</td><td rowspan="3"></td></tr>
<tr><td>Indian 2: 7,430 af
6,100 af (San Carlos) & 1,330 af (Salt River)</td></tr>
<tr><td>Indian 1: 291,574 af</td></tr>
<tr><td>CAP 1</td><td>Salt River Exchange Cities: 20,900 af</td><td colspan="2">Ak-Chin: 47,500 af (plus up to 10,000 af excess water if available in the CAP canal)</td><td>68,400</td></tr>
<tr><td colspan="4">TOTAL</td><td>1,415,000</td></tr>
</table>

<table>
<tr><th colspan="3">Cap Priorities After 2044 (After Losses)</th><th>Total Entitlement by Priority</th></tr>
<tr><td>CAP 5</td><td colspan="2">Arizona Water Bank</td><td>Balance</td></tr>
<tr><td>CAP 4</td><td colspan="2">Excess Water for Agriculture</td><td>Available</td></tr>
<tr><td>CAP 3</td><td>M&I: 101,295 af</td><td>Indian: 216,100 af</td><td>317,395</td></tr>
</table>

Table G-2
CAP Priorities Before and After 2044

<table>
<tr><td rowspan="4">CAP 2</td><td rowspan="4">M&I: 686,126 af</td><td rowspan="4">Indian: 343,079af</td><td><u>Indian</u> 4: 32,770 af
31,970 af (GRIC)
800 af (Tohono O'Odham Nation)</td><td>1,029,205</td></tr>
<tr><td><u>Indian</u> 3: 11,305 af (GRIC)</td><td rowspan="3"></td></tr>
<tr><td><u>Indian</u> 2: 7,430 af
6,100 af (San Carlos) & 1,330 af (Salt River)</td></tr>
<tr><td><u>Indian</u> 1: 291,574 af</td></tr>
<tr><td>CAP 1</td><td>Salt River Exchange Cities:
20,900 af</td><td colspan="2">Ak-Chin: 47,500 af (plus up to 10,000 af excess water if available in the CAP canal)</td><td>68,400</td></tr>
<tr><td colspan="4">TOTAL</td><td>1,415,000</td></tr>
</table>

It is noted that the water contracting framework for CAP is based on an assumption that at least 1,415,000 af will be available for diversion from the CAP aqueduct in a normal year. This quantity assumes that there is a five percent conveyance loss in the CAP aqueduct. Therefore, 1,490,000 af is required to be available at the CAP pumping plant on the Colorado River. In the event that the priority one, two, and three consumptive use within Arizona (excluding the 68,400 af of priority three water that is included within the CAP supply) exceeds 1,310,000 af of consumptive use in any year, the CAP entitlement holders would receive less than 1,415,000 af and the impact would be absorbed by the lowest CAP priorities. Table G-3 provides a list of specific entitlement holders within each CAP priority.

Table G-3
CAP Entitlements by Priority Prior to 2044

	Entitlement (af)					
	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Water)	CAP 5 (Bank)	TOTAL
Arizona Water Banking Authority					Balance	0
Excess Agricultural Contracts				Available		0
Ak-Chin Indian Community**	47,500	27,500				75,000
Fort McDowell		18,233				18,233
Gila River		191,200	120,600			311,800
TON-Chui Chu		8,000				8,000
TON-San Xavier		27,000	23,000			50,000
TON-Schuk Toak		10,800	5,200			16,000
Pasqua Yaqui		500				500
Salt River		13,300				13,300
San Carlos Apache		43,500				43,500
Tonto Apache		128				128
Yavapai Apache (Camp Verde)		1,200				1,200
Unallocated HVD		1,218				1,218

Table G-3
CAP Entitlements by Priority Prior to 2044

	Entitlement (af)					
	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Water)	CAP 5 (Bank)	TOTAL
Reserved Federal			67,300			67,300
Indian Subtotal	47,500	343,079	216,100	0	0	606,679
Apache Junction (AZ Water Co)		6,000				6,000
Avra Coop		808				808
AZ-American (Agua Fria)		11,093				11,093
AZ-American (Paradise Valley)		3,231				3,231
AZ-American (Sun City)		4,189				4,189
AZ-American (Sun City West)		2,372				2,372
AZ State Land Dept. (9,026 af is used for Agriculture)		32,076	9,026			41,102
ASARCO (Ray Mine)		21,000				21,000
Avondale		5,416				5,416
Bernell Water Co (Cave Creek)		200				200
Buckeye		25				25
Carefree Water Co		1,300				1,300
Casa Grande (AZ Water Co)		8,884				8,884
Cave Creek Water Co		2,406				2,406
CAGRD		7,746				7,746
Chandler*	4,064	8,654	3,924			16,642
Chandler Heights Citrus ID		315				315
Chaparral City Water Co		8,909				8,909
Circle City Water Co		3,932				3,932
Comm. Water Co (Green Valley)		2,858				2,858
Coolidge (AZ Water Co)		2,000				2,000
El Mirage		508				508
Eloy		2,171				2,171
Florence		2,048				2,048
Flowing Wells ID		4,354				4,354
Gilbert	6,424	7,235	1,537			15,196
Glendale	2,850	17,236	682			20,768
Goodyear		10,742				10,742
Green Valley DWID		1,900				1,900
H20 Water Co		147				147
Marana		47				47
Maricopa County Parks & Rec		665				665
Mesa*	2,622	43,503	5,551			51,677
MDWID		13,460				13,460

Table G-3
CAP Entitlements by Priority Prior to 2044

	Entitlement (af)					
	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Water)	CAP 5 (Bank)	TOTAL
Oro Valley		10,305				10,305
Peoria		25,236				25,236
Phelps Dodge Miami		2,906				2,906
Phoenix*	4,750	122,120	37,280			164,150
Phoenix Memorial Park		84				84
Pine Water Co		161				161
Queen Creek Water Co		348				348
Rio Verde Utilities		812				812
San Tan ID		236				236
Scottsdale*	95	52,810	3,306			56,211
Spanish Trail Water Co		3,037				3,037
Superior		285				285
Surprise		10,249				10,249
Tempe	95	4,315	23			4,433
Tonto Hills Utility Co		71				71
Tucson		144,172				144,172
Vail Water Co		1,857				1,857
Valley Utilities Water Co		250				250
Water Utilities Comm. Fac. Dist. (AJ)		2,919				2,919
Water Util. Greater Buckeye		43				43
Water Util. Greater Tonopah		64				64
White Tank Sys. (AZ Water Co.)		968				968
San Carlos (Phelps Dodge/Globe)		18,145				18,145
State Reserved			87,269			87,268
M&I Subtotal	20,900	638,823	148,598	0	0	808,321
TOTAL	68,400	981,902	364,698	Available	Balance	1,415,000

**47,303 af of M&I CAP 3 water converts to M&I CAP 2 water on January 1, 2044; 2,952 af is distributed to Chandler, 4,924 af to Mesa, 36,144 af to Phoenix, and 3,283 af to Scottsdale.*

*** For years in which water is available for banking by the ABWA, up to an additional 10,000 af is available for the Ak-Chin Indian Community pursuant to Section 2(b) of the Ak-Chin Indian Water Rights Settlement Act (Settlement). After the Secretary has met the water delivery obligation to the Ak-Chin Indian Community under the Ak-Chin Water Rights Settlement, any excess water is available for delivery to the San Carlos Apache Tribe. Estimated delivery losses of 4,500 af on the Santa Rosa Canal, incurred in the delivery of water to the Ak-Chin Indian Community, are charged to the Ak-Chin Indian Community's CAP Settlement.*

Within the Indian portion of CAP 2 are entitlements in four sub-priorities (Table G-4).

Table G-4
CAP 2 Indian Entitlements by Sub-priority

AWSA Indian Priority Distribution	Entitlement (af)					
	Indian 1		Indian 2	Indian 3	Indian 4	Total
Ak-Chin (27,500 af) & San Carlos (maximum of 30,800 af)*	27,500	24,970	5,830	0	0	58,300
Fort McDowell	18,233		0	0	0	18,233
Gila River	147,925		0	11,305	31,970	191,200
TON-Chui Chu	7,200		0	0	800	8,000
TON-San Xavier	27,000		0	0	0	27,000
TON-Schuk Toak	10,800		0	0	0	10,800
Pasqua Yaqui	500		0	0	0	500
Salt River	11,970		1,330	0	0	13,300
San Carlos Apache	12,430		270	0	0	12,700
Tonto Apache	128		0	0	0	128
Yavapai Apache (Camp Verde)	1,200		0	0	0	1,200
Yavapai Prescott	500		0	0	0	500
Unallocated HVID	1,218		0	0	0	1,218
Total	291,574		7,430	11,305	32,770	343,079

**The Ak-Chin Indian Community is entitled to an additional 10,000 af, not shown, if excess water is available in the CAP canal. After the Secretary has met the water delivery obligation to the Ak-Chin Indian Community under the Ak-Chin Water Rights Settlement, any excess water under the Ak-Chin Indian Community's CAP water delivery contract is available for delivery to the San Carlos Apache Tribe. Estimated delivery losses of six percent or 4,500 af on the Santa Rosa Canal, incurred in the delivery of water to the Ak-Chin Indian Community, are charged to the Community's CAP water delivery contract.*

G.4.9 General CAP Assumptions

- some of the Tribes or Nations lease their CAP water to cities. The Shortage Allocation Model does not address the shortage to the lessee, and assumes that it is up to the Tribe or Nation to administer the terms and conditions of its lease to determine the amount of water available to the lessee in the shortage year;

- in the projected water use schedules:

    - The original CAP projected water use schedules exceeded the available water for CAP on Arizona schedules, so the CAP projected water use schedules were reduced to keep Arizona within its 2.8 maf apportionment. The following entitlement holders were affected: the AWBA, excess agricultural water users, and the CAP 3 (NIA) Priority (consisting of Indian, M&I, and Agricultural entitlement holders);

- CAP 3 projected water use scheduled for the Maricopa-Stanfield Irrigation and Drainage District and Central Arizona Irrigation and Drainage District were adjusted from a combined total of 12,000 af to 9,026 af for the Arizona State Land Department to reflect the desire of that entity to subcontract for 9,026 af of CAP 3 priority water for irrigation use. All other agricultural water in the CAP 3 priority has been relinquished by the original subcontractors as part of the AWSA;

- ADWR projected CAP 2 M&I water use to year 2035, at which point almost all entitlement holders were using their full entitlement. With ADWR's concurrence, Reclamation adjusted the 2035 projected water use schedule to show full entitlement use by entitlement holders and extended the 2035 projected water use schedules to later years for which a projected water use schedule had not been available;

- for the Final EIS, CAP 2 schedules for the San Carlos Apache Tribe water rights settlement were adjusted to account for losses on the Santa Rosa Canal of 6 percent or 4,500 af; and

- under the implementing documents for the Salt River Pima Maricopa Indian Community Water Rights Settlement Act of 1988, there is a formula that provides for the distribution of the 20,900 af of acquired CAP 1 priority water among all CAP 2 M&I users during a time of shortage. In non-shortage years, this water is made available only to four Phoenix area cities. Reclamation has been informed that the present formula is inoperable and that a technical correction to the formula will have to be developed and agreed to by the appropriate parties. The Shortage Allocation Model does not attempt to model this element of the Salt River Pima Maricopa Indian Community Water Rights Settlement Agreement.

G.4.10 CAP 2 Shortage Assumptions:

The Shortage Allocation Model uses the following assumptions to allocate available CAP 2 water. These assumptions are based on Reclamation staff interpretation of the CAP shortage compromise that was incorporated as part of the Arizona Water Settlements Act (AWSA).

Step I. Under the AWSA, a CAP shortage exists if:

- ♦ prior to January 1, 2044, there is not enough water available to meet the CAP 2 scheduled water use of 981,902 af (638,823 af for M&I and 343,079 af for Indian); or

- ♦ after January 1, 2044, there is not enough water available to meet the CAP 2 scheduled water use of 1,029,205 af (686,126 af for M&I and 343,079 af for Indian).

Step II. If there is a shortage based on Step I above, the available CAP water is allocated between the CAP 2 M&I and Indian entitlement holders as follows:

- ♦ if the available CAP 2 water supply is less than 981,902 af and greater than 853,079 af, then the water is allocated as follows:
  - prior to January 1, 2044, the water allocated to the Indian portion is equal to 25.4 percent of the available CAP water plus 93,303 af. The remainder is allocated to the M&I priority; and
  - after January 1, 2044, the water allocated to the Indian portion is equal to 18.59 percent of the available CAP water plus 151,691 af. The remainder is allocated to the M&I priority.
- ♦ if the available CAP water is less than 853,079 af (or the sub-priority of Indian 4 has been reduced completely), then 36.38 percent of the available CAP water supply is allocated to the remaining Indian portions of CAP 2, and the remainder is allocated to the M&I portion of CAP 2.

Step III. Distribute the available CAP water to the individual entitlement holders within the M&I and Indian Portions:

- within the M&I priority, the quantity of the available water (determined above) is allocated to each entitlement holder proportionately based on each entitlement holder's scheduled delivery relative to the total delivery schedule; and
- within the Indian portion, the available water supply satisfies Indian sub-priorities in order of highest to lowest (Indian 1 to Indian 4). Within each sub-priority, available water is distributed proportionately to users (Table G-4) based on their scheduled use. A shortage occurs when there is not enough water to satisfy all scheduled users.

G.5 Operation of the Shortage Allocation Model

G.5.1 Operation of Regional and State Shortages

The Shortage Allocation Model is designed to allocate Colorado River water under normal and shortage conditions on the mainstream of the lower Colorado River. The model is operated by entering any normal or shortage volume in the "yellow box" labeled "total reduction" as shown below. Following the yellow box is a brown list-box in which any year between 2008 and 2060 may be selected (see below).

Once the year is selected and processed, the Shortage Allocation Model will collect the projected water use schedules for each Arizona user and determine the point at which a Stage 1 and Stage 2 Shortage will occur as discussed in the assumptions section above.

If a shortage is so severe that Arizona fourth priority users are reduced to a zero acre-foot water delivery, California begins to share in the Stage 2 Shortage. In the example below reflecting a 500,000 and a 1.8 million acre-foot shortage in year 2017, the first simulated shortage is not sufficient to cause a Stage 2 Shortage, while the second is. The simulated reductions to Arizona, Nevada, and Mexico are shown in the far right hand column of Table G-5.

Table G-5
Snapshot from Regional Worksheet

Run Mode	Total Reduction	500,000	PROCESS	
Arizona	2,400,000	400,000		
Nevada	283,333	16,667		
California	4,400,000	0		
Mexico	1,416,667	83,333		

500,000 af Shortage in Year 2017	Shortage Distribution	Consumptive Use Entitlement (af)	Deliverable Consumptive Use (af)	Consumptive Use Reduction (af)
Stage I Shortage		1,729,907	1,229,907	500,000
Mexico	16.67 %	288,318	204,984	83,333
United States				
Arizona	80.00 %	1,383,925	983,925	400,000
Nevada	3.33 %	57,664	40,997	16,667
California	0.00 %	0	0	0
Stage II Shortage (When AZ 4th=0)		7,270,093	7,270,093	0
Mexico	16.67 %	1,211,682	1,211,682	0
United States				
Arizona	19.48 %	1,416,075	1,416,075	0
Nevada	3.33 %	242,336	242,336	0
California	60.52 %	4,400,000	4,400,000	0
Stage I & II Total		9,000,000	8,500,000	500,000

1,800,000 af Shortage in Year 2017	Shortage Distribution	Consumptive Use Entitlement (af)	Deliverable Consumptive Use (af)	Consumptive Use Reduction (af)
Stage I Shortage		1,729,907	0	1,729,907
Mexico	16.67 %	288,318	0	288,318
United States				
Arizona	80.00 %	1,383,925	0	1,383,925
Nevada	3.33 %	57,664	0	57,664
California	0.00 %	0	0	0

Table G-5
Snapshot from Regional Worksheet

Stage II Shortage (When AZ 4th=0)		7,270,093	7,200,000	70,093
Mexico	16.67 %	1,211,682	1,200,000	11,682
United States				
Arizona	19.48 %	1,416,075	1,402,422	13,653
Nevada	3.33 %	242,336	240,000	2,336
California	60.52 %	4,400,000	4,357,578	42,422
Stage I & II Total		9,000,000	7,200,000	1,800,000

The “consumptive use reduction” column above shows the potential Stage 1 and Stage 2 Shortages for each state and Mexico. Given a regional shortage, the following columns show the “Deliverable Consumptive Use” and the “Consumptive Use Reduction”. These values are transferred to each state worksheet. Each state worksheet provides priority and entitlement information, as well as the selected year’s schedules. As seen in Attachment A, Table Att. A-2 through A-4 of the State worksheets, the last two columns show the adjusted delivery and reduction for each entitlement holder. Arizona entitlement holders are reduced from their scheduled use for the selected year. California and Nevada entitlement holders are reduced from full entitlement use, as projected use schedules were not programmed for these States. Shortages are equally shared pro-rata by all the users within the same priority, with the exception of PPRs.

Each State page is strung with formulas to calculate the adjusted delivery and reduction to each priority. For the users within each priority, shortages are simply calculated by subtracting the adjusted delivery from the projected consumptive use schedules (in Arizona and CAP) or full entitlement (in California and Nevada). For the CAP, the formulas are highly complicated and some even require programming due to time dependent changes expressed in the AWSA.

G.5.2 Operation of Arizona and CAP Shortages

In 2017, a simulated shortage of 500,000 af to the Lower Basin States and Mexico reduces users as displayed in Attachment A, Tables Att. A-2 through A-4. Within Arizona the 400,000 af shortage first reduces deliveries to Arizona fifth priorities (which are not modeled because Reclamation did not receive fifth priority schedules). Next, Arizona fourth priority river users are reduced 23 percent and CAP is reduced 29 percent. The available fourth priority CAP water from the Arizona worksheet, minus five percent losses, is inserted into the CAP worksheet. Table G-6 shows the remaining delivery to CAP is 876,371 af (71 percent). The CAP worksheet distributes shortages to CAP entitlement holders, by satisfying the highest CAP entitlement holders first.

The share of the available CAP water from Arizona fourth priority is first allocated to CAP 2 (a detailed description of Indian tribes impacted by the assumed Indian shortage sharing scheme is provided in Section G.4.7 CAP Framework and Assumptions). Based on the process described in Section G.4.7, the following formulas were created to allocate the proper volume of water to the Indian portion of CAP 2 under shortage conditions, where B6 is the available water for CAP:

= IF(B6>981902,343079,IF(B6>853079,(0.25438*B6+93303),(0.3637518*B6))

This formula is read as: If the available water supply to CAP is greater than 981,902 af, allocate to the Indian portion of CAP 2 the full entitlement of 343,079 af. If the available water supply is less than 981,902 af and greater than 853,079 af, allocate to the Indian portion 25.44 percent of the available water supply plus an additional 93,303 af. If the available water supply is less than 853,079 af, allocate to the Indian portion 36.38 percent of the available water supply to the CAP.

After 2044, the formula to calculate the CAP Indian priority adjusted entitlement is below, followed by a description:

= IF(B6>981902,343079,IF(B6>853079,(0.1859354*B6+151691),(0.3637518*B6))

This formula is read as: If the available water supply to CAP fourth priority is greater than 981,902 af, allocate to the Indian portion of CAP 2 the full entitlement of 343,079 af. If the available water supply is less than 343,079 af and greater than 853,079 af, allocate to the Indian portion 18.59 percent of the available water supply plus an additional 151,691 af. If the available water supply is less than 853,079 af, allocate to the Indian portion 36.38 percent of the water available to the CAP.

For example, the adjusted delivery to the M&I portion of CAP 2 is the difference between available water to CAP 2 and the delivery to the Indian portion. CAP 3 and CAP 4 receive the remaining available water, which would be “0” in this example. However, CAP 3 and CAP 4 users are entitled to unused entitlement from CAP 2. Before the unused entitlement is available to CAP 3 and CAP 4 users, M&I and Indian entitlement holders of CAP 2 are permitted to use the other portion’s unused entitlement, which is called “cross-over”.

Table G-6 shows that the M&I portion creates cross-over water, since M&I scheduled use (512,767 af) is less than the M&I entitlements (560,931 af) under the shortage condition. Therefore, 47,370 af of cross-over is available for Indian entitlement holders in the below example. The Indian priority needs to use 16,752 af of the cross-over to meet projected water schedules for 2017. The remaining 30,618 af is available to CAP 3. In this shortage scenario, CAP water is not available to CAP 4 or CAP 5.

Table G-6
2017 Shortage Allocation to CAP Priorities

Fourth Priority Water Available to CAP	876,371	**2017**			
			scheduled use		
CAP 5: Excess for Arizona Water Banking Authority	**0**	**0**	0		
CAP 4: Excess for Agriculture Users	**0**	**0**	277,891	**Non-Indian Portion**	**Indian Portion**
CAP 3: NIA Available and Adjusted Entitlement	**0**	**30,618**		**24,452**	**6,166**
	allowed use	adj. delivery	Scheduled use	unused (cross over)	
CAP 2: M&I Available and Adjusted Entitlement	**560,137**	**512,767**	512,767	47,370	
CAP 2: Indian Available and Adjusted Entitlement	**316,234**	**332,986**	332,986	0	

The above 30,618 af of water allocated to CAP 3 users is distributed below in the "Adjusted Delivery" column of Table G-7. Shortages to all CAP 3 entitlement holders are shown in the last column "Shortage Allocation".

Table G-7
2017 Shortage Allocation to CAP 3 (NIA Priority)

	Entitlement	Scheduled Use	Adjusted Delivery	Shortage Allocation
Non-Indian Portion				
Chandler	3,924	3,924	1,038	2,886
Gilbert	1,537	1,537	407	1,130
Glendale	682	682	180	502
Mesa	5,551	5,551	1,469	4,082
Phoenix	37,280	37,280	9,866	27,414
Scottsdale	3,306	3,306	875	2,431
Tempe	23	23	6	17
ASLD (Agriculture)	9,026	9,026	2,389	6,637
State Reserved	87,269	31,072	8,223	22,849
Total	148,598	92,401	24,452	67,949
Indian Portion				
Gila River	120,600	0	0	0
TON-San Xavier	23,000	8,972	2,374	6,597
TON-Schuk Toak	5,200	2,028	537	1,492
Reserved Federal	67,300	12,300	3,255	9,045
Total	216,100	23,300	6,166	17,134

The shortage distribution to the M&I portion of CAP 2 under a 500,000 af basin-wide shortage simulated for the year 2017 is shown in Table G-8.

Table G-8
2017 Shortage Allocation to CAP 2 (M&I Portion)

M&I Priority Distribution	Entitlement (af)	Scheduled Use (af)	Adjusted Delivery (af)	Shortage Allocation (af)
Apache Junction (AZ Water Co)	6,000	6,000	6,000	0
Avra Coop	808	0	0	0
AZ-American (Agua Fria)	11,093	11,093	11,093	0
AZ-American (Paradise Valley)	3,231	3,231	3,231	0
AZ-American (Sun City)	4,189	4,189	4,189	0
AZ-American (Sun City West)	2,372	2,372	2,372	0
AZ State Land Dept.	32,076	700	700	0
ASARCO (Ray Mine)	21,000	0	0	0
Avondale	5,416	4,746	4,746	0
Bernell Water Co (Cave Creek)	200	0	0	0
Buckeye	25	0	0	0
Carefree Water Co	1,300	400	400	0
Casa Grande (AZ Water Co)	8,884	2,000	2,000	0
Cave Creek Water Co	2,406	2,048	2,048	0
CAGRD	7,746	7,746	7,746	0
Chandler*	8,654	8,654	8,654	0
Chandler Heights Citrus ID	315	0	0	0
Chaparral City Water Co	8,909	5,705	5,705	0
Circle City Water Co	3,932	0	0	0
Comm. Water Co (Green Valley)	2,858	0	0	0
Coolidge (AZ Water Co)	2,000	0	0	0
El Mirage	508	0	0	0
Eloy	2,171	2,171	2,171	0
Florence	2,048	2,048	2,048	0
Flowing Wells ID	4,354	0	0	0
Gilbert	7,235	7,235	7,235	0
Glendale	17,236	14,183	14,183	0
Goodyear	10,742	10,742	10,742	0
Green Valley DWID	1,900	500	500	0
H20 Water Co	147	0	0	0
Marana	47	0	0	0
Maricopa County Parks & Rec	665	645	645	0
Mesa*	43,503	30,029	30,029	0
MDWID	13,460	10,613	10,613	0
Oro Valley	10,305	10,305	10,305	0

Table G-8
2017 Shortage Allocation to CAP 2 (M&I Portion)

M&I Priority Distribution	Entitlement (af)	Scheduled Use (af)	Adjusted Delivery (af)	Shortage Allocation (af)
Peoria	25,236	19,067	19,067	0
Phelps Dodge Miami	2,906	0	0	0
Phoenix*	122,120	134,120	134,120	0
Phoenix Memorial Park	84	0	0	0
Pine Water Co	161	0	0	0
Queen Creek Water Co	348	348	348	0
Rio Verde Utilities	812	812	812	0
San Tan ID	236	0	0	0
Scottsdale*	52,810	52,810	52,810	0
Spanish Trail Water Co	3,037	0	0	0
Superior	285	0	0	0
Surprise	10,249	10,249	10,249	0
Tempe	4,315	4,315	4,315	0
Tonto Hills Utility Co	71	0	0	0
Tucson	144,172	142,672	142,672	0
Vail Water Co	1,857	0	0	0
Valley Utilities Water Co	250	0	0	0
Water Utilities Comm. Fac. Dist. (AJ)	2,919	50	50	0
Water Util. Greater Buckeye	43	0	0	0
Water Util. Greater Tonopah	64	0	0	0
White Tank Sys. (AZ Water Co.)	968	968	968	0
Subtotal	620,678	512,767	512,767	0
San Carlos Apache Tribe Phelps Dodge/Globe	18,145	0	0	0
Total	638,823	512,767	512,767	0

**47,303 af NIA Priority water converts to M&I Priority on January 1, 2044, and 2,952 af is distributed to Chandler, 4,924 af to Mesa, 36,144 af to Phoenix, and 3,283 af to Scottsdale.*

The shortage to the Indian portion of CAP 2 under a 500,000 af basin-wide shortage simulated for the year 2017 is distributed as follows:

Table G-9
2017 Shortage Allocation to CAP 2 (Indian Portion)

AWSA Indian Priority Distribution	Scheduled Use (af)				
	Indian 1	Indian 2	Indian 3	Indian 4	Total
AK-Chin (27,500 af) & San Carlos (estimated maximum of 30,800 af)*	27,500 / 24,970	5,830	0	0	58,300
Fort McDowell	8,140	0	0	0	8,140
Gila River	147,925	0	11,305	31,970	191,200
TON-Chui Chu	7,200	0	0	800	8,000
TON-San Xavier	27,000	0	0	0	27,000
TON-Schuk Toak	10,800	0	0	0	10,800
Pasqua Yaqui	500	0	0	0	500
Salt River	11,970	1,330	0	0	13,300
San Carlos Apache	12,430	270	0	0	12,700
Tonto Apache	128	0	0	0	128
Yavapai Apache (Camp Verde)	1,200	0	0	0	1,200
Yavapai Prescott	500	0	0	0	500
Unallocated HVID	1,218	0	0	0	1,218
Total	281,481	7,430	11,305	32,770	332,986

AWSA Indian Priority Distribution	Adjusted Delivery (af)				
	Indian 1	Indian 2	Indian 3	Indian 4	Total
AK-Chin (27,500 af) & San Carlos (estimated maximum of 30,800 af)*	27,500 / 24,970	5,830	0	0	58,300
Fort McDowell	8,140	0	0	0	8,140
Gila River	147,925	0	11,305	31,970	191,200
TON-Chui Chu	7,200	0	0	800	8,000
TON-San Xavier	27,000	0	0	0	27,000
TON-Schuk Toak	10,800	0	0	0	10,800
Pasqua Yaqui	500	0	0	0	500
Salt River	11,970	1,330	0	0	13,300
San Carlos Apache	12,430	270	0	0	12,700
Tonto Apache	128	0	0	0	128
Yavapai Apache (Camp Verde)	1,200	0	0	0	1,200
Yavapai Prescott	500	0	0	0	500
Unallocated HVID	1,218	0	0	0	0
Total	281,481	7,430	11,305	32,770	332,986

Table G-9
2017 Shortage Allocation to CAP 2 (Indian Portion)

AWSA Indian Priority Distribution	Shortage Allocation (af)				
	Indian 1	Indian 2	Indian 3	Indian 4	Total
AK-Chin (27,500 af) & San Carlos (estimated maximum of 30,800 af)*	0	0	0	0	0
Fort McDowell	0	0	0	0	0
Gila River	0	0	0	0	0
TON-Chui Chu	0	0	0	0	0
TON-San Xavier	0	0	0	0	0
TON-Schuk Toak	0	0	0	0	0
Pasqua Yaqui	0	0	0	0	0
Salt River	0	0	0	0	0
San Carlos Apache	0	0	0	0	0
Tonto Apache	0	0	0	0	0
Yavapai Apache (Camp Verde)	0	0	0	0	0
Yavapai Prescott	0	0	0	0	0
Unallocated HVID	0	0	0	0	0
Total	0	0	0	0	0

**The Ak-Chin Indian Community is entitled to an additional 10,000 af, not shown, if excess water is available in the CAP canal. After the Secretary has met the water delivery obligation to the Ak-Chin Indian Community under the Ak-Chin Water Rights Settlement, any excess water under the Ak-Chin Indian Community's CAP water delivery contract is available for delivery to the San Carlos Apache Tribe. Estimated delivery losses of six percent on the Santa Rosa Canal, incurred in the delivery of water to the Ak-Chin Indian Community, are charged to the Community's CAP water delivery contract.*

A summary of the above CAP shortages is displayed in Attachment A, Table Att. A-5.

G.5.3 Shortage Allocation Model Results

Attachment A provides detailed shortages at the regional, state, and CAP level for a 500,000 af shortage in year 2017. Attachment B displays Arizona and CAP diversion shortages to individual Indian agricultural entitlement holders. Attachment C displays Arizona and CAP diversion shortages to individual non-Indian agricultural entitlement holders. Attachment D displays Arizona and CAP consumptive use shortages to M&I entitlement holders. Attachment E displays a summary of consumptive use shortages to all priorities within the Lower Basin States. Attachment F displays supporting documents to the Shortage Allocation Model.

Shortages generated in Attachments B and C were aggregated by county and class of use for the analysis in Section 4.14 (Socioeconomics). Because some of Arizona's entitlements are shared between agricultural and M&I use, a ratio was developed to split the entitlement for analysis purposes. Thus, for such entitlements, the reduction in agricultural consumptive use is a proportion of the ratio of agricultural use to M&I use permitted in the entitlement holder’s contract. For unquantified contract entitlements, the specified M&I amount in the contract was subtracted from the scheduled use for the selected year.

A summary of shortages generated in Attachment E were used in Section 4.4 (Water Deliveries). All shortages displayed in he tables provided in Attachments B through E were based on the following years: 2008, 2017, 2026, 2027, 2040, and 2060.

G.6 Relationship between CRSS and the Shortage Allocation Model

The CRSS was used to model a variety of river and reservoir parameters in the Colorado River Basin, including shortage amounts, reservoir elevations, and river flows (Section 4.2 and Appendix A). The Shortage Allocation Model provides a more detailed allocation of shortages to the Lower Basin states, specifically to Arizona and the CAP. The Shortage Allocation Model distributes shortages according to the ADWR Director’s Shortage Sharing Workshop Recommendation for Arizona and according to the AWSA for the CAP.

In terms of the total Stage 1 and Stage 2 Shortages, CRSS and the Shortage Allocation Model generate similar results. The distribution of Stage 1 Shortages amongst Arizona fourth priority entitlement holder’s contrasts between the models as CRSS does not recognize the ADWR Director’s Shortage Sharing Workshop Recommendation. When the ADWR Director’s Shortage Sharing Workshop Recommendation was incorporated into the Shortage Allocation Model, ADWR requested that fourth priority schedules be adjusted to prevent them from exceeding Reclamation’s estimated entitlements displayed in the Shortage Allocation Model. Also, in the Final EIS the Shortage Allocation Model incorporated Brooke Water Company’s new contract for 120 af, Mohave County Water Authority’s recommended contract of 3,500 af, and the City of Needle’s quitclaimed PPR of 1,260 af from Atchison, Topeka, and Santa Fe Railway Company. For these reasons the results in the models differ slightly.

Furthermore, the distribution of shortages analyzed within California and Nevada are slightly different than CRSS, because CRSS uses schedules provided by California and Nevada, while the Shortage Allocation Model assumes entitlement holders in these states are using their full entitlement. This difference can only be seen at the maximum shortages analyzed and varies only slightly. Comparison of the Final EIS results between the two models is provided in Table G-10.

Table G-10
Comparison of CRSS and Shortage Allocation Model Results

Year	User	Shortage Allocation Model	CRSS	Difference (Shortage Allocation Model – CRSS)
2017 (500,000 Acre-Foot Shortage)				
	Mexico	83,333	83,333	0
	Nevada	16,667	16,667	0
	SNWA	16,667	16,667	0
	California	0	0	0
	MWD	0	0	0
	Arizona	400,000	400,000	0
	AZ 4th	400,000	400,000	0
	CAP	382,454	376,200	6,254
	River	17,546	23,800	-6,254
	AZ 2/3	0	0	0
2027 (1,921,236 Acre-Foot Shortage)				
	Mexico	320,206	320,206	0
	Nevada	64,041	64,041	0
	SNWA	64,041	64,041	0
	California	119,475	119,475	0
	MWD	119,475	119,475	0
	Arizona	1,417,514	1,417,514	0
	AZ 4th	1,378,928	1,378,928	0
	CAP	1,297,146	1,292,743	4,403
	River	81,782	86,185	-4,403
	AZ 2/3	38,587	38,587	0

One last difference between CRSS and the Shortage Allocation Model exists. In distributing the available water supply to individual users, CRSS models the quantity of water used by the individual entitlement holder in the previous year. The Shortage Allocation Model uses the quantity of water projected to be ordered in the shortage year as the basis for distributing the available water supply to individual users. In the example above, the Shortage Allocation Model results were computed based on the previous year's use to produce comparable results to CRSS.

Comparison of results generated in the Shortage Allocation Model for the Draft EIS and the Final EIS, is provided in Attachment F, Table Att. F-3. A list of all output and attachments is provided in the table of contents of this appendix.

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Attachment A

Operational Worksheets
in the Shortage Allocation Model

This attachment to Appendix G contains tables produced by the Shortage Allocation Model that show the distribution of shortages at the regional and Lower Division state levels, and to the CAP water users based on a 500,000 af Lower Basin shortage for the year 2017.

Table Att. A-1
Operational Worksheet: Region

2017		U.S. & Mexico Shortage Sharing	Consumptive Use Entitlement	Deliverable Consumptive Use	Consumptive Use Reduction	
Stage I Shortage:			**1,729,907**	**1,229,907**	**500,000**	
Mexico		16.67 %	288,318	204,984	83,333	
Arizona		80.00 %	1,383,925	983,925	400,000	
Nevada		3.33 %	57,664	40,997	16,667	
California		0.00 %	0	0	0	
Stage II Shortage (when AZ 4th = 0):			**7,270,093**	**7,270,093**	**0**	
Mexico		16.67 %	1,211,682	1,211,682	0	
Arizona		19.48 %	1,416,075	1,416,075	0	
Nevada		3.33 %	242,336	242,336	0	
California		60.52 %	4,400,000	4,400,000	0	
Stage I & II Total:			**9,000,000**	**8,500,000**	**500,000**	
RUN MODE				**TOTAL REDUCTION:**	**500,000**	PROCESS
Arizona				2,400,000	400,000	
Nevada				283,333	16,667	
California				4,400,000	0	
Mexico				1,416,667	83,333	

Table Att. A-2
Operational Worksheet: Nevada

2017	500,000				ENTITLEMENT		DELIVERY[1]		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
	State Consumptive Use							300,000		283,333		-16,667
8th - Balance & Surplus	Southern Nevada Water Authority (includes banking)	2-07-30-W0266	1992	M&I	balance + surplus		116,918	70,914	89,440	54,248	-27,479	-16,667
	TOTAL						116,918	70,914	89,440	54,248	-27,479	-16,667
	PERCENT									76%		-24%
8th	Big Bend Water District	2-07-30-W0269	1992	M&I	10,000		10,000	4,251	10,000	4,251	0	0
	Robert B. Griffith Project	7-07-30-W0004	1992	M&I	304,000		304,000	172,070	304,000	172,070	0	0
	Sub. to City of Boulder City (8,918)			M&I						0		
	Sub. to City of Henderson (27,021)			M&I						0		
	Sub. to City of North Las Vegas (26,635)			M&I						0		
	Sub. to Las Vegas Valley Water District (232,426)			M&I						0		
	TOTAL				314,000	0	314,000	176,322	314,000	176,322	0	0
	PERCENT									100%		0%
7th	Boy Scouts of America (annexed by SNWA)	9-07-30-W0011	1978	M&I	10		10	6	10	6	0	0
	Bureau of Reclamation (includes Sportsman Park)	Secretarial Res.	1998	M&I	300		300	188	300	188	0	0
	Nevada Dept. of Wildlife (formerly Nevada Dept of Fish & Game)	14-06-300-2405	1972	M&I		25	1,082	25	1,082	25	0	0
	U.S. Air Force (4,000 af) (Delivery from SNWA)				4,000		4,000	2,264	4,000	2,264	0	0
	TOTAL				310	25	1,392	218	1,392	218	0	0
	PERCENT									100%		0%
6th	Las Vegas Valley Water District	14-06-300-2130	1969	M&I	15,407		15,407	15,407	15,407	15,407	0	0
	TOTAL				15,407	0	15,407	15,407	15,407	15,407	0	0
	PERCENT									100%		0%
5th	Lakeview Company (Hacienda Casino)	14-06-300-1523	1965	M&I	0		0	0	0	0	0	0
	Pacific Coast Building Products, Inc. (PABCO)	5-07-30-W0089	1965	M&I	928		928	928	928	928	0	0
	TOTAL				928	0	928	928	928	928	0	0
	PERCENT									100%		0%
4th	Basic Management, Inc.	14-06-300-2083	1969	M&I	8,608		8,608	8,608	8,608	8,608	0	0
	City of Henderson	0-07-30-W0246	1967	M&I	15,878		15,878	14,700	15,878	14,700	0	0
	TOTAL				24,486	0	24,486	23,308	24,486	23,308	0	0
	PERCENT									100%		0%
3rd	Boulder City	14-06-300-978	1931	M&I	5,876		5,876	3,326	5,876	3,326	0	0
	TOTAL				5,876	0	5,876	3,326	5,876	3,326	0	0
	PERCENT									100%		0%
2nd	Lake Mead National Recreation Area[2]	1964 Decree	1930	M&I	unlimited		679	679	679	679	0	0
	TOTAL				0	0	679	679	679	679	0	0
	PERCENT									100%		0%
1st[3]	Lake Mead National Recreation Area	PPR 82/1979 Decree	1926	M&I	500	300	500	500	500	500	0	0
	Fort Mohave Indian Reservation	PPR 81	1890	Indian	12,534		12,534	8,398	12,534	8,398	0	0
	TOTAL				13,034	0	13,034	8,898	12,534	8,898	0	0
	PERCENT									100%		0%
Nevada Totals					374,041	325	492,720	300,000	464,741	283,333	-27,479	-16,667
Nevada Percent										94%		-6%

Note: CU means Consumptive Use. All units are in acre-feet per year.
Subcontracts are displayed below the Entitlement Holder and indented five spaces.
[1]2004 Decree Accounting values and Diversion/CU conversion ratios were used to estimate not specified and unquantified entitlements.
[2]This unlimited entitlement is estimated based on 2004 use.
[3]In a shortage, PPR's are delivered water in order of priority date regardless of state lines.

Table Att. A-3
Operational Worksheet: California

2017	500,000				ENTITLEMENT		DELIVERY[1]		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
	State Consumptive Use							4,400,000		4,400,000		0
4th	Metropolitan Water District of Southern California (4)	I1r-645	1930, 1931	M&I		550,000	450,412	450,412	450,412	450,412	0	0
	TOTAL				0		450,412	2	450,412		0	0
	PERCENT									100%		0%
3rd	Palo Verde Irrigation District (3b) - Lower Palo Verde Mesa Lands	PVID20733C_P5	1933	Agricultural	≤16,000 acres	Unquantified	26,909	11,460	26,909	11,460	0	0
	Coachella Valley Water District (3a)[2]	I1r-781	1934	Agricultural		330,000	336,973	327,000	336,973	327,000	0	0
	Imperial Irrigation Districts (3a)[3]	I1r-747	1932	Agricultural		572,659	577,674	561,159	577,674	561,159	0	0
	TOTAL					902,659	941,555	899,619	941,555	899,619	0	0
	PERCENT									100%		0%
2nd	Yuma Project, Reservation Division[4] (includes Bard, Indian, Island[5])	Water Certificates[5]	1905	Indian/Agricultural	≤25,000 acres		13,644	7,545	13,644	7,545	0	0
	TOTAL				0	0	13,644	7,545	13,644	7,545	0	0
	PERCENT									100%		0%
1st	Palo Verde Irrigation District - Valley Lands (1)[6]	PVID20733C_P2	1933	Agricultural	≤104,500 acres	Unquantified	749,260	319,099	749,260	319,099	0	0
	TOTAL				0	0	749,260	319,099	749,260	319,099	0	0
	PERCENT									100%		0%
PPR's[7]	One Acre PPR's	PPR's 45-80	1895-1928	M&I	36	21.6	36	22	36	22	0	0
	Sonny Gowan (Grannis)	PPR 32 & 7-07-30-W0158	1928	Agricultural	180		180	108	180	108	0	0
	Chagnon	PPR No. 41	1925	Agricultural	120		120	72	120	72	0	0
	Stephenson	PPR No. 30	1923	Agricultural	240		240	144	240	144	0	0
	Colorado River Sportsmen's League	PPR No. 36	1921	Agricultural	96		96	58	96	58	0	0
	Andrade (AKA Andrade, Andrews, Bly, Brown, Carney, Daniel, Fairbanks, Glynn, Lindeman, Leon, Schroeder, Sherman, Perrett, Wetmore, Wetmore, Williams)	PPR No. 38	1921	M&I/Agricultural	66		66	47	66	47	0	0
	Milpitas	PPR No. 34	1918	Agricultural	108		108	65	108	65	0	0
	Lawrence	PPR No. 42	1915	Agricultural	120		120	72	120	72	0	0
	Milpitas	PPR No. 37	1914	Agricultural	69		69	41	69	41	0	0
	Morgan	PPR No. 33	1913	Agricultural	150		150	90	150	90	0	0
	Chemehuevi Indian Reservation	PPR No. 22	2/2/1907	Indian	11,340	or if less, irrigation for 1,900 acres	11,340	6,094	11,340	6,094	0	0
	Cooper	PPR No. 40	1905	Agricultural	60		60	36	60	36	0	0
	Yuma Project, Reservation Division (non-Indian portion)	PPR 28 & Water Cert.	7/8/1905	Indian/Agricultural	38,270	or if less, irrigation for 6,294 acres	38,270	17,918	38,270	17,918	0	0
	Reynolds	PPR No. 39	1904	Agricultural	36		36	22	36	22	0	0
	Imperial Irrigation District (includes lands in CVWD)	PPR No. 27	1901	Agricultural	2,600,000	or if less, irrigation for 424,145 acres	2,600,000	2,527,341	2,600,000	2,527,341	0	0
	Needles (formerly Atchison, Topeka, and Santa Fe Railway Co.)	PPR No. 44	1896	M&I	1,260	273	1,260	273	1,260	273	0	0
	Picacho Development Corp and CA Department of Parks and Recreation	PPR 31 & 8-07-30-W0187	1893	Agricultural	120		120	66	120	66	0	0
	Fort Mohave Indian Reservation	PPR No. 25	9/18/1890	Indian	16,720	or if less, irrigation for 2,587 acres	16,720	8,994	16,720	8,994	0	0
	Simons	PPR No. 35	1889	Agricultural	60		60	36	60	36	0	0
	City of Needles	PPR No. 43/5-XX-30-W0445	1885	M&I	1,500	950	1,500	950	1,500	950	0	0
	Fort Yuma Indian Reservation	PPR No. 23	1/9/1884	Indian	71,616	or if less, irrigation for 10,742 acres	71,616	34,506	71,616	34,506	0	0
	Palo Verde Irrigation District	PPR No. 26	1877	Agricultural	219,780	or if less, irrigation for 33,604 acres	219,780	93,601	219,780	93,601	0	0

Table Att. A-3
Operational Worksheet: California

2017	500,000				ENTITLEMENT		DELIVERY[1]		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
	Colorado River Indian Reservation	PPR No. 24	5/15/1876	Indian	5,860	or if less, irrigation for 879 acres	5,860	3,324	5,860	3,324	0	0
	Colorado River Indian Reservation	PPR No. 24	11/16/1874	Indian	40,241	or if less, irrigation for 6,037 acres	40,241	22,823	40,241	22,823	0	0
	Colorado River Indian Reservation	PPR No. 24	10/22/1873	Indian	10,745	or if less, irrigation for 1,612 acres	10,745	6,094	10,745	6,094	0	0
	Yuma Associates LTD and Winterhaven Water District (262.8 M&I)	PPR 29 & 4-07-30-W0053	1856	M&I/Agricultural	780		780	528	780	528	0	0
	TOTAL				3,019,573	1,245	3,019,573	2,723,325	3,019,573	2,723,325	0	0
	PERCENT									100%		0%
	CALIFORNIA TOTALS				3,019,598	2,706,926	5,174,444	4,400,000	5,174,444	4,400,000	0	0
	CALIFORNIA PERCENT									100%		0%

Note: CU means Consumptive Use; all units are in AFY (acre-feet annually).
These priorities are based on the California Seven Party Agreement, modified to include the PPR's identified by the Consolidated Decree.
Forbearances and transfers are displayed in Appendix G, Attachment 6, Table Att. 6-3
The Lower Colorado Water Supply Project exchanges non-project water for Colorado River water. During a declared shortage on the Colorado River, the Colorado Water Supply Project would not be shorted.
[1]2004 Decree Accounting values and Diversion/CU conversion ratios were used to estimate not specified and unquantified entitlements. Consumptive use on Lower Palo Verde Mesa lands assumed to be equal to 2007 Palo Verde Irrigation District request. PVID's estimated entitlement is based on 2004 Decree Accounting use.
[2]Coachella Valley Water District's estimated entitlement shown in this table is reduced by 3,000 af to permit the Secretary of the Interior to satisfy PPR use not covered by the Seven Party Agreement.
[3]IID's PPR protects 2,600,000 acre-feet of its Seven Party 3rd priority diversion entitlement, which is consumptively estimated to be 2,527,341 af. IID's 3rd priority estimated entitlement shown in this table is reduced by the PPR right and 11,500 af to permit the Secretary of the Interior to satisfy PPR use not covered by the Seven Party Agreement.
[4]A portion of this Seven Party Agreement entitlement is shown below under two separate PPR entitlements, the Fort Yuma Indian Reservation (PPR 23) and the Yuma Project, Reservation Division (PPR 28).
[5]Incorporation of Yuma Island pumpers' use within this priority does not represent either a final approval of this use by Reclamation or a final determination of the appropriate Decree accounting for this use; and is not an admission by any Colorado River contractor as to the legality of this use or diversion of Colorado River water. No Water Certificates have been issued for use of water on the Yuma Island in California.
[6]PVID's PPR protects 219,780 af of its Seven Party 1st priority diversion entitlement, which is consumptively estimated to be93,601. Dependent upon call, PVID will fallow a minimum of 25,000 af for the Metropolitan Water District of Southern California.
[7]In a shortage, PPRs are delivered water in order of priority date regardless of state lines. It is assumed that each PPR holders would divert and consumptively use all of its entitlement by 2017.

Table Att. A-4
Operational Worksheet: Arizona

2017	500,000				ENTITLEMENT[1] *(estimated)*		SCHEDULED USE		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
	State Consumptive Use							2,800,000		2,400,000		400,000
4th (River Users)	Arizona State Land Department	7-07-30-W0358	2004	M&I	1,534	997	817	531	817	531	0	0
	Arizona State Land Department	4-07-30-W0317	1999	Agricultural	6,607	4,294	6,607	4,294	4,697	3,053	-1,909	-1,241
	Arizona State Parks Board - Contact Point	(Recommendation)		M&I	20	20	13	13	13	13	0	0
	Arizona State Parks Board - Windsor Beach	7-07-30-W0364	1998	M&I	90	58	31	20	31	20	0	0
	Arizona-American Water Company	00-XX-30-W0391	2001	M&I	1,420	922	463	300	463	300	0	0
	Beattie Farms Southwest	06-XX-30-W0446	2006	Agricultural	1,110	722	1,110	722	789	513	-321	-209
	Brooke Water Company (formerly Graham)	4-07-30-W0444	1983/2007	M&I	440	294	79	53	79	53	0	0
	Bullhead City (includes subcontract w/ MCWA of 6,000)	2-07-30-W0273	1982	M&I	21,210	14,208	13,025	8,725	13,025	8,725	0	0
	Bureau of Land Management[4] (Estimated diversion entitlement of 6,171 af)	8-07-30-W0373	1973/81/87	M&I	6,171	4,010	1,309	851	1,309	851	0	0
	CHACHA, LLC (formerly Curtis Family Trust)	(Recommendation)		Agricultural	2,100	1,365	2,100	1,365	1,493	970	-607	-395
	B&F Investment, LLC	06-XX-30-W0453	1983	M&I	60	60	0		0	0	0	0
	Cibola Valley Irrigation & Drainage District (M&I: 300)	2-07-30-W0028	1983	M&I/Agricultural	12,066	8,627	10,842	7,752	8,579	6,134	-2,264	-1,619
	City of Somerton	03-XX-30-W0419	2006	M&I	750	488	751	488	533	347	-218	-141
	City of Yuma (Smucker Park)	14-06-303-2702	1969	M&I	33	22	0	0	0	0	0	0
	Cocopah Indian Reservation	1974 Decree	1974	Indian	2,026	1,989	1,362	1,337	1,362	1,337	0	0
	Crystal Beach Water Conservation District	6-07-30-W0352	1997	M&I	132	86	106	69	94	61	-12	-8
	Curtis, Armon (Curry Family LTD)	3-07-30-W0037	1983	Agricultural	300	195	300	195	213	139	-87	-56
	Desert Lawn Memorial Park Association, Inc.	14-06-300-2587	1975	M&I	360	244	22	15	22	15	0	0
	Ehrenburg Improvement District	8-07-30-W0006	1977	M&I	500	358	500	358	355	255	-144	-103
	Fisher's Landing Water and Sewer Works, LLC	6-XX-30-W0450	2007	M&I	53	34	52	34	38	24	-15	-10
	Gila Monster Farms (formerly Sturges Farms Inc.)	6-07-30-W0337	1997	Agricultural	1,435	775	1,436	775	1,020	551	-416	-224
	Gold Dome Mining Corporation	0-07-030-W0250	1990	M&I	7	5	0	0	0	0	0	0
	Gold Standard Mines Corporation	3-07-30-W0038	1983	M&I	75	49	0	0	0	0	0	0
	Golden Shores Water Conservation District	9-07-30-W0203	1989	M&I	2,000	1,339	759	508	759	508	0	0
	Hillcrest Water Company	5-07-30-W0078	1985	M&I	84	55	56	36	56	36	0	0
	Hopi Tribe	04-XX-30-W0432	1983	Indian	5,997	3,898	5,898	3,834	4,264	2,772	-1,634	-1,062
	JRS Partners LLC (formerly Jessen Family Limited)	06-XX-30-W0448	2007	Agricultural	1,080	702	1,080	702	768	499	-312	-203
	Lake Havasu City (includes subcontract w/ MCWA of 6,000 af)	3-07-30-W0039	1995	M&I	25,180	15,611	24,264	15,043	17,902	11,099	-6,361	-3,944
	Marble Canyon Company, Inc.	5-07-30-W0322	1996	M&I	70	45	24	16	24	16	0	0
	Martinez Lake Cabin Sites	(Recommendation)		M&I	23	15	23	15	16	11	-7	-4
	McAlister, Maurice L.	7-07-30-W0355	1998	M&I	40	26	6	4	6	4	0	0
	Mohave County Water Authority	04-XX-30-W0431	1983	Agricultural	5,997	3,898	5,898	3,834	4,264	2,772	-1,634	-1,062
	Mohave County Water Authority	5-07-30-W0320	1968	M&I	3,500	2,275	3,500	2,275	2,488	1,618	-1,011	-657
	Subcontracts to Arizona-American Water Co. (900 af)								0	0		
	Subcontracts to MVIDD (380 af & 600 af)								0	0		
	Mohave Valley Irrigation and Drainage District (8,000 af M&I)	14-06-W-204	1968	M&I/Agricultural	35,060	18,933	35,060	18,933	24,927	13,461	-10,133	-5,472
	Mohave Water Conservation District (includes subcontract w/ MCWA of 3,000 af)	9-07-30-W0012	1968	M&I	4,800	3,218	928	622	928	622	0	0
	North Baja LLC (formerly Jamar Produce) (72 af M&I)	5-07-30-W0066	1984	M&I/Agricultural	480	337	480	337	341	240	-138	-97
	Ogram Boys Enterprises	1-XX-30-W0402	2005	Agricultural	924	601	925	601	657	427	-268	-174
	Ogram, George	01-XX-30-W0398	2003	Agricultural	480	312	480	312	341	222	-139	-90
	Pasquinelli, Gary and Barbara (formerly Ansel Hall)	5-07-30-W0065	1986	Agricultural	486	316	486	316	346	225	-141	-91
	Peach, John	(Recommendation)		Agricultural	456	296	455	296	324	211	-131	-85
	Phillips, Milton and Jean	(Recommendation)		Agricultural	18	12	18	12	13	8	-6	-4
	Rayner Ranches	5-07-30-W0064	1984	Agricultural	4,500	2,924	4,500	2,924	3,199	2,079	-1,300	-845
	Reserved Secretary Water for Indian Settlements				3,500	2,275	0		0	0	0	0
	Roy, Edward P. & Anna R.	6-07-30-W0124	1986	M&I	1	1	2	1	1	0	-1	-1
	Shepard Water Company	(Recommendation)		M&I	50	33	50	33	36	23	-14	-9

Table Att. A-4
Operational Worksheet: Arizona

2017	500,000				ENTITLEMENT[1] *(estimated)*		SCHEDULED USE		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
	City of Parker	2-07-30-W0025	1998	M&I	1,030	*390*	1,030	390	732	277	-298	-113
	Town of Quartzsite	7-07-30-W0353	1999	M&I	1,070	*1,070*	409	409	409	409	0	0
	Verizon (formerly Continental Telephone)	14-06-300-2506	1974	M&I	1	*1*	2	1	1	0	-1	-1
	Unallocated Priority 4 Water			M&I	9,326	6,062	0	0	0	0	0	0
	TOTAL River Users				164,652	104,464	127,256	79,350	97,734	61,429	-29,522	-17,921
	PERCENT								77%	77%	-23%	-23%
4th (CAP)	Central Arizona Water Conservation District (CAP)[3]	14-06-W-245	1972	M&I/Agricultural/Indian	AZ Balance	AZ Balance	1,304,575	1,304,575	922,496	922,496	-382,079	-382,079
	TOTAL CAP						1,304,575	1,304,575	922,496	922,496	-382,079	-382,079
	PERCENT								71%	71%	-29%	-29%
4th	TOTAL 4th Priority						1,431,832	1,383,925	1,020,231	983,925	-411,601	-400,000
	PERCENT									71%		-29%
2nd & 3rd (co-equal)	Cibola National Wildlife Refuge (2nd Priority)	Secretarial Res.	8/21/1964	M&I	34,500	orif less, 16,793	13,692	8,505	13,692	8,505	0	0
	Yuma Irrigation District (5,000 af M&I) (2nd Priority)	14-06-300-1270	1962	M&I/Agricultural		67,278	72,177	32,860	72,177	32,860	0	0
	National Park Service (2nd Priority)	1964 Decree	1961	M&I	unquantified		738	738	738	738	0	0
	Yuma Union High School (3rd Priority)	14-06-303-179	1960	M&I	200		157	117	157	117	0	0
	Union Pacific Railroad (formerly Southern Pacific Co.) (3rd Priority)	14-06-303-1524	12/21/1959	M&I	48		59	29	59	29	0	0
	Kaman, Inc. (3rd Priority)	14-06-303-1555	12/2/1959	M&I	2		0	0	0	0	0	0
	City of Yuma (3rd Priority)	14-06-W-106	11/12/1959	M&I		48,522	43,445	28,852	43,445	28,852	0	0
	Department of Navy MCAS (2nd Priority)	14-06-300-937	1/1/1959	M&I	3,000		2,129	2,129	2,129	2,129	0	0
	Yuma County Water Users' Association (14,701 af M&I) (2nd Priority)	14-06-300-621 & Certificates	1957	M&I/Agricultural	unquantified		0		0	0	0	0
	Yuma Area Office (489.95 af M&I Conversion)				490					0		
	City of Yuma (cemetery) (3rd Priority)	14-06-303-1078	11/12/1956	M&I	60		0	0	0	0	0	0
	Yuma Mesa Fruit Growers (3rd Priority)	14-06-303-1196	10/1/1956	Agricultural	15		12	12	12	12	0	0
	Yuma Mesa Irrigation & Drainage District (10,000 af M&I) (2nd Priority)	14-06-W102	5/26/1956	M&I/Agricultural		141,519	307,476	159,354	307,476	159,354	0	0
	Desert Lawn Memorial Park (3rd Priority)	14-06-300-1079	5/1/1956	M&I	200		207	140	207	140	0	0
	Ak-Chin Indian Community[3] (2nd Priority)	AK-CHIN121180A	1/1/1956	Indian	50,000		50,000	50,000	50,000	50,000	0	0
	University of Arizona (3rd Priority)	14-06-300-144	1954	Agricultural	1,088		840	840	840	840	0	0
	Yuma Mesa Grapefruit Company (Camille Allec Jr.) (3rd Priority)	14-06-303-528	12/23/1953	Agricultural	120		84	60	84	60	0	0
	North Gila Valley Irrigation District (2,500 af M&I) (2nd Priority)	14-06-W-54	5/12/1953	M&I/Agricultural		41,203	0		0	0	0	0
	Yuma Auxiliary Project (Unit B) (2nd Priority)	14-06-300-44	12/22/1962	Agricultural	unquantified		21,499	12,973	21,499	12,973	0	0
	Wellton-Mohawk Irrigation and Drainage District (5,000 af M&I) (2nd Priority)	1-07-30-W0021	3/4/1952	M&I/Agricultural		278,000	441,740	277,997	441,740	277,997	0	0
	Chandler (Salt River Pima-Maricopa Exchange)[3] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	4,278		4,278	4,278	4,278	4,278	0	0
	Gilbert (Salt River Pima-Maricopa Exchange)[3] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	6,762		6,762	6,762	6,762	6,762	0	0
	Glendale (Salt River Pima-Maricopa Exchange)[3] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	3,000		3,000	3,000	3,000	3,000	0	0
	Mesa (Salt River Pima-Maricopa Exchange)[3] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	2,760		2,760	2,760	2,760	2,760	0	0
	Phoenix (Salt River Pima-Maricopa Exchange)[3] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	5,000		5,000	5,000	5,000	5,000	0	0
	Scottsdale (Salt River Pima-Maricopa Exchange)[3] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	100		100	100	100	100	0	0
	Tempe (Salt River Pima-Maricopa Exchange)[3] (2nd Priority)	Salt River Settlement	3/4/1952	M&I	100		100	100	100	100	0	0
	Gila Monster Farms (formerly Sturges) (3rd Priority)	6-07-30-W0337	1/1/1952	Agricultural	6,285		6,670	3,600	6,670	3,600	0	0
	Sturges, Harold (2nd Priority)	I76R-733	1/1/1952	Agricultural	0		0		0	0	0	0
	Sturges, Irma (2nd Priority)	I76R-735	1/1/1952	Agricultural	0		0		0	0	0	0
	Department of Army - Yuma Proving Ground (2nd Priority)	I76r-696	1951	M&I	1,129		760	760	760	760	0	0
	Bureau of Reclamation - Davis Dam (2nd Priority)	Secretarial Res.	4/26/1941	M&I	100		1	1	1	1	0	0
	Imperial National Wildlife Refuge (2nd Priority)	1964 Decree	2/14/1941	M&I	28,000	or if less, 23,000	5,831	3,618	5,831	3,618	0	0
	Havasu Lake National Wildlife Refuge (2nd Priority)	1964 Decree	1/22/1941	M&I	41,839	or if less, 37,399	42,279	4,841	42,279	4,841	0	0
	TOTAL				189,076	576,522	1,031,796	609,426	1,031,796	609,426	0	0

Table Att. A-4
Operational Worksheet: Arizona

2017	500,000				ENTITLEMENT[1] *(estimated)*		SCHEDULED USE		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
	PERCENT									100%		0%
1st (PPR's)[2]	Molina	PPR No. 15	1928	Agricultural	318		0	0	0	0	0	0
	Gila Monster Farms (formerly Sturges)	PPR No. 16	1925	Agricultural	780		1,445	780	1,445	780	0	0
	Cocopah Indian Reservation	PPR No. 1	9/27/1917	Indian	7,681		6,950	6,792	6,950	6,792	0	0
	Cocopah Indian Reservation	PPR No. 8	1915	Indian	1,140		1,031	1,008	1,031	1,008	0	0
	Powers (Power, R.E. & P.)	PPR No. 7	1915	Agricultural	960		960	624	960	624	0	0
	Zozaya (in MVIDD)	PPR No. 17	1912	Agricultural	720		720	389	720	389	0	0
	Fort Mohave Indian Reservation	PPR No. 3	2/2/1911	Indian	75,566		98,653	53,280	98,653	53,280	0	0
	Brooke Water Company (formerly Graham)	PPR No. 9	1910	M&I	360		361	241	361	241	0	0
	North Gila Valley Irrigation District	PPR No. 6	7/8/1905	Agricultural	24,500		85,059	19,761	85,059	19,761	0	0
	Yuma Auxiliary Project (Unit B)	PPR No. 5 & Certificates	7/8/1905	Agricultural	6,800		11,269	6,800	11,269	6,800	0	0
	City of Parker	PPR No. 20	1905	M&I	630	or if less, 400	1,057	400	1,057	400	0	0
	Hulet (in MVIDD)	PPR No. 10	1902	Agricultural	1,080		1,080	583	1,080	583	0	0
	Hoover (in MVIDD/formerly Hopal)	4-07-30-W0052/PPR 11	1902	Agricultural	1,050		1,050	567	1,050	567	0	0
	Miller (in MVIDD)	PPR No. 12	1902	M&I	240		240	130	240	130	0	0
	McKellips and Granite Reef Farms (in MVIDD)	PPR No. 13	1902	Agricultural	810		810	437	810	437	0	0
	Sherill & Lafollette (in MVIDD)	PPR No. 14	1902	Agricultural	1,080		1,080	583	1,080	583	0	0
	Swan (in MVIDD)	PPR No 18	1902	M&I	960		960	518	960	518	0	0
	Yuma County Water Users' Association	PPR No. 4 & Certificates	1901	Agricultural	254,200		357,227	228,368	357,227	228,368	0	0
	Phillips, Milton and Jean	PPR No. 19	1900	Agricultural	42		0	0	0	0	0	0
	City of Yuma	PPR No. 21	1893	M&I	2,333	or if less, 1,478	2,350	1,489	2,350	1,489	0	0
	Fort Mohave Indian Reservation	PPR No. 3	9/18/1890	Indian	27,969		36,514	19,720	36,514	19,720	0	0
	Fort Yuma Indian Reservation (new entitlement)	PPR No. 3a	1/9/1884	Indian	6,350		1,812	1,178	1,812	1,178	0	0
	Colorado River Indian Reservation	PPR No. 2	11/16/1874	Indian	51,986		64,947	36,337	64,947	36,337	0	0
	Colorado River Indian Reservation	PPR No. 2	11/22/1873	Indian	252,016		314,848	176,152	314,848	176,152	0	0
	Colorado River Indian Reservation	PPR No. 2	3/3/1865	Indian	358,400		447,755	250,511	447,755	250,511	0	0
	TOTAL				11,077,971		1,438,179	806,649	1,438,179	806,649	0	0
	PERCENT									100%		0%
	ARIZONA TOTALS						3,901,806	2,800,000	2,490,205	2,400,000	-411,601	-400,000
	ARIZONA TOTAL PERCENT									86%		-14%

Note: CU means Consumptive Use; all units are in AFY (acre-feet annually).
Subcontracts are displayed below the Entitlement Holder and indented five spaces.
[1]2004 Decree Accounting values and Diversion/CU ratios were used to estimate not specified and unquantified entitlements.
[2]In a shortage, PPR's are delivered water in order of priority date regardless of state lines.
[3]These CAP users are subject to CAP conveyance losses which are assumed to be 5 percent.
[4]BLM Diversion entitlement is estimated from Consumptive Use Entitlement based on 2004 Decree Accounting.

Table Att. A-5
Operational Worksheet: CAP

Year: 2017

Lower Basin Shortage: 500,000	Entitlement						Scheduled Use						Adjusted Delivery						Shortage Allocation					
	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Agricultural)	CAP 5 (AWBA)	TOTAL	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Agricultural)	CAP 5 (AWBA)	TOTAL	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Agricultural)	CAP 5 (AWBA)	TOTAL	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Agricultural)	CAP 5 (AWBA)	TOTAL
Excess Water for ABWA					Balance						0						0	0					0	0
Excess Water for Agriculture				Available		0				277,891		277,891				0		0				277,891		277,891
Ak-Chin Indian Community**	47,500	27,500				75,000	47,500	27,500				75,000	47,500	27,500				75,000	0	0				0
Fort McDowell		18,233				18,233		8,140				8,140		8,140				8,140		0				0
Gila River		191,200	120,600			311,800		191,200	0			191,200		191,200	0			191,200		0	0			0
TON-Chui Chu		8,000				8,000		8,000				8,000		8,000				8,000		0				0
TON-San Xavier		27,000	23,000			50,000		27,000	8,972			35,972		27,000	2,374			29,374		0	6,597			6,597
TON-Schuk Toak		10,800	5,200			16,000		10,800	2,028			12,828		10,800	537			11,337		0	1,492			1,492
Pasqua Yaqui		500				500		500				500		500				500		0				0
Salt River		13,300				13,300		13,300				13,300		13,300				13,300		0				0
San Carlos Apache**		39,000				39,000		39,000				39,000		39,000				39,000		0				0
Tonto Apache		128				128		128				128		128				128		0				0
Yavapai Apache (Camp Verde)		1,200				1,200		1,200				1,200		1,200				1,200		0				0
Yavapai Prescott		500				500		500				500		500				500		0				0
Unallocated HVID		1,218				1,218		1,218				1,218		1,218				1,218		0				0
Reserved Federal			67,300			67,300			12,300			12,300			3,255			3,255			9,045			9,045
Indian Subtotal:	47,500	338,579	216,100	0		602,179	47,500	328,486	23,300	0		399,286	47,500	328,486	6,166	0		382,152	0	0	17,134	0		17,134
Apache Junction (AZ Water Co)		6,000				6,000		6,000				6,000		6,000				6,000		0				0
Avra Coop		808				808		0				0		0				0		0				0
AZ-American (Agua Fria)		11,093				11,093		11,093				11,093		11,093				11,093		0				0
AZ-American (Paradise Valley)		3,231				3,231		3,231				3,231		3,231				3,231		0				0
AZ-American (Sun City)		4,189				4,189		4,189				4,189		4,189				4,189		0				0
AZ-American (Sun City West)		2,372				2,372		2,372				2,372		2,372				2,372		0				0
AZ State Land Dept. (9,026 is Agricultural)		32,076	9,026			41,102		700	9,026			9,726		700	2,389			3,089		0	6,637			6,637
ASARCO (Ray Mine)		21,000				21,000		0				0		0				0		0				0
Avondale		5,416				5,416		4,746				4,746		4,746				4,746		0				0
Berneil Water Co (Cave Creek)		200				200		0				0		0				0		0				0
Buckeye		25				25		0				0		0				0		0				0
Carefree Water Co		1,300				1,300		400				400		400				400		0				0
Casa Grande (AZ Water Co)		8,884				8,884		2,000				2,000		2,000				2,000		0				0
Cave Creek Water Co		2,406				2,406		2,048				2,048		2,048				2,048		0				0
CAGRD		7,746				7,746		7,746				7,746		7,746				7,746		0				0
Chandler*	4,064	8,654	3,924			16,642	4,064	8,654	3,924			16,642	4,064	8,654	1,038			13,757	0	0	2,886			2,886
Chandler Heights Citrus ID		315				315		0				0		0				0		0				0
Chaparral City Water Co		8,909				8,909		5,705				5,705		5,705				5,705		0				0
Circle City Water Co		3,932				3,932		0				0		0				0		0				0
Comm. Water Co (Green Valley)		2,858				2,858		0				0		0				0		0				0
Coolidge (AZ Water Co)		2,000				2,000		0				0		0				0		0				0
El Mirage		508				508		0				0		0				0		0				0
Eloy		2,171				2,171		2,171				2,171		2,171				2,171		0				0
Florence		2,048				2,048		2,048				2,048		2,048				2,048		0				0
Flowing Wells ID		4,354				4,354		0				0		0				0		0				0
Gilbert	6,424	7,235	1,537			15,196	6,424	7,235	1,537			15,196	6,424	7,235	407			14,066	0	0	1,130			1,130

Table Att. A-5
Operational Worksheet: CAP

Year: 2017

Lower Basin Shortage: 500,000	Entitlement						Scheduled Use						Adjusted Delivery						Shortage Allocation					
	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Agricultural)	CAP 5 (AWBA)	TOTAL	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Agricultural)	CAP 5 (AWBA)	TOTAL	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Agricultural)	CAP 5 (AWBA)	TOTAL	CAP 1 (CR)	CAP 2 (M&I / Indian)	CAP 3 (NIA)	CAP 4 (Excess Agricultural)	CAP 5 (AWBA)	TOTAL
Glendale	2,850	17,236	682			20,768	2,850	14,183	682			17,715	2,850	14,183	180			17,213	0	0	502			502
Goodyear		10,742				10,742		10,742				10,742		10,742				10,742		0				0
Green Valley DWID		1,900				1,900		500				500		500				500		0				0
H2O Water Co		147				147		0				0		0				0		0				0
Marana		47				47		0				0		0				0		0				0
Maricopa County Parks & Rec		665				665		645				645		645				645		0				0
Mesa*	2,622	43,503	5,551			51,676	2,622	30,029	5,551			38,202	2,622	30,029	1,469			34,120	0	0	4,082			4,082
MDWID		13,460				13,460		10,613				10,613		10,613				10,613		0				0
Oro Valley		10,305				10,305		10,305				10,305		10,305				10,305		0				0
Peoria		25,236				25,236		19,067				19,067		19,067				19,067		0				0
Phelps Dodge Miami		2,906				2,906		0				0		0				0		0				0
Phoenix*	4,750	122,120	37,280			164,150	4,750	134,120	37,280			176,150	4,750	134,120	9,866			148,736	0	0	27,414			27,414
Phoenix Memorial Park		84				84		0				0		0				0		0				0
Pine Water Co		161				161		0				0		0				0		0				0
Queen Creek Water Co		348				348		348				348		348				348		0				0
Rio Verde Utilities		812				812		812				812		812				812		0				0
San Tan ID		236				236		0				0		0				0		0				0
Scottsdale*	95	52,810	3,306			56,211	95	52,810	3,306			56,211	95	52,810	875			53,780	0	0	2,431			2,431
Spanish Trail Water Co		3,037				3,037		0				0		0				0		0				0
Superior		285				285		0				0		0				0		0				0
Surprise		10,249				10,249		10,249				10,249		10,249				10,249		0				0
Tempe	95	4,315	23			4,433	95	4,315	23			4,433	95	4,315	6			4,416	0	0	17			17
Tonto Hills Utility Co		71				71		0				0		0				0		0				0
Tucson		144,172				144,172		142,672				142,672		142,672				142,672		0				0
Vail Water Co		1,857				1,857		0				0		0				0		0				0
Valley Utilities Water Co		250				250		0				0		0				0		0				0
Water Util. Comm. Fac. Dist. (AJ)		2,919				2,919		50				50		50				50		0				0
Water Util. Greater Buckeye		43				43		0				0		0				0		0				0
Water Util. Greater Tonopah		64				64		0				0		0				0		0				0
White Tank Sys. (AZ Water Co.)		968				968		968				968		968				968		0				0
San Carlos (Phelps Dodge/Globe)		18,145				18,145		0				0		0				0		0				0
State Reserved			87,269			87,269			31,072			31,072			8,223			8,223			22,849			22,849
M&I Subtotal	20,900	638,823	148,598	0		808,321	20,900	512,767	92,401	0		626,068	20,900	512,767	24,452	0		558,119	0	0	67,949	0		67,949
TOTAL	68,400	977,402	364,698	Available		1,410,500	68,400	841,253	115,701	277,891	0	1,303,245	68,400	841,253	30,618	0	0	940,271	0	0	85,083	277,891	0	362,974
PERCENT												92%	100%	100%	26%	0%	0%	72%	0%	0%	74%	100%	0%	28%

*47,303 af NIA Priority water converts to M&I Priority on January 1, 2044 and 2,952 af is distributed to Chandler, 4,924 af to Mesa, 36,144 af to Phoenix, and 3,283 af to Scottsdale.

**After the Secretary has met the water delivery obligation to the Ak-Chin Indian Community under the Ak-Chin Water Rights Settlement, any excess water under the Ak-Chin Indian Community's CAP water delivery contract is available for delivery to the San Carlos Apache Tribe.

Estimated delivery losses of 6 percent on the Santa Rosa Canal, incurred in the delivery of water to the Ak-Chin Indian Community, are charged to the Community's CAP water delivery contract.

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Attachment B

Indian Agricultural Distribution of Shortages (2008-2060)

This attachment to Appendix G contains tables produced by the Shortage Allocation Model that show the distribution of shortages to Indian agricultural tribes within Arizona. The shortages shown on these tables are based on the diversion volumes of the affected entities. The tables show the distribution of shortages to both tribes within the CAP and to other Arizona Indian tribes, for the years 2008, 2017, 2026, 2027, 2040, and 2060.

Table Att. B-1
2008 Indian Agricultural Shortages (Based on Diversions)

CAP	County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Ak-Chin Indian Community	Pinal County	0	0	0	0	0	0	0	25,453	37,357
Fort McDowell	Maricopa County	0	0	0	0	0	0	0	0	0
Gila River	Maricopa and Pinal County	0	0	0	0	0	0	0	53,626	56,605
TON-Chui Chu	Pinal County	0	0	0	0	0	0	0	1,895	2,000
TON-San Xavier	Pima County	0	0	0	0	0	17	1,631	12,052	12,631
TON-Schuk Toak	Pima County	0	0	0	0	0	4	369	10,600	11,169
Pasqua Yaqui	Pima County	0	0	0	0	0	0	0	474	500
Salt River	Maricopa County	0	0	0	0	0	0	0	12,670	13,300
San Carlos Apache	Gila County	0	0	0	0	0	0	0	9,750	9,750
Tonto Apache	Gila County	0	0	0	0	0	0	0	121	128
Yavapai Apache (Camp Verde)	Gila County	0	0	0	0	0	0	0	0	0
Yavapai Prescott	Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	0	0	0	0	0	0	0	474	500
Unallocated HVID	Maricopa County	0	0	0	0	0	0	0	0	0
Reserved Federal	---	0	0	0	0	0	0	0	0	0
CAP Tribal Total:		0	0	0	0	0	21	2,000	127,115	143940.2
Arizona										
Cocopah Indian Reservation	Yuma County	0	0	0	1	223	445	667	1,332	1,362
Hopi Tribe (new entitlement)	La Paz County	557	1,213	1,541	1,870	2,526	3,182	3,838	5,807	5,898
Fort Mohave Indian Reservation	Mohave County	0	0	0	0	0	0	0	0	0
Fort Yuma Indian Reservation (new entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
Colorado River Indian Reservation	La Paz County	0	0	0	0	0	0	0	0	0
Arizona Tribal Total:		557	1,213	1,541	1,871	2,749	3,627	4,505	7,139	7259.887
Tribal Summary by County	Tribes per County									
Gila County	3	0	0	0	0	0	0	0	9,871	9,878
La Paz County	2	557	1,213	1,541	1,870	2,526	3,182	3,838	5,807	5,898
Maricopa County	3	0	0	0	0	0	0	0	28,758	30,282
Mohave County	1	0	0	0	0	0	0	0	0	0
Pima County	3	0	0	0	0	0	21	2,000	23,126	24,300
Pinal County	2	0	0	0	0	0	0	0	64,886	78,981
Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	1	0	0	0	0	0	0	0	474	500
Yuma County	2	0	0	0	1	223	445	667	1,332	1,362
---	1	0	0	0	0	0	0	0	0	0
Total Tribal Shortages:	18	557	1,213	1,541	1,871	2,749	3,648	6,505	134,254	151,200

Table Att. B-2

2017 Indian Agricultural Shortages (Based on Diversions)

CAP		County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
	Ak-Chin Indian Community	Pinal County	0	0	0	0	0	0	2,032	28,564	39,191
	Fort McDowell	Maricopa County	0	0	0	0	1,189	2,690	4,189	8,140	8,140
	Gila River	Maricopa and Pinal County	0	0	0	39,688	64,884	92,161	119,401	191,200	191,200
	TON-Chui Chu	Pinal County	0	0	0	800	1,852	3,179	4,505	8,000	8,000
	TON-San Xavier	Pima County	0	992	6,597	8,972	12,916	17,895	22,867	35,972	35,972
	TON-Schuk Toak	Pima County	0	224	1,492	2,028	3,606	5,598	7,586	12,828	12,828
	Pasqua Yaqui	Pima County	0	0	0	0	73	165	257	500	500
	Salt River	Maricopa County	0	0	0	0	3,079	5,286	7,490	13,300	13,300
	San Carlos Apache	Gila County	0	0	0	0	15,580	27,548	37,467	39,000	39,000
	Tonto Apache	Gila County	0	0	0	0	19	42	66	128	128
	Yavapai Apache (Camp Verde)	Gila County	0	0	0	0	175	397	618	1,200	1,200
	Yavapai Prescott	Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	0	0	0	0	73	165	257	500	500
	Unallocated HVID	Maricopa County	0	0	0	0	178	403	627	1,218	1,218
	Reserved Federal	---	0	1,360	9,045	12,300	12,300	12,300	12,300	12,300	12,300
	CAP Tribal Total:		0	2,576	17,134	63,788	115,923	167,829	219,663	352,850	363477.5
Arizona											
	Cocopah Indian Reservation	Yuma County	0	0	0	39	273	507	742	1,362	1,362
	Hopi Tribe (new entitlement)	La Paz County	594	1,287	1,634	1,981	2,674	3,367	4,061	5,898	5,898
	Fort Mohave Indian Reservation	Mohave County	0	0	0	0	0	0	0	0	0
	Fort Yuma Indian Reservation (new entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
	Colorado River Indian Reservation	La Paz County	0	0	0	0	0	0	0	0	0
	Arizona Tribal Total:		594	1,287	1,634	2,020	2,947	3,875	4,802	7,260	7259.887
Tribal Summary by County		Tribes per County									
	Gila County	3	0	0	0	0	15,774	27,987	38,150	40,328	40,328
	La Paz County	2	594	1,287	1,634	1,981	2,674	3,367	4,061	5,898	5,898
	Maricopa County	3	0	0	0	11,906	23,911	36,027	48,126	80,018	80,018
	Mohave County	1	0	0	0	0	0	0	0	0	0
	Pima County	3	0	1,216	8,089	11,000	16,595	23,657	30,710	49,300	49,300
	Pinal County	2	0	0	0	28,582	47,270	67,692	90,119	170,404	181,031
	Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	1	0	0	0	0	73	165	257	500	500
	Yuma County	2	0	0	0	39	273	507	742	1,362	1,362
	---	1	0	1,360	9,045	12,300	12,300	12,300	12,300	12,300	12,300
	Total Tribal Shortages:	18	594	3,863	18,768	65,807	118,870	171,703	224,465	360,110	370,737

Table Att. B-3

2026 Indian Agricultural Shortages (Based on Diversions)

CAP	County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Ak-Chin Indian Community	Pinal County	0	0	0	0	0	0	3,034	28,637	39,146
Fort McDowell	Maricopa County	0	0	0	0	2,885	5,821	8,752	16,398	16,398
Gila River	Maricopa and Pinal County	14,401	42,744	74,087	91,515	117,537	144,023	170,464	239,440	239,440
TON-Chui Chu	Pinal County	0	0	647	800	2,067	3,356	4,643	8,000	8,000
TON-San Xavier	Pima County	4,870	14,454	16,312	16,312	21,062	25,896	30,722	43,312	43,312
TON-Schuk Toak	Pima County	1,101	3,268	3,688	3,688	5,588	7,522	9,452	14,488	14,488
Pasqua Yaqui	Pima County	0	0	0	0	88	177	267	500	500
Salt River	Maricopa County	0	0	0	1,165	3,436	5,579	7,718	13,300	13,300
San Carlos Apache	Gila County	0	0	0	5,342	17,517	29,137	37,704	39,000	39,000
Tonto Apache	Gila County	0	0	0	0	23	45	68	128	128
Yavapai Apache (Camp Verde)	Gila County	0	0	0	0	211	426	640	1,200	1,200
Yavapai Prescott	Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	0	0	0	0	88	177	267	500	500
Unallocated HVID	Maricopa County	0	0	0	0	214	432	650	1,218	1,218
Reserved Federal	---	17,106	50,772	57,300	57,300	57,300	57,300	57,300	57,300	57,300
CAP Tribal Total:		37,477	111,238	152,034	176,122	228,014	279,892	331,681	463,421	473,929.7
Arizona										
Cocopah Indian Reservation	Yuma County	0	0	0	41	276	511	746	1,362	1,362
Hopi Tribe (new entitlement)	La Paz County	596	1,292	1,640	1,987	2,683	3,379	4,074	5,898	5,898
Fort Mohave Indian Reservation	Mohave County	0	0	0	0	0	0	0	0	0
Fort Yuma Indian Reservation (new entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
Colorado River Indian Reservation	La Paz County	0	0	0	0	0	0	0	0	0
Arizona Tribal Total:		596	1,292	1,640	2,029	2,959	3,890	4,820	7,260	7,259.887
Tribal Summary by County	Tribes per County									
Gila County	3	0	0	0	5,342	17,750	29,609	38,413	40,328	40,328
La Paz County	2	596	1,292	1,640	1,987	2,683	3,379	4,074	5,898	5,898
Maricopa County	3	4,320	12,823	22,226	28,619	41,796	55,039	68,259	102,748	102,748
Mohave County	1	0	0	0	0	0	0	0	0	0
Pima County	3	5,971	17,721	20,000	20,000	26,738	33,595	40,441	58,300	58,300
Pinal County	2	10,081	29,921	52,508	64,861	84,343	104,172	127,001	204,245	214,754
Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	1	0	0	0	0	88	177	267	500	500
Yuma County	2	0	0	0	41	276	511	746	1,362	1,362
---	1	17,106	50,772	57,300	57,300	57,300	57,300	57,300	57,300	57,300
Total Tribal Shortages:	18	38,073	112,529	153,673	178,150	230,974	283,782	336,501	470,681	481,190

Table Att. B-4

2027 Indian Agricultural Shortages (Based on Diversions)

CAP	County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Ak-Chin Indian Community	Pinal County	0	0	0	0	0	0	3,141	28,644	39,137
Fort McDowell	Maricopa County	0	0	0	10	3,101	6,192	9,277	17,315	17,315
Gila River	Maricopa and Pinal County	29,442	67,319	99,234	115,720	142,129	168,530	194,886	263,560	263,560
TON-Chui Chu	Pinal County	0	0	672	804	2,090	3,375	4,657	8,000	8,000
TON-San Xavier	Pima County	6,969	15,934	17,128	17,143	21,964	26,782	31,593	44,128	44,128
TON-Schuk Toak	Pima County	1,576	3,603	3,872	3,879	5,807	7,734	9,658	14,672	14,672
Pasqua Yaqui	Pima County	0	0	0	0	90	179	268	500	500
Salt River	Maricopa County	0	0	0	1,337	3,474	5,610	7,743	13,300	13,300
San Carlos Apache	Gila County	0	0	0	6,137	17,724	29,307	37,729	39,000	39,000
Tonto Apache	Gila County	0	0	0	0	23	46	69	128	128
Yavapai Apache (Camp Verde)	Gila County	0	0	0	1	215	429	643	1,200	1,200
Yavapai Prescott	Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	0	0	0	0	90	179	268	500	500
Unallocated HVID	Maricopa County	0	0	0	1	218	436	653	1,218	1,218
Reserved Federal	---	25,348	57,959	62,300	62,300	62,300	62,300	62,300	62,300	62,300
CAP Tribal Total:		63,334	144,815	183,206	207,332	259,224	311,098	362,884	494,466	504,958.2
Arizona										
Cocopah Indian Reservation	Yuma County	0	0	0	41	277	512	747	1,362	1,362
Hopi Tribe (new entitlement)	La Paz County	597	1,292	1,640	1,988	2,684	3,380	4,076	5,898	5,898
Fort Mohave Indian Reservation	Mohave County	0	0	0	0	0	0	0	0	0
Fort Yuma Indian Reservation (new entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
Colorado River Indian Reservation	La Paz County	0	0	0	0	0	0	0	0	0
Arizona Tribal Total:		597	1,292	1,640	2,030	2,961	3,892	4,822	7,260	7,259.887
Tribal Summary by County	Tribes per County									
Gila County	3	0	0	0	6,138	17,962	29,782	38,441	40,328	40,328
La Paz County	2	597	1,292	1,640	1,988	2,684	3,380	4,076	5,898	5,898
Maricopa County	3	8,832	20,196	29,770	36,064	49,432	62,796	76,138	110,901	110,901
Mohave County	1	0	0	0	0	0	0	0	0	0
Pima County	3	8,544	19,537	21,000	21,022	27,860	34,695	41,519	59,300	59,300
Pinal County	2	20,609	47,123	70,136	81,808	101,580	121,346	144,218	221,136	231,629
Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	1	0	0	0	0	90	179	268	500	500
Yuma County	2	0	0	0	41	277	512	747	1,362	1,362
---	1	25,348	57,959	62,300	62,300	62,300	62,300	62,300	62,300	62,300
Total Tribal Shortages:	18	63,931	146,107	184,847	209,362	262,184	314,989	367,706	501,726	512,218

Table Att. B-5

2040 Indian Agricultural Shortages (Based on Diversions)

CAP		County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
	Ak-Chin Indian Community	Pinal County	0	0	0	0	0	0	3,780	28,770	39,147
	Fort McDowell	Maricopa County	0	0	0	282	3,526	6,767	9,990	18,233	18,233
	Gila River	Maricopa and Pinal County	48,107	91,719	109,442	124,889	151,205	177,499	203,652	270,525	270,525
	TON-Chui Chu	Pinal County	0	310	754	911	2,192	3,472	4,745	8,000	8,000
	TON-San Xavier	Pima County	9,175	15,128	15,128	15,546	20,350	25,149	29,922	42,128	42,128
	TON-Schuk Toak	Pima County	2,074	3,420	3,420	3,587	5,509	7,429	9,338	14,220	14,220
	Pasqua Yaqui	Pima County	0	0	0	8	97	186	274	500	500
	Salt River	Maricopa County	0	0	0	1,515	3,645	5,772	7,889	13,300	13,300
	San Carlos Apache	Gila County	0	0	0	7,104	18,650	30,186	37,881	39,000	39,000
	Tonto Apache	Gila County	0	0	0	2	25	48	70	128	128
	Yavapai Apache (Camp Verde)	Gila County	0	0	0	19	232	445	658	1,200	1,200
	Yavapai Prescott	Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	0	0	0	8	97	186	274	500	500
	Unallocated HVID	Maricopa County	0	0	0	19	236	452	667	1,218	1,218
	Reserved Federal	---	26,846	44,267	44,267	44,267	44,267	44,267	44,267	44,267	44,267
	CAP Tribal Total:		86,201	154,845	173,011	198,156	250,029	301,857	353,406	481,988	492365.6
Arizona											
	Cocopah Indian Reservation	Yuma County	0	0	0	45	282	518	754	1,362	1,362
	Hopi Tribe (new entitlement)	La Paz County	600	1,300	1,650	2,000	2,699	3,399	4,098	5,898	5,898
	Fort Mohave Indian Reservation	Mohave County	0	0	0	0	0	0	0	0	0
	Fort Yuma Indian Reservation (new entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
	Colorado River Indian Reservation	La Paz County	0	0	0	0	0	0	0	0	0
	Arizona Tribal Total:		600	1,300	1,650	2,045	2,981	3,917	4,853	7,260	7259.887
Tribal Summary by County		Tribes per County									
	Gila County	3	0	0	0	7,125	18,907	30,679	38,608	40,328	40,328
	La Paz County	2	600	1,300	1,650	2,000	2,699	3,399	4,098	5,898	5,898
	Maricopa County	3	14,432	27,516	32,833	39,283	52,768	66,241	79,642	113,908	113,908
	Mohave County	1	0	0	0	0	0	0	0	0	0
	Pima County	3	11,249	18,549	18,549	19,141	25,955	32,763	39,534	56,849	56,849
	Pinal County	2	33,675	64,514	77,363	88,333	108,036	127,721	151,081	226,137	236,514
	Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	1	0	0	0	8	97	186	274	500	500
	Yuma County	2	0	0	0	45	282	518	754	1,362	1,362
	---	1	26,846	44,267	44,267	44,267	44,267	44,267	44,267	44,267	44,267
	Total Tribal Shortages:	18	86,802	156,144	174,661	200,201	253,010	305,773	358,259	489,248	499,625

Table Att. B-6

2060 Indian Agricultural Shortages (Based on Diversions)

		County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP											
	Ak-Chin Indian Community	Pinal County	0	0	0	0	0	0	3,783	28,770	39,147
	Fort McDowell	Maricopa County	0	0	0	318	3,546	6,770	9,991	18,233	18,233
	Gila River	Maricopa and Pinal County	55,082	89,684	102,575	117,465	143,654	169,811	195,943	262,808	262,808
	TON-Chui Chu	Pinal County	0	452	775	926	2,200	3,474	4,745	8,000	8,000
	TON-San Xavier	Pima County	10,505	13,657	13,657	14,128	18,908	23,682	28,452	40,657	40,657
	TON-Schuk Toak	Pima County	2,375	3,088	3,088	3,276	5,188	7,098	9,006	13,888	13,888
	Pasqua Yaqui	Pima County	0	0	0	9	97	186	274	500	500
	Salt River	Maricopa County	0	0	0	1,539	3,658	5,775	7,889	13,300	13,300
	San Carlos Apache	Gila County	0	0	0	7,233	18,723	30,199	37,881	39,000	39,000
	Tonto Apache	Gila County	0	0	0	2	25	48	70	128	128
	Yavapai Apache (Camp Verde)	Gila County	0	0	0	21	233	446	658	1,200	1,200
	Yavapai Prescott	Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	0	0	0	9	97	186	274	500	500
	Unallocated HVID	Maricopa County	0	0	0	21	237	452	667	1,218	1,218
	Reserved Federal	---	30,738	39,960	39,960	39,960	39,960	39,960	39,960	39,960	39,960
	CAP Tribal Total:		98,701	146,840	160,054	184,906	236,527	288,087	339,595	468,161	478538.2
Arizona											
	Cocopah Indian Reservation	Yuma County	0	0	0	45	282	518	754	1,362	1,362
	Hopi Tribe (new entitlement)	La Paz County	600	1,300	1,650	2,000	2,699	3,399	4,098	5,898	5,898
	Fort Mohave Indian Reservation	Mohave County	0	0	0	0	0	0	0	0	0
	Fort Yuma Indian Reservation (new entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
	Colorado River Indian Reservation	La Paz County	0	0	0	0	0	0	0	0	0
	Arizona Tribal Total:		600	1,300	1,650	2,045	2,981	3,917	4,853	7,260	7259.887
Tribal Summary by County		Tribes per County									
	Gila County	3	0	0	0	7,256	18,981	30,692	38,609	40,328	40,328
	La Paz County	2	600	1,300	1,650	2,000	2,699	3,399	4,098	5,898	5,898
	Maricopa County	3	16,525	26,905	30,773	37,118	50,537	63,941	77,331	111,593	111,593
	Mohave County	1	0	0	0	0	0	0	0	0	0
	Pima County	3	12,880	16,744	16,744	17,413	24,193	30,966	37,732	55,044	55,044
	Pinal County	2	38,558	63,231	72,578	83,151	102,758	122,342	145,688	220,735	231,113
	Yavapai, 500 AF was re-assigned to Scottsdale (1994 Act, PL 103-434)	1	0	0	0	9	97	186	274	500	500
	Yuma County	2	0	0	0	45	282	518	754	1,362	1,362
	---	1	30,738	39,960	39,960	39,960	39,960	39,960	39,960	39,960	39,960
	Total Tribal Shortages:	18	99,301	148,140	161,704	186,951	239,508	292,003	344,447	475,421	485,798

Attachment C

Non-Indian Agricultural Distribution of Shortages (2008-2060)

This attachment to Appendix G contains tables produced by the Shortage Allocation Model that show the distribution of shortages to non-Indian agricultural entitlement holders within Arizona. The shortages shown on these tables are based on the diversion volumes of the affected entities. The tables show the distribution of shortages to non-Indian agricultural entitlement holders within Arizona, for the years 2008, 2017, 2026, 2027, 2040, and 2060.

Table Att. C-1

2008 Non-Indian Agricultural Shortages (Based on Diversions)

Arizona Agriculture	County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP Agricultural Relinquished Water Contracts under AWSA	Maricopa/Pinal/Pima	0	0	38,611	111,222	256,233	400,000	400,000	400,000	400,000
CAP Arizona State Land Department	Pinal County	0	0	0	0	0	94	9,026	9,026	9026
Arizona State Land Department	Yuma County	723	1,446	1,807	2,169	2,892	3,615	4,338	6,507	6606.702
Beattie Farms Southwest (new contract) (2004 over use of 263 af)	Yuma County	121	243	304	364	486	607	729	1,093	1110
ChaCha (Curtis Family Trust) (Auza Farm and West Farm)	Yuma County	230	460	575	690	919	1,149	1,379	2,069	2100.174
Cibola Resources	La Paz County	0	0	0	0	0	0	0	0	0
Cibola Valley Irrigation & Drainage District (M&I: 300 af)	La Paz County	93	1,362	1,997	2,632	3,901	5,170	6,440	10,248	10422.68
Curtis, Armon (Curry Family LTD)	Yuma County	33	66	82	99	131	164	197	296	300.0249
Gila Monster Farms (formerly Sturges Farms Inc.)	Yuma County	158	315	393	472	629	786	943	1,414	1435.828
JRS Partners LLC (formerly Jessen Family Limited) (new contract) (2004 over use of 4,984 af)	Yuma County	118	236	296	355	473	591	709	1,064	1080.09
Mohave County Water Authority (new entitlement)	La Paz County	557	1,213	1,541	1,870	2,526	3,182	3,838	5,807	5897.677
Mohave Valley Irrigation and Drainage District (5,000 af M&I)	Mohave County	2,824	5,647	7,059	8,471	11,294	14,118	16,941	25,412	25800.99
North Baja LLC (formerly Jamar Produce) (72 af M&I)	La Paz County	41	82	103	124	165	206	248	372	377.2242
Ogram Boys Enterprises (new contract)	Yuma County	102	203	253	304	405	506	607	911	924.6154
Ogram, George	Yuma County	53	105	131	158	210	263	315	473	480
Pasquinelli, Gary and Barbara (formerly Ansel Hall)	Yuma County	53	107	133	160	213	266	319	479	486.1942
Peach, John (2004 over use of 45 af)	Yuma County	49	99	124	149	199	249	299	449	455.3846
Phillips, Milton and Jean	Yuma County	2	4	5	6	8	10	12	18	18.46154
Rayner Ranches	Yuma County	492	985	1,231	1,477	1,970	2,462	2,955	4,432	4499.816
Yuma Irrigation District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	0	12602.29
Yuma County Water Users' Association (14,701 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95 af M&I Conversion)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Mesa Fruit Growers	Yuma County	0	0	0	0	0	0	0	0	2.490203
Yuma Mesa Irrigation & Drainage District (10,000 af M&I)	Yuma County	0	0	0	0	0	0	0	0	59987.14
University of Arizona	Yuma County	0	0	0	0	0	0	0	0	174.3142
Yuma Mesa Grapefruit Company (Camille Allec Jr.)	Yuma County	0	0	0	0	0	0	0	0	17.41851
North Gila Valley Irrigation District (2,500 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Auxiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	0	4536.032
Welton-Mohawk Irrigation and Drainage District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	0	90019.89
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	0	1384.181
Sturges, Harold (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Sturges, Irma (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Molina (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	0	0
Powers (Power, R.E. & P.) (2004 use 384 af over entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
Zozaya (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
North Gila Valley Irrigation District****	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	0	0
Hulet (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Holpal (in MVIDD/formerly Hurschler) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
McKellips and Granite Reef Farms (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Sherill & Lafollette (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Yuma County Water Users' Association	Yuma County	0	0	0	0	0	0	0	0	0
Phillips, Milton and Jean (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Arizona Total		5,649	12,573	54,647	130,719	282,654	433,440	449,296	470,068	639745.6

Table Att. C-1

2008 Non-Indian Agricultural Shortages (Based on Diversions)

Arizona Agriculture	County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Agriculture Summary by County	Agriculture per County									
Coconino County	0	0	0	0	0	0	0	0	0	0
La Paz County	4	691	2,658	3,641	4,625	6,592	8,559	10,526	16,427	16697.58
Maricopa County	0	0	0	8,881	25,581	58,934	92,000	92,000	92,000	92000
Mohave County	6	2,824	5,647	7,059	8,471	11,294	14,118	16,941	25,412	25800.99
Pinal County	1	0	0	29,731	85,641	197,299	308,094	317,026	317,026	317026
Yuma County	32	2,135	4,268	5,335	6,402	8,536	10,669	12,803	19,203	188221
Total Arizona Agriculture	43	5,649	12,573	54,647	130,719	282,654	433,440	449,296	470,068	639,746

Table Att. C-2

2017 Non-Indian Agricultural Shortages (Based on Diversions)

Arizona Agriculture	County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP Agricultural Relinquished Water Contracts under AWSA	Maricopa/Pinal/Pima	146,088	277,891	277,891	277,891	277,891	277,891	277,891	277,891	277,891
CAP Arizona State Land Department	Pinal County	0	998	6,637	9,026	9,026	9,026	9,026	9,026	9026
Arizona State Land Department	Yuma County	764	1,527	1,909	2,291	3,055	3,819	4,583	6,607	6606.702
Beattie Farms Southwest (new contract) (2004 over use of 263 af)	Yuma County	128	257	321	385	513	642	770	1,110	1110
ChaCha (Curtis Family Trust) (Auza Farm and West Farm) (over 13 af)	Yuma County	243	486	607	729	971	1,214	1,457	2,100	2100.174
Cibola Resources	La Paz County	0	0	0	0	0	0	0	0	0
Cibola Valley Irrigation & Drainage District (M&I: 300 af)	La Paz County	165	1,506	2,176	2,847	4,188	5,529	6,870	10,423	10422.68
Curtis, Armon (Curry Family LTD)	Yuma County	35	69	87	104	139	173	208	300	300.0249
Gila Monster Farms (formerly Sturges Farms Inc.)	Yuma County	167	333	416	499	664	830	996	1,436	1435.828
JRS Partners LLC (formerly Jessen Family Limited) (new contract) (2004 over use of 4,984 af)	Yuma County	125	250	312	375	500	624	749	1,080	1080.09
Mohave County Water Authority (new entitlement)	La Paz County	594	1,287	1,634	1,981	2,674	3,367	4,061	5,898	5897.677
Mohave Valley Irrigation and Drainage District (5,000 af M&I)	Mohave County	2,983	5,966	7,457	8,949	11,932	14,915	17,898	25,801	25800.99
North Baja LLC (formerly Jamar Produce) (72 af M&I)	La Paz County	43	87	109	131	174	218	262	377	377.2242
Ogram Boys Enterprises (new contract)	Yuma County	107	214	268	321	428	535	642	925	924.6154
Ogram, George	Yuma County	55	111	139	166	222	277	333	480	480
Pasquinelli, Gary and Barbara (formerly Ansel Hall)	Yuma County	56	113	141	169	225	281	337	486	486.1942
Peach, John (2004 over use of 45 af)	Yuma County	52	105	131	158	210	263	316	455	455.3846
Phillips, Milton and Jean	Yuma County	3	5	6	7	9	11	13	18	18.46154
Rayner Ranches	Yuma County	520	1,040	1,300	1,561	2,081	2,601	3,121	4,500	4499.816
Yuma Irrigation District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	1,371	15061.97
Yuma County Water Users' Association (14,701 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95 af M&I Conversion)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Mesa Fruit Growers	Yuma County	0	0	0	0	0	0	0	0	2.953587
Yuma Mesa Irrigation & Drainage District (10,000 af M&I)	Yuma County	0	0	0	0	0	0	0	6,456	70930.67
University of Arizona	Yuma County	0	0	0	0	0	0	0	19	206.7511
Yuma Mesa Grapefruit Company (Camille Allec Jr.)	Yuma County	0	0	0	0	0	0	0	2	20.65979
North Gila Valley Irrigation District (2,500 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	482	5291.596
Welton-Mohawk Irriation and Drainage District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	9,718	106771
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	149	1641.753
Sturges, Harold (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Sturges, Irma (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Molina (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	0	0
Powers (Power, R.E. & P.) (2004 use 384 af over entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
Zozaya (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
North Gila Valley Irrigation District****	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	0	0
Hulet (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Holpal (in MVIDD/formerly Hurschler) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
McKellips and Granite Reef Farms (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Sherill & Lafollette (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Yuma County Water Users' Association	Yuma County	0	0	0	0	0	0	0	0	0
Phillips, Milton and Jean (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Arizona Total		152,128	292,244	301,541	307,587	314,902	322,217	329,532	367,110	548,840.6
Agriculture Summary by County	Agriculture per County									
Coconino County	0	0	0	0	0	0	0	0	0	0
La Paz County	4	802	2,880	3,919	4,958	7,036	9,114	11,192	16,698	16697.58
Maricopa County	0	33,600	63,915	63,915	63,915	63,915	63,915	63,915	63,915	63915.01
Mohave County	6	2,983	5,966	7,457	8,949	11,932	14,915	17,898	25,801	25800.99
Pinal County	1	112,488	214,974	220,614	223,002	223,002	223,002	223,002	223,002	223002.3
Yuma County	32	2,255	4,509	5,636	6,763	9,017	11,271	13,525	37,695	219424.7
Total Arizona Agriculture	43	152,128	292,244	301,541	307,587	314,902	322,217	329,532	367,110	548,841

Table Att. C-3
2026 Non-Indian Agricultural Shortages (Based on Diversions)

Arizona Agriculture	County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP Agricultural Relinquished Water Contracts under AWSA	Maricopa/Pinal/Pima	72,075	72,075	72,075	72,075	72,075	72,075	72,075	72,075	72,075
CAP Arizona State Land Department	Pinal County	2,694	7,998	9,026	9,026	9,026	9,026	9,026	9,026	9026
Arizona State Land Department	Yuma County	766	1,532	1,916	2,299	3,065	3,831	4,598	6,607	6606.702
Beattie Farms Southwest (new contract) (2004 over use of 263 af)	Yuma County	129	257	322	386	515	644	772	1,110	1110
ChaCha (Curtis Family Trust) (Auza Farm and West Farm) (over 13 af)	Yuma County	244	487	609	731	974	1,218	1,462	2,100	2100.174
Cibola Resources	La Paz County	0	0	0	0	0	0	0	0	0
Cibola Valley Irrigation & Drainage District (M&I: 300 af)	La Paz County	169	1,514	2,187	2,860	4,205	5,551	6,896	10,423	10422.68
Curtis, Armon (Curry Family LTD)	Yuma County	35	70	87	104	139	174	209	300	300.0249
Gila Monster Farms (formerly Sturges Farms Inc.)	Yuma County	167	334	417	500	667	833	1,000	1,436	1435.828
JRS Partners LLC (formerly Jessen Family Limited) (new contract) (2004 over use of 4,984 af)	Yuma County	125	251	313	376	501	626	752	1,080	1080.09
Mohave County Water Authority (new entitlement)	La Paz County	596	1,292	1,640	1,987	2,683	3,379	4,074	5,898	5897.677
Mohave Valley Irrigation and Drainage District (5,000 af M&I)	Mohave County	2,993	5,985	7,482	8,978	11,971	14,963	17,956	25,801	25800.99
North Baja LLC (formerly Jamar Produce) (72 af M&I)	La Paz County	44	87	109	131	175	219	262	377	377.2242
Ogram Boys Enterprises (new contract)	Yuma County	108	215	269	322	429	536	644	925	924.6154
Ogram, George	Yuma County	56	111	139	167	223	278	334	480	480
Pasquinelli, Gary and Barbara (formerly Ansel Hall)	Yuma County	57	113	141	169	226	282	338	486	486.1942
Peach, John (2004 over use of 45 af)	Yuma County	52	105	132	158	211	264	317	455	455.3846
Phillips, Milton and Jean	Yuma County	3	5	6	7	9	11	13	18	18.46154
Rayner Ranches	Yuma County	522	1,044	1,305	1,566	2,088	2,610	3,132	4,500	4499.816
Yuma Irrigation District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	1,498	15345.82
Yuma County Water Users' Association (14,701 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95 af M&I Conversion)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Mesa Fruit Growers	Yuma County	0	0	0	0	0	0	0	0	2.942086
Yuma Mesa Irrigation & Drainage District (10,000 af M&I)	Yuma County	0	0	0	0	0	0	0	6,812	69781.95
University of Arizona	Yuma County	0	0	0	0	0	0	0	20	205.946
Yuma Mesa Grapefruit Company (Camille Allec Jr.)	Yuma County	0	0	0	0	0	0	0	2	20.57935
North Gila Valley Irrigation District (2,500 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	494	5059.144
Welton-Mohawk Irriation and Drainage District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	10,382	106355.3
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	160	1635.36
Sturges, Harold (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Sturges, Irma (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Molina (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	0	0
Powers (Power, R.E. & P.) (2004 use 384 af over entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
Zozaya (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
North Gila Valley Irrigation District****	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	0	0
Hulet (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Holpal (in MVIDD/formerly Hurschler) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
McKellips and Granite Reef Farms (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Sherill & Lafollette (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Yuma County Water Users' Association	Yuma County	0	0	0	0	0	0	0	0	0
Phillips, Milton and Jean (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Arizona Total		80,833	93,475	98,173	101,842	109,181	116,520	123,859	162,465	341,503.6
Agriculture Summary by County	Agriculture per County									
Coconino County	0	0	0	0	0	0	0	0	0	0
La Paz County	4	809	2,894	3,936	4,978	7,063	9,148	11,233	16,698	16697.58
Maricopa County	0	16,577	16,577	16,577	16,577	16,577	16,577	16,577	16,577	16577.18
Mohave County	6	2,993	5,985	7,482	8,978	11,971	14,963	17,956	25,801	25800.99
Pinal County	1	58,192	63,495	64,524	64,524	64,524	64,524	64,524	64,524	64523.5
Yuma County	32	2,263	4,524	5,655	6,785	9,047	11,308	13,569	38,866	217904.3
Total Arizona Agriculture	43	80,833	93,475	98,173	101,842	109,181	116,520	123,859	162,465	341,504

Table Att. C-4

2027 Non-Indian Agricultural Shortages (Based on Diversions)

Arizona Agriculture	County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP Agricultural Relinquished Water Contracts under AWSA	Maricopa/Pinal/Pima	33,158	33,158	33,158	33,158	33,158	33,158	33,158	33,158	33,158
CAP Arizona State Land Department	Pinal County	3,672	8,397	9,026	9,026	9,026	9,026	9,026	9,026	9026
Arizona State Land Department	Yuma County	766	1,533	1,916	2,300	3,066	3,833	4,599	6,607	6606.702
Beattie Farms Southwest (new contract) (2004 over use of 263 af)	Yuma County	129	258	322	386	515	644	773	1,110	1110
ChaCha (Curtis Family Trust) (Auza Farm and West Farm) (over 13 af)	Yuma County	244	488	609	731	975	1,219	1,462	2,100	2100.174
Cibola Resources	La Paz County	0	0	0	0	0	0	0	0	0
Cibola Valley Irrigation & Drainage District (M&I: 300 af)	La Paz County	169	1,515	2,188	2,861	4,207	5,553	6,899	10,423	10422.68
Curtis, Armon (Curry Family LTD)	Yuma County	35	70	87	104	139	174	209	300	300.0249
Gila Monster Farms (formerly Sturges Farms Inc.)	Yuma County	167	334	417	500	667	833	1,000	1,436	1435.828
JRS Partners LLC (formerly Jessen Family Limited) (new contract) (2004 over use of 4,984)	Yuma County	125	251	313	376	501	627	752	1,080	1080.09
Mohave County Water Authority (new entitlement)	La Paz County	597	1,292	1,640	1,988	2,684	3,380	4,076	5,898	5897.677
Mohave Valley Irrigation and Drainage District (5,000 af M&I)	Mohave County	2,994	5,987	7,484	8,981	11,975	14,969	17,962	25,801	25800.99
North Baja LLC (formerly Jamar Produce) (72 af M&I)	La Paz County	44	87	109	131	175	219	263	377	377.2242
Ogram Boys Enterprises (new contract)	Yuma County	108	215	269	322	429	537	644	925	924.6154
Ogram, George	Yuma County	56	111	139	167	223	278	334	480	480
Pasquinelli, Gary and Barbara (formerly Ansel Hall)	Yuma County	57	113	141	169	226	282	339	486	486.1942
Peach, John (2004 over use of 45 af)	Yuma County	52	105	132	158	211	264	317	455	455.3846
Phillips, Milton and Jean	Yuma County	3	5	6	7	9	11	13	18	18.46154
Rayner Ranches	Yuma County	522	1,044	1,305	1,566	2,088	2,611	3,133	4,500	4499.816
Yuma Irrigation District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	1,513	15390.97
Yuma County Water Users' Association (14,701 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95 af M&I Conversion)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Mesa Fruit Growers	Yuma County	0	0	0	0	0	0	0	0	2.939806
Yuma Mesa Irrigation & Drainage District (10,000 af M&I)	Yuma County	0	0	0	0	0	0	0	6,842	69582.55
University of Arizona	Yuma County	0	0	0	0	0	0	0	20	205.7864
Yuma Mesa Grapefruit Company (Camille Allec Jr.)	Yuma County	0	0	0	0	0	0	0	2	20.5634
North Gila Valley Irrigation District (2,500 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	494	5019.942
Welton-Mohawk Irriation and Drainage District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	10,450	106272.8
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	161	1634.093
Sturges, Harold (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Sturges, Irma (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Molina (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	0	0
Powers (Power, R.E. & P.) (2004 use 384 af over entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
Zozaya (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
North Gila Valley Irrigation District****	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	0	0
Hulet (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Holpal (in MVIDD/formerly Hurschler) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
McKellips and Granite Reef Farms (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Sherill & Lafollette (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Yuma County Water Users' Association	Yuma County	0	0	0	0	0	0	0	0	0
Phillips, Milton and Jean (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Arizona Total		42,897	54,964	59,263	62,934	70,275	77,617	84,958	123,663	302,309.8
Agriculture Summary by County	Agriculture per County									
Coconino County	0	0	0	0	0	0	0	0	0	0
La Paz County	4	810	2,895	3,938	4,981	7,066	9,152	11,237	16,698	16697.58
Maricopa County	0	7,626	7,626	7,626	7,626	7,626	7,626	7,626	7,626	7626.392
Mohave County	6	2,994	5,987	7,484	8,981	11,975	14,969	17,962	25,801	25800.99
Pinal County	1	29,204	33,929	34,558	34,558	34,558	34,558	34,558	34,558	34557.83
Yuma County	32	2,263	4,526	5,657	6,788	9,050	11,312	13,574	38,980	217627
Total Arizona Agriculture	43	42,897	54,964	59,263	62,934	70,275	77,617	84,958	123,663	302,310

Table Att. C-5
2040 Non-Indian Agricultural Shortages (Based on Diversions)

Arizona Agriculture	County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP Agricultural Relinquished Water Contracts under AWSA	Maricopa/Pinal/Pima	0	0	0	0	0	0	0	0	0
CAP Arizona State Land Department	Pinal County	3,600	5,937	5,937	5,937	5,937	5,937	5,937	5,937	5936.854
Arizona State Land Department	Yuma County	770	1,541	1,927	2,312	3,083	3,854	4,624	6,607	6606.702
Beattie Farms Southwest (new contract) (2004 over use of 263 af)	Yuma County	129	259	324	388	518	647	777	1,110	1110
ChaCha (Curtis Family Trust) (Auza Farm and West Farm) (over 13 af)	Yuma County	245	490	613	735	980	1,225	1,470	2,100	2100.174
Cibola Resources	La Paz County	0	0	0	0	0	0	0	0	0
Cibola Valley Irrigation & Drainage District (M&I: 300 af)	La Paz County	177	1,530	2,207	2,883	4,236	5,589	6,943	10,423	10422.68
Curtis, Armon (Curry Family LTD)	Yuma County	35	70	88	105	140	175	210	300	300.0249
Gila Monster Farms (formerly Sturges Farms Inc.)	Yuma County	168	336	419	503	670	838	1,005	1,436	1435.828
JRS Partners LLC (formerly Jessen Family Limited) (new contract) (2004 over use of 4,984 af)	Yuma County	126	252	315	378	504	630	756	1,080	1080.09
Mohave County Water Authority (new entitlement)	La Paz County	600	1,300	1,650	2,000	2,699	3,399	4,098	5,898	5897.677
Mohave Valley Irrigation and Drainage District (5,000 af M&I)	Mohave County	3,010	6,020	7,525	9,030	12,040	15,050	18,060	25,801	25800.99
North Baja LLC (formerly Jamar Produce) (72 af M&I)	La Paz County	44	88	110	132	176	220	264	377	377.2242
Ogram Boys Enterprises (new contract)	Yuma County	108	216	270	324	432	540	647	925	924.6154
Ogram, George	Yuma County	56	112	140	168	224	280	336	480	480
Pasquinelli, Gary and Barbara (formerly Ansel Hall)	Yuma County	57	114	142	170	227	284	340	486	486.1942
Peach, John (2004 over use of 45 af)	Yuma County	53	106	132	159	212	265	319	455	455.3846
Phillips, Milton and Jean	Yuma County	3	5	6	7	9	11	13	18	18.46154
Rayner Ranches	Yuma County	525	1,050	1,312	1,575	2,100	2,625	3,150	4,500	4499.816
Yuma Irrigation District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	1,698	15575.47
Yuma County Water Users' Association (14,701 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95 af M&I Conversion)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Mesa Fruit Growers	Yuma County	0	0	0	0	0	0	0	0	2.942334
Yuma Mesa Irrigation & Drainage District (10,000 af M&I)	Yuma County	0	0	0	0	0	0	0	7,544	69206.1
University of Arizona	Yuma County	0	0	0	0	0	0	0	22	205.9634
Yuma Mesa Grapefruit Company (Camille Allec Jr.)	Yuma County	0	0	0	0	0	0	0	2	20.58108
North Gila Valley Irrigation District (2,500 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	536	4918.327
Welton-Mohawk Irriation and Drainage District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	11,594	106364.2
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	178	1635.498
Sturges, Harold (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Sturges, Irma (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Molina (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	0	0
Powers (Power, R.E. & P.) (2004 use 384 af over entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
Zozaya (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
North Gila Valley Irrigation District****	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	0	0
Hulet (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Holpal (in MVIDD/formerly Hurschler) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
McKellips and Granite Reef Farms (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Sherill & Lafollette (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Yuma County Water Users' Association	Yuma County	0	0	0	0	0	0	0	0	0
Phillips, Milton and Jean (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Arizona Total		9,707	19,425	23,115	26,806	34,187	41,568	48,950	89,508	265,861.8
Agriculture Summary by County	Agriculture per County									
Coconino County	0	0	0	0	0	0	0	0	0	0
La Paz County	4	821	2,918	3,966	5,015	7,111	9,208	11,305	16,698	16697.58
Maricopa County	0	0	0	0	0	0	0	0	0	0
Mohave County	6	3,010	6,020	7,525	9,030	12,040	15,050	18,060	25,801	25800.99
Pinal County	1	3,600	5,937	5,937	5,937	5,937	5,937	5,937	5,937	5936.854
Yuma County	32	2,276	4,550	5,687	6,825	9,099	11,373	13,648	41,072	217426.4
Total Arizona Agriculture	43	9,707	19,425	23,115	26,806	34,187	41,568	48,950	89,508	265,862

Table Att. C-6

2060 Non-Indian Agricultural Shortages (Based on Diversions)

Arizona Agriculture	County	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP Agricultural Relinquished Water Contracts under AWSA	Maricopa/Pinal/Pima	0	0	0	0	0	0	0	0	0
CAP Arizona State Land Department	Pinal County	4,123	5,359	5,359	5,359	5,359	5,359	5,359	5,359	5359.3
Arizona State Land Department	Yuma County	770	1,541	1,927	2,312	3,083	3,854	4,624	6,607	6606.7
Beattie Farms Southwest (new contract) (2004 over use of 263 af)	Yuma County	129	259	324	388	518	647	777	1,110	1110
ChaCha (Curtis Family Trust) (Auza Farm and West Farm) (over 13 af)	Yuma County	245	490	613	735	980	1,225	1,470	2,100	2100.17
Cibola Resources	La Paz County	0	0	0	0	0	0	0	0	0
Cibola Valley Irrigation & Drainage District (M&I: 300 af)	La Paz County	177	1,530	2,207	2,883	4,236	5,589	6,943	10,423	10422.7
Curtis, Armon (Curry Family LTD)	Yuma County	35	70	88	105	140	175	210	300	300.025
Gila Monster Farms (formerly Sturges Farms Inc.)	Yuma County	168	336	419	503	670	838	1,005	1,436	1435.83
JRS Partners LLC (formerly essen Family Limite) (new contract) (2004 over use of 4,984 af)	Yuma County	126	252	315	378	504	630	756	1,080	1080.09
Mohave County Water Authority (new entitlement)	La Paz County	600	1,300	1,650	2,000	2,699	3,399	4,098	5,898	5897.68
Mohave Valley Irrigation and Drainage District (5,000 af M&I)	Mohave County	3,010	6,020	7,525	9,030	12,040	15,050	18,060	25,801	25801
North Baja LLC (formerly Jamar Produce) (72 af M&I)	La Paz County	44	88	110	132	176	220	264	377	377.224
Ogram Boys Enterprises (new contract)	Yuma County	108	216	270	324	432	540	647	925	924.615
Ogram, George	Yuma County	56	112	140	168	224	280	336	480	480
Pasquinelli, Gary and Barbara (formerly Ansel Hall)	Yuma County	57	114	142	170	227	284	340	486	486.194
Peach, John (2004 over use of 45 af)	Yuma County	53	106	132	159	212	265	319	455	455.385
Phillips, Milton and Jean	Yuma County	3	5	6	7	9	11	13	18	18.4615
Rayner Ranches	Yuma County	525	1,050	1,312	1,575	2,100	2,625	3,150	4,500	4499.82
Yuma Irrigation District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	1,698	15576
Yuma County Water Users' Association (14,701 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95 af M&I Conversion)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Mesa Fruit Growers	Yuma County	0	0	0	0	0	0	0	0	2.94243
Yuma Mesa Irrigation & Drainage District (10,000 af M&I)	Yuma County	0	0	0	0	0	0	0	7,544	69208.3
University of Arizona	Yuma County	0	0	0	0	0	0	0	22	205.97
Yuma Mesa Grapefruit Company (Camille Allec Jr.)	Yuma County	0	0	0	0	0	0	0	2	20.5817
North Gila Valley Irrigation District (2,500 af M&I)	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	536	4918.48
Welton-Mohawk Irriation and Drainage District (5,000 af M&I)	Yuma County	0	0	0	0	0	0	0	11,595	106368
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	178	1635.55
Sturges, Harold (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Sturges, Irma (not taking water)	Yuma County	0	0	0	0	0	0	0	0	0
Molina (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Gila Monster Farms (formerly Sturges)	Yuma County	0	0	0	0	0	0	0	0	0
Powers (Power, R.E. & P.) (2004 use 384 af over entitlement)	Yuma County	0	0	0	0	0	0	0	0	0
Zozaya (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
North Gila Valley Irrigation District****	Yuma County	0	0	0	0	0	0	0	0	0
Yuma Axiliary Project (Unit B)	Yuma County	0	0	0	0	0	0	0	0	0
Hulet (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Holpal (in MVIDD/formerly Hurschler) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
McKellips and Granite Reef Farms (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Sherill & Lafollette (in MVIDD) (Water Use Not Reported)	Mohave County	0	0	0	0	0	0	0	0	0
Yuma County Water Users' Association	Yuma County	0	0	0	0	0	0	0	0	0
Phillips, Milton and Jean (Water Use Not Reported)	Yuma County	0	0	0	0	0	0	0	0	0
Arizona Total		10,229	18,847	22,538	26,228	33,610	40,991	48,372	88,931	265,291
Agriculture Summary by County	Agriculture per County									
Coconino County	0	0	0	0	0	0	0	0	0	0
La Paz County	4	821	2,918	3,966	5,015	7,111	9,208	11,305	16,698	16697.58
Maricopa County	0	0	0	0	0	0	0	0	0	0
Mohave County	6	3,010	6,020	7,525	9,030	12,040	15,050	18,060	25,801	25800.99
Pinal County	1	4,123	5,359	5,359	5,359	5,359	5,359	5,359	5,359	5359.303
Yuma County	32	2,276	4,550	5,687	6,825	9,099	11,373	13,648	41,073	217432.7
Total Arizona Agriculture	43	10,229	18,847	22,538	26,228	33,610	40,991	48,372	88,931	265,291

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Attachment D

M&I Water Users
Distribution of Shortages (2008-2060)

This attachment to Appendix G contains tables produced by the Shortage Allocation Model that show the distribution of shortages to Municipal and Industrial (M&I) entitlement holders within Arizona. The shortages shown on these tables are based on the consumptive use volumes of the affected entities. The tables show the distribution of shortages to both M&I entitlement holders within the CAP and other Arizona M&I entitlement holders, for the years 2008, 2017, 2026, 2027, 2040, and 2060.

Table Att. D-1

2008 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP M&I												
Apache Junction (AZ Water Co)	Pinal County			0	0	0	0	0	0	1,202	5,808	6,000
Avra Coop	Pima County			0	0	0	0	0	0	0	0	0
AZ-American (Agua Fria)	Maricopa County			0	0	0	0	0	0	2,184	10,551	10,900
AZ-American (Paradise Valley)	Maricopa County			0	0	0	0	0	0	647	3,128	3,231
AZ-American (Sun City)	Maricopa County			0	0	0	0	0	0	839	4,055	4,189
AZ-American (Sun City West)	Maricopa County			0	0	0	0	0	0	475	2,296	2,372
AZ State Land Dept.	Maricopa County			0	0	0	0	0	0	140	678	700
ASARCO (Ray Mine)	Pima County			0	0	0	0	0	0	0	0	0
Avondale	Maricopa County			0	0	0	0	0	0	951	4,594	4,746
B&F Investment, LLC	La Paz County			0	0	0	0	0	0	0	0	0
Berneil Water Co (Cave Creek)	Maricopa County			0	0	0	0	0	0	0	0	0
Buckeye	Maricopa County			0	0	0	0	0	0	0	0	0
Carefree Water Co	Maricopa County			0	0	0	0	0	0	80	387	400
Casa Grande (AZ Water Co)	Pinal County			0	0	0	0	0	0	401	1,936	2,000
Cave Creek Water Co	Maricopa County			0	0	0	0	0	0	320	1,547	1,598
CAGRD	Maricopa County			0	0	0	0	0	0	1,552	7,498	7,746
Chandler*	Maricopa County			0	0	0	0	0	41	4,987	9,059	10,072
Chandler Heights Citrus ID	Maricopa County			0	0	0	0	0	0	0	0	0
Chaparral City Water Co	Maricopa County			0	0	0	0	0	0	954	4,609	4,761
Circle City Water Co	Maricopa County			0	0	0	0	0	0	0	0	0
Comm. Water Co (Green Valley)	Pima County			0	0	0	0	0	0	0	0	0
Coolidge (AZ Water Co)	Pinal County			0	0	0	0	0	0	0	0	0
El Mirage	Maricopa County			0	0	0	0	0	0	0	0	0
Eloy	Pinal County			0	0	0	0	0	0	435	2,101	2,171
Florence	Pinal County			0	0	0	0	0	0	410	1,982	2,048
Flowing Wells ID	Pima County			0	0	0	0	0	0	0	0	0
Gilbert	Maricopa County			0	0	0	0	0	16	2,987	8,540	10,105
Glendale	Maricopa County			0	0	0	0	0	7	3,524	14,411	15,456
Goodyear	Maricopa County			0	0	0	0	0	0	2,152	10,398	10,742
Green Valley DWID	Pima County			0	0	0	0	0	0	100	484	500
H2O Water Co	Maricopa County			0	0	0	0	0	0	0	0	0
Marana	Pima County			0	0	0	0	0	0	0	0	0
Maricopa County Parks & Rec	Maricopa County			0	0	0	0	0	0	126	610	630
Mesa*	Maricopa County			0	0	0	0	0	58	9,733	25,755	26,967
MDWID	Pima County			0	0	0	0	0	0	2,024	9,777	10,101
Oro Valley	Pima County			0	0	0	0	0	0	0	0	0
Peoria	Maricopa County			0	0	0	0	0	0	1,483	7,164	7,401
Phelps Dodge Miami	Gila County			0	0	0	0	0	0	0	0	0
Phoenix*	Maricopa County			0	0	0	0	0	390	60,867	151,226	155,981
Phoenix Memorial Park	Maricopa County			0	0	0	0	0	0	0	0	0
Pine Water Co	Gila County			0	0	0	0	0	0	0	0	0
Queen Creek Water Co	Maricopa County			0	0	0	0	0	0	70	337	348
Rio Verde Utilities	Maricopa County			0	0	0	0	0	0	163	786	812
San Tan ID	Maricopa County			0	0	0	0	0	0	0	0	0
Scottsdale*	Maricopa County			0	0	0	0	0	35	12,616	48,279	49,786
Spanish Trail Water Co	Pima County			0	0	0	0	0	0	0	0	0
Superior	Pinal County			0	0	0	0	0	0	0	0	0
Surprise	Maricopa County			0	0	0	0	0	0	923	4,459	4,606
Tempe	Maricopa County			0	0	0	0	0	0	888	4,200	4,358
Tonto Hills Utility Co	Maricopa County			0	0	0	0	0	0	0	0	0
Tucson	Pima County			0	0	0	0	0	0	16,782	81,068	83,750
Vail Water Co	Pima County			0	0	0	0	0	0	0	0	0

Table Att. D-1
2008 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Valley Utilities Water Co	Maricopa County			0	0	0	0	0	0	0	0	0
Water Util. Comm. Fac. Dist. (AJ)	Pinal County			0	0	0	0	0	0	10	48	50
Water Util. Greater Buckeye	Maricopa County			0	0	0	0	0	0	0	0	0
Water Util. Greater Tonopah	Maricopa County			0	0	0	0	0	0	0	0	0
White Tank Sys. (AZ Water Co.)	Maricopa County			0	0	0	0	0	0	194	937	968
San Carlos (Phelps Dodge/Globe)	Gila County			0	0	0	0	0	0	0	0	0
State Reserved	All Counties in CAP			0	0	0	0	0	31	2,974	2,974	2,974
CAP M&I Subtotal				0	0	0	0	0	578	133,195	431,681	448,468.8
Arizona M&I												
Arizona State Land Department	Yuma County			0	0	0	0	0	0	0	275	290
Arizona State Parks Board - Contact Point	Mohave County			0	0	0	0	2	4	6	13	13
Arizona State Parks Board - Windsor Beach	Mohave County			0	0	0	0	0	0	0	19	20
Arizona-American Water Company	Mohave County			0	0	0	0	0	0	0	275	289
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	48	53
Bullhead City (includes 6,000 af subcontract)	Mohave County			0	0	0	0	0	579	2,133	6,798	7,012
Bureau of Land Management	La Paz County			0	0	0	0	0	0	0	790	851
Cibola Valley Irrigation & Drainage District******* (M&I: 300 af)	La Paz County	M&I/Ag	0.039	3	39	57	76	112	149	185	295	300
City of Somerton (new contract)	Yuma County			54	107	134	161	214	267	321	481	488
City of Yuma (Smucker Park)	Yuma County			0	0	0	0	0	0	0	0	0
Crystal Beach Water Conservation District	Mohave County			0	0	0	2	12	21	31	59	60
Desert Lawn Memorial Park Association, Inc.	Yuma County			0	0	0	0	0	0	0	11	15
Ehrenburg Improvement District	La Paz County			39	78	98	117	157	196	235	353	358
Fisher's Landing Water and Sewer Works, LLC	Yuma County			3	7	9	11	15	18	22	33	34
Gold Dome Mining Corporation	Yuma County			0	0	0	0	0	0	0	0	0
Gold Standard Mines Corporation	Mohave County			0	0	0	0	0	0	0	0	0
Golden Shores Water Conservation District	Mohave County			0	0	0	0	0	0	0	409	429
Hillcrest Water Company	La Paz County			0	0	0	0	0	0	6	24	25
Lake Havasu City (includes 6,000 af subcontract)	Mohave County			0	128	982	1,836	3,545	5,253	6,962	12,087	12,322
Marble Canyon Company, Inc.	Coconino County			0	0	0	0	0	0	0	15	16
Martinez Lake Cabin Sites (recommended)	Yuma County			2	3	4	5	7	8	10	15	15
McAlister, Maurice L.	Mohave County			0	0	0	0	0	0	0	4	4
Mohave County Water Authority (recommended 3,500 af)	Mohave County			0	0	0	0	0	0	0	200	235
Mohave Valley Irrigation and Drainage District (5,000 af M&I)	Mohave County	M&I/Ag	0.264	547	1,094	1,368	1,642	2,189	2,736	3,283	4,925	5,000
Mohave Water Conservation District (includes 3,000 af subcontract)	Mohave County			0	0	0	0	0	0	0	451	500
North Baja LLC (formerly Jamar Produce) (72 af M&I)	La Paz County	M&I/Ag	0.214	8	16	20	24	31	39	47	71	72
Roy, Edward P. & Anna R.	Yuma County			0	0	1	1	1	1	1	1	1
Shepard Water Company	Yuma County			4	7	9	11	14	18	21	32	33
City of Parker	La Paz County			0	0	1	23	65	108	151	279	284
Town of Quartzsite	La Paz County			0	0	0	0	0	0	0	271	288
Verizon (formerly Continental Telephone)	La Paz County			0	0	1	1	1	1	1	1	1
Cibola National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	0	1,588
Yuma Irrigation District (5,000 af M&I)	Yuma County	M&I/Ag	0.152	0	0	0	0	0	0	0	0	1,038
National Park Service	Mohave County			0	0	0	0	0	0	0	0	153
Yuma Union High School	Yuma County			0	0	0	0	0	0	0	0	24
Union Pacific Railroad (formerly Southern Pacific Co.)	Yuma County			0	0	0	0	0	0	0	0	6
Kaman, Inc.	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	0	5,039
Department of Navy MCAS	Yuma County			0	0	0	0	0	0	0	0	442
Yuma County Water Users' Association (14,701 af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95 af M&I Conversion)	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma (cemetery)	Yuma County			0	0	0	0	0	0	0	0	0
Yuma Mesa Irrigation & Drainage District (10,000 af M&I)	Yuma County	M&I/Ag	0.063	0	0	0	0	0	0	0	0	2,075
Desert Lawn Memorial Park	Yuma County			0	0	0	0	0	0	0	0	29
North Gila Valley Irrigation District (2,500 af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0

Table Att. D-1

2008 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Wellton-Mohawk Irrigation and Drainage District (5,000 af M&I)	Yuma County	M&I/Ag	0.018	0	0	0	0	0	0	0	0	1,038
Chandler (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	0	888
Gilbert (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	0	1,403
Glendale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	0	623
Mesa (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	0	573
Phoenix (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	0	1,038
Scottsdale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	0	21
Tempe (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	0	21
Department of Army - Yuma Proving Ground	Yuma County			0	0	0	0	0	0	0	0	158
Bureau of Reclamation - Davis Dam	Mohave County			0	0	0	0	0	0	0	0	0
Imperial National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	0	751
Havasu Lake National Wildlife Refuge (2004 over use of 7,777 af)	Mohave County			0	0	0	0	0	0	0	0	1,005
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	0	0
City of Parker	La Paz County			0	0	0	0	0	0	0	0	0
Miller (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
Swan (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	0	0
Arizona M&I Subtotal:				660	1,481	2,683	3,908	6,363	9,398	13,415	28,234	46,917.2
M&I Summary by County	M&I per County											
Coconino County	1			0	0	0	0	0	0	0	15	16
Gila County	3			0	0	0	0	0	0	0	0	0
La Paz County	14			50	134	177	240	366	493	625	2,132	4,571
Maricopa County	36			0	0	0	0	0	547	108,856	325,501	338,875
Mohave County	20			547	1,222	2,350	3,480	5,747	8,593	12,415	25,239	27,042
Pima County	11			0	0	0	0	0	0	18,906	91,330	94,351
Pinal County	7			0	0	0	0	0	0	2,458	11,876	12,269
Yuma County	24			63	125	156	188	250	312	375	848	10,723
All Counties in CAP	1			0	0	0	0	0	31	2,974	2,974	2,974
(blank)	0			0	0	0	0	0	0	0	0	0
Total Arizona M&I:	117			660	1,481	2,683	3,908	6,363	9,976	146,610	459,916	490,821

Table Att. D-2

2017 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP M&I												
Apache Junction (AZ Water Co)	Pinal County			0	0	0	13	1,081	2,143	3,204	6,000	6,000
Avra Coop	Pima County			0	0	0	0	0	0	0	0	0
AZ-American (Agua Fria)	Maricopa County			0	0	0	25	1,998	3,962	5,923	11,093	11,093
AZ-American (Paradise Valley)	Maricopa County			0	0	0	7	582	1,154	1,725	3,231	3,231
AZ-American (Sun City)	Maricopa County			0	0	0	9	754	1,496	2,237	4,189	4,189
AZ-American (Sun City West)	Maricopa County			0	0	0	5	427	847	1,267	2,372	2,372
AZ State Land Dept.	Maricopa County			0	0	0	2	126	250	374	700	700
ASARCO (Ray Mine)	Pima County			0	0	0	0	0	0	0	0	0
Avondale	Maricopa County			0	0	0	11	855	1,695	2,534	4,746	4,746
B&F Investment, LLC	La Paz County			0	0	0	0	0	0	0	0	0
Berneil Water Co (Cave Creek)	Maricopa County			0	0	0	0	0	0	0	0	0
Buckeye	Maricopa County			0	0	0	0	0	0	0	0	0
Carefree Water Co	Maricopa County			0	0	0	1	72	143	214	400	400
Casa Grande (AZ Water Co)	Pinal County			0	0	0	4	360	714	1,068	2,000	2,000
Cave Creek Water Co	Maricopa County			0	0	0	5	369	731	1,094	2,048	2,048
CAGRD	Maricopa County			0	0	0	17	1,395	2,766	4,136	7,746	7,746
Chandler*	Maricopa County			0	434	2,886	3,943	5,482	7,015	8,545	12,669	13,578
Chandler Heights Citrus ID	Maricopa County			0	0	0	0	0	0	0	0	0
Chaparral City Water Co	Maricopa County			0	0	0	13	1,027	2,038	3,046	5,705	5,705
Circle City Water Co	Maricopa County			0	0	0	0	0	0	0	0	0
Comm. Water Co (Green Valley)	Pima County			0	0	0	0	0	0	0	0	0
Coolidge (AZ Water Co)	Pinal County			0	0	0	0	0	0	0	0	0
El Mirage	Maricopa County			0	0	0	0	0	0	0	0	0
Eloy	Pinal County			0	0	0	5	391	775	1,159	2,171	2,171
Florence	Pinal County			0	0	0	5	369	731	1,094	2,048	2,048
Flowing Wells ID	Pima County			0	0	0	0	0	0	0	0	0
Gilbert	Maricopa County			0	170	1,130	1,553	2,840	4,121	5,400	8,916	10,353
Glendale	Maricopa County			0	75	502	714	3,236	5,747	8,255	14,929	15,566
Goodyear	Maricopa County			0	0	0	24	1,934	3,836	5,736	10,742	10,742
Green Valley DWID	Pima County			0	0	0	1	90	179	267	500	500
H2O Water Co	Maricopa County			0	0	0	0	0	0	0	0	0
Marana	Pima County			0	0	0	0	0	0	0	0	0
Maricopa County Parks & Rec	Maricopa County			0	0	0	1	116	230	344	645	645
Mesa*	Maricopa County			0	614	4,082	5,618	10,959	16,276	21,585	35,639	36,226
MDWID	Pima County			0	0	0	24	1,911	3,790	5,667	10,613	10,613
Oro Valley	Pima County			0	0	0	23	1,856	3,680	5,502	10,305	10,305
Peoria	Maricopa County			0	0	0	43	3,434	6,810	10,181	19,067	19,067
Phelps Dodge Miami	Gila County			0	0	0	0	0	0	0	0	0
Phoenix*	Maricopa County			0	4,121	27,414	37,581	61,433	85,180	108,894	171,506	172,569
Phoenix Memorial Park	Maricopa County			0	0	0	0	0	0	0	0	0
Pine Water Co	Gila County			0	0	0	0	0	0	0	0	0
Queen Creek Water Co	Maricopa County			0	0	0	1	63	124	186	348	348
Rio Verde Utilities	Maricopa County			0	0	0	2	146	290	434	812	812
San Tan ID	Maricopa County			0	0	0	0	0	0	0	0	0
Scottsdale*	Maricopa County			0	365	2,431	3,424	12,816	22,167	31,504	56,118	56,139
Spanish Trail Water Co	Pima County			0	0	0	0	0	0	0	0	0
Superior	Pinal County			0	0	0	0	0	0	0	0	0
Surprise	Maricopa County			0	0	0	23	1,846	3,660	5,473	10,249	10,249
Tempe	Maricopa County			0	3	17	33	800	1,564	2,327	4,340	4,361
Tonto Hills Utility Co	Maricopa County			0	0	0	0	0	0	0	0	0
Tucson	Pima County			0	0	0	320	25,693	50,954	76,181	142,672	142,672
Vail Water Co	Pima County			0	0	0	0	0	0	0	0	0

Table Att. D-2

2017 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Valley Utilities Water Co	Maricopa County			0	0	0	0	0	0	0	0	0
Water Util. Comm. Fac. Dist. (AJ)	Pinal County			0	0	0	0	9	18	27	50	50
Water Util. Greater Buckeye	Maricopa County			0	0	0	0	0	0	0	0	0
Water Util. Greater Tonopah	Maricopa County			0	0	0	0	0	0	0	0	0
White Tank Sys. (AZ Water Co.)	Maricopa County			0	0	0	2	174	346	517	968	968
San Carlos (Phelps Dodge/Globe)	Gila County			0	0	0	0	0	0	0	0	0
State Reserved	All Counties in CAP			0	3,435	22,849	31,072	31,072	31,072	31,072	31,072	31,072
CAP M&I Subtotal				0	9,216	61,311	84,525	175,716	266,505	357,170	596,610	601,286.1
Arizona M&I												
Arizona State Land Department	Yuma County			0	0	0	0	0	110	226	531	531
Arizona State Parks Board - Contact Point	Mohave County			0	0	0	0	2	5	7	13	13
Arizona State Parks Board - Windsor Beach	Mohave County			0	0	0	0	0	0	2	20	20
Arizona-American Water Company	Mohave County			0	0	0	0	0	0	18	300	300
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	53	53
Bullhead City (includes 6,000 af subcontract)	Mohave County			0	0	0	0	1,088	2,730	4,373	8,725	8,725
Bureau of Land Management	La Paz County			0	0	0	0	0	0	0	851	851
Cibola Valley Irrigation & Drainage District******* (M&I: 300 af)	La Paz County	M&I/Ag	0.039	5	43	63	82	121	159	198	300	300
City of Somerton (new contract)	Yuma County			57	113	141	170	226	282	339	488	488
City of Yuma (Smucker Park)	Yuma County			0	0	0	0	0	0	0	0	0
Crystal Beach Water Conservation District	Mohave County			0	3	8	13	23	33	43	69	69
Desert Lawn Memorial Park Association, Inc.	Yuma County			0	0	0	0	0	0	0	15	15
Ehrenburg Improvement District	La Paz County			41	83	103	124	165	207	248	358	358
Fisher's Landing Water and Sewer Works, LLC	Yuma County			4	8	10	11	15	19	23	34	34
Gold Dome Mining Corporation	Yuma County			0	0	0	0	0	0	0	0	0
Gold Standard Mines Corporation	Mohave County			0	0	0	0	0	0	0	0	0
Golden Shores Water Conservation District	Mohave County			0	0	0	0	0	0	98	508	508
Hillcrest Water Company	La Paz County			0	0	0	1	7	13	20	36	36
Lake Havasu City (includes 6,000 af of subcontract)	Mohave County			1,237	3,042	3,944	4,846	6,651	8,456	10,261	15,043	15,043
Marble Canyon Company, Inc.	Coconino County			0	0	0	0	0	0	2	16	16
Martinez Lake Cabin Sites (recommended)	Yuma County			2	3	4	5	7	9	10	15	15
McAlister, Maurice L.	Mohave County			0	0	0	0	0	0	0	4	4
Mohave County Water Authority (recommended 3,500 af)	Mohave County			263	526	657	789	1,052	1,315	1,578	2,275	2,275
Mohave Valley Irrigation and Drainage District (5,000af M&I)	Mohave County	M&I/Ag	0.264	578	1,156	1,445	1,734	2,312	2,890	3,468	5,000	5,000
Mohave Water Conservation District (includes 3,000 af of subcontract)	Mohave County			0	0	0	0	0	0	0	622	622
North Baja LLC (formerly Jamar Produce) (72af M&I)	La Paz County	M&I/Ag	0.214	8	17	21	25	33	42	50	72	72
Roy, Edward P. & Anna R.	Yuma County			0	1	1	1	1	1	1	1	1
Shepard Water Company	Yuma County			4	8	9	11	15	19	23	33	33
City of Parker	La Paz County			45	90	113	135	180	225	271	390	390
Town of Quartzsite	La Paz County			0	0	0	0	0	0	81	409	409
Verizon (formerly Continental Telephone)	La Paz County			0	1	1	1	1	1	1	1	1
Cibola National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	191	2,093
Yuma Irrigation District (5,000af M&I)	Yuma County	M&I/Ag	0.152	0	0	0	0	0	0	0	112	1,231
National Park Service	Mohave County			0	0	0	0	0	0	0	17	182
Yuma Union High School	Yuma County			0	0	0	0	0	0	0	3	29
Union Pacific Railroad (formerly Southern Pacific Co.)	Yuma County			0	0	0	0	0	0	0	1	7
Kaman, Inc.	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	646	7,101
Department of Navy MCAS	Yuma County			0	0	0	0	0	0	0	48	524
Yuma County Water Users' Association (14,701af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95af M&I Conversion)	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma (cemetery)	Yuma County			0	0	0	0	0	0	0	0	0
Yuma Mesa Irrigation & Drainage District (10,000af M&I)	Yuma County	M&I/Ag	0.063	0	0	0	0	0	0	0	224	2,461
Desert Lawn Memorial Park	Yuma County			0	0	0	0	0	0	0	3	34
North Gila Valley Irrigation District (2,500af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0

Table Att. D-2

2017 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Wellton-Mohawk Irrigation and Drainage District (5,000af M&I)	Yuma County	M&I/Ag	0.018	0	0	0	0	0	0	0	112	1,231
Chandler (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	96	1,053
Gilbert (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	151	1,664
Glendale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	67	738
Mesa (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	62	679
Phoenix (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	112	1,231
Scottsdale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	2	25
Tempe (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	2	25
Department of Army - Yuma Proving Ground	Yuma County			0	0	0	0	0	0	0	17	187
Bureau of Reclamation - Davis Dam	Mohave County			0	0	0	0	0	0	0	0	0
Imperial National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	81	891
Havasu Lake National Wildlife Refuge (2004 over use of 7,777af)	Mohave County			0	0	0	0	0	0	0	108	1,192
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	0	0
City of Parker	La Paz County			0	0	0	0	0	0	0	0	0
Miller (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
Swan (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	0	0
Arizona M&I Subtotal:				2,244	5,092	6,520	7,948	11,900	16,517	21,340	38,236	58,759.14
M&I Summary by County	M&I per County											
Coconino County	1			0	0	0	0	0	0	2	16	16
Gila County	3			0	0	0	0	0	0	0	0	0
La Paz County	14			100	233	300	368	507	647	868	2,742	5,454
Maricopa County	36			0	5,782	38,462	53,058	112,885	172,448	231,930	389,179	393,855
Mohave County	20			2,078	4,727	6,054	7,382	11,128	15,429	19,848	32,705	33,953
Pima County	11			0	0	0	368	29,550	58,603	87,617	164,090	164,090
Pinal County	7			0	0	0	28	2,209	4,382	6,551	12,269	12,269
Yuma County	24			66	132	165	198	264	440	621	2,282	13,922
All Counties in CAP	1			0	3,435	22,849	31,072	31,072	31,072	31,072	31,072	31,072
(blank)	0			0	0	0	0	0	0	0	0	0
Total Arizona M&I:	117			2,244	14,308	67,831	92,473	187,616	283,022	378,510	634,354	654,630

Table Att. D-3

2026 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP M&I												
Apache Junction (AZ Water Co)	Pinal County			0	0	186	681	1,631	2,580	3,528	6,000	6,000
Avra Coop	Pima County			0	0	11	40	96	152	208	354	354
AZ-American (Agua Fria)	Maricopa County			0	0	343	1,260	3,015	4,770	6,522	11,093	11,093
AZ-American (Paradise Valley)	Maricopa County			0	0	100	367	878	1,389	1,900	3,231	3,231
AZ-American (Sun City)	Maricopa County			0	0	130	476	1,139	1,801	2,463	4,189	4,189
AZ-American (Sun City West)	Maricopa County			0	0	73	269	645	1,020	1,395	2,372	2,372
AZ State Land Dept.	Maricopa County			0	0	284	1,042	2,495	3,946	5,396	9,177	9,177
ASARCO (Ray Mine)	Pima County			0	0	284	1,043	2,497	3,951	5,402	9,188	9,188
Avondale	Maricopa County			0	0	156	572	1,370	2,167	2,963	5,039	5,039
B&F Investment, LLC	La Paz County			0	0	0	0	0	0	0	0	0
Berneil Water Co (Cave Creek)	Maricopa County			0	0	3	10	24	38	51	88	88
Buckeye	Maricopa County			0	0	0	1	3	5	6	11	11
Carefree Water Co	Maricopa County			0	0	25	90	216	341	467	794	794
Casa Grande (AZ Water Co)	Pinal County			0	0	155	569	1,362	2,155	2,947	5,012	5,012
Cave Creek Water Co	Maricopa County			0	0	74	273	654	1,035	1,415	2,406	2,406
CAGRD	Maricopa County			0	0	240	880	2,106	3,331	4,554	7,746	7,746
Chandler*	Maricopa County			1,171	3,477	4,192	4,907	6,276	7,646	9,012	12,675	13,574
Chandler Heights Citrus ID	Maricopa County			0	0	4	16	37	59	81	138	138
Chaparral City Water Co	Maricopa County			0	0	224	822	1,967	3,111	4,254	7,235	7,235
Circle City Water Co	Maricopa County			0	0	53	195	468	740	1,011	1,720	1,720
Comm. Water Co (Green Valley)	Pima County			0	0	39	142	340	538	735	1,250	1,250
Coolidge (AZ Water Co)	Pinal County			0	0	27	99	238	376	514	875	875
El Mirage	Maricopa County			0	0	7	25	60	96	131	222	222
Eloy	Pinal County			0	0	67	247	590	934	1,276	2,171	2,171
Florence	Pinal County			0	0	63	233	557	881	1,204	2,048	2,048
Flowing Wells ID	Pima County			0	0	59	216	518	819	1,120	1,905	1,905
Gilbert	Maricopa County			459	1,362	1,761	2,359	3,504	4,648	5,791	8,926	10,347
Glendale	Maricopa County			204	604	1,162	2,444	4,900	7,356	9,807	16,269	16,899
Goodyear	Maricopa County			0	0	333	1,220	2,920	4,619	6,316	10,742	10,742
Green Valley DWID	Pima County			0	0	34	126	302	478	654	1,113	1,113
H2O Water Co	Maricopa County			0	0	2	7	17	28	38	64	64
Marana	Pima County			0	0	1	2	6	9	12	21	21
Maricopa County Parks & Rec	Maricopa County			0	0	20	75	179	284	388	660	660
Mesa*	Maricopa County			1,657	4,919	6,717	9,830	15,793	21,754	27,705	43,292	43,872
MDWID	Pima County			0	0	369	1,354	3,241	5,128	7,011	11,924	11,924
Oro Valley	Pima County			0	0	319	1,170	2,801	4,432	6,059	10,305	10,305
Peoria	Maricopa County			0	0	781	2,866	6,860	10,852	14,838	25,236	25,236
Phelps Dodge Miami	Gila County			0	0	39	144	346	547	748	1,271	1,271
Phoenix*	Maricopa County			11,129	33,033	41,432	52,512	73,737	94,956	116,139	171,514	172,565
Phoenix Memorial Park	Maricopa County			0	0	1	4	10	16	22	37	37
Pine Water Co	Gila County			0	0	2	8	19	30	41	70	70
Queen Creek Water Co	Maricopa County			0	0	11	40	95	150	205	348	348
Rio Verde Utilities	Maricopa County			0	0	25	92	221	349	477	812	812
San Tan ID	Maricopa County			0	0	3	12	28	44	61	103	103
Scottsdale*	Maricopa County			987	2,929	4,941	9,304	17,661	26,016	34,357	56,118	56,139
Spanish Trail Water Co	Pima County			0	0	41	151	361	571	781	1,329	1,329
Superior	Pinal County			0	0	4	14	34	54	73	125	125
Surprise	Maricopa County			0	0	317	1,164	2,786	4,407	6,026	10,249	10,249
Tempe	Maricopa County			7	20	157	513	1,196	1,879	2,560	4,340	4,361
Tonto Hills Utility Co	Maricopa County			0	0	1	4	8	13	18	31	31
Tucson	Pima County			0	0	4,437	16,277	38,960	61,636	84,274	143,328	143,328
Vail Water Co	Pima County			0	0	25	92	221	349	478	812	812

Table Att. D-3

2026 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Valley Utilities Water Co	Maricopa County			0	0	3	12	30	47	64	109	109
Water Util. Comm. Fac. Dist. (AJ)	Pinal County			0	0	40	148	355	561	767	1,305	1,305
Water Util. Greater Buckeye	Maricopa County			0	0	1	2	5	8	11	19	19
Water Util. Greater Tonopah	Maricopa County			0	0	1	3	8	12	16	28	28
White Tank Sys. (AZ Water Co.)	Maricopa County			0	0	30	110	263	416	569	968	968
San Carlos (Phelps Dodge/Globe)	Gila County			0	0	246	902	2,158	3,414	4,668	7,938	7,938
State Reserved	All Counties in CAP			17,664	52,430	59,171	59,171	59,171	59,171	59,171	59,171	59,171
CAP M&I Subtotal				33,278	98,774	129,228	176,610	267,377	358,118	448,703	685,516	690,139.5
Arizona M&I												
Arizona State Land Department	Yuma County			0	0	0	34	150	265	381	684	684
Arizona State Parks Board - Contact Point	Mohave County			0	0	0	0	2	5	7	13	13
Arizona State Parks Board - Windsor Beach	Mohave County			0	0	0	0	0	0	2	20	20
Arizona-American Water Company	Mohave County			0	0	0	0	0	0	28	308	308
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	53	53
Bullhead City (includes 6,000 af subcontract)	Mohave County			0	0	0	776	2,424	4,072	5,720	10,040	10,040
Bureau of Land Management	La Paz County			0	0	0	0	0	0	0	851	851
Cibola Valley Irrigation & Drainage District******* (M&I: 300af)	La Paz County	M&I/Ag	0.039	5	44	63	82	121	160	198	300	300
City of Somerton (new contract)	Yuma County			57	114	142	170	227	283	340	488	488
City of Yuma (Smucker Park)	Yuma County			0	0	0	0	0	0	0	0	0
Crystal Beach Water Conservation District	Mohave County			0	10	15	20	30	40	50	76	76
Desert Lawn Memorial Park Association, Inc.	Yuma County			0	0	0	0	0	0	0	15	15
Ehrenburg Improvement District	La Paz County			41	83	104	124	166	208	249	358	358
Fisher's Landing Water and Sewer Works, LLC	Yuma County			4	8	10	12	16	20	24	34	34
Gold Dome Mining Corporation	Yuma County			0	0	0	0	0	0	0	0	0
Gold Standard Mines Corporation	Mohave County			0	0	0	0	0	0	0	0	0
Golden Shores Water Conservation District	Mohave County			0	0	0	0	0	0	144	551	551
Hillcrest Water Company	La Paz County			0	3	6	9	15	22	28	44	44
Lake Havasu City (includes 6,000 af subcontract)	Mohave County			1,811	3,621	4,527	5,432	7,243	9,054	10,864	15,611	15,611
Marble Canyon Company, Inc.	Coconino County			0	0	0	0	0	0	2	16	16
Martinez Lake Cabin Sites (recommended)	Yuma County			2	3	4	5	7	9	10	15	15
McAlister, Maurice L.	Mohave County			0	0	0	0	0	0	0	4	4
Mohave County Water Authority (recommended 3,500af)	Mohave County			264	528	659	791	1,055	1,319	1,583	2,275	2,275
Mohave Valley Irrigation and Drainage District (5,000af M&I)	Mohave County	M&I/Ag	0.264	580	1,160	1,450	1,740	2,320	2,900	3,480	5,000	5,000
Mohave Water Conservation District (includes 6,000 af subcontract)	Mohave County			0	0	0	0	0	0	0	716	716
North Baja LLC (formerly Jamar Produce) (72af M&I)	La Paz County	M&I/Ag	0.214	8	17	21	25	33	42	50	72	72
Roy, Edward P. & Anna R.	Yuma County			0	1	1	1	1	1	1	1	1
Shepard Water Company	Yuma County			4	8	9	11	15	19	23	33	33
City of Parker	La Paz County			45	91	113	136	181	226	271	390	390
Town of Quartzsite	La Paz County			0	0	0	0	0	43	167	492	492
Verizon (formerly Continental Telephone)	La Paz County			0	1	1	1	1	1	1	1	1
Cibola National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	326	3,336
Yuma Irrigation District (5,000af M&I)	Yuma County	M&I/Ag	0.152	0	0	0	0	0	0	0	120	1,226
National Park Service	Mohave County			0	0	0	0	0	0	0	18	181
Yuma Union High School	Yuma County			0	0	0	0	0	0	0	3	29
Union Pacific Railroad (formerly Southern Pacific Co.)	Yuma County			0	0	0	0	0	0	0	1	7
Kaman, Inc.	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	809	8,291
Department of Navy MCAS	Yuma County			0	0	0	0	0	0	0	51	522
Yuma County Water Users' Association (14,701af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95af M&I Conversion)	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma (cemetery)	Yuma County			0	0	0	0	0	0	0	0	0
Yuma Mesa Irrigation & Drainage District (10,000af M&I)	Yuma County	M&I/Ag	0.063	0	0	0	0	0	0	0	239	2,452
Desert Lawn Memorial Park	Yuma County			0	0	0	0	0	0	0	3	34
North Gila Valley Irrigation District (2,500af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0

Table Att. D-3
2026 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Wellton-Mohawk Irrigation and Drainage District (5,000af M&I)	Yuma County	M&I/Ag	0.018	0	0	0	0	0	0	0	120	1,226
Chandler (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	102	1,049
Gilbert (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	162	1,658
Glendale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	72	736
Mesa (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	66	677
Phoenix (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	120	1,226
Scottsdale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	2	25
Tempe (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	2	25
Department of Army - Yuma Proving Ground	Yuma County			0	0	0	0	0	0	0	18	186
Bureau of Reclamation - Davis Dam	Mohave County			0	0	0	0	0	0	0	0	0
Imperial National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	87	887
Havasu Lake National Wildlife Refuge (2004 over use of 7,777af)	Mohave County			0	0	0	0	0	0	0	116	1,187
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	0	0
City of Parker	La Paz County			0	0	0	0	0	0	0	0	0
Miller (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
Swan (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	0	0
Arizona M&I Subtotal:				2,821	5,688	7,123	9,369	14,006	18,686	23,623	40,897	63,418.86
M&I Summary by County	M&I per County											
Coconino County	1			0	0	0	0	0	0	2	16	16
Gila County	3			0	0	287	1,054	2,523	3,991	5,457	9,280	9,280
La Paz County	14			100	237	307	377	517	700	965	2,974	6,785
Maricopa County	36			15,614	46,344	63,608	93,778	151,573	209,351	267,031	418,001	422,625
Mohave County	20			2,654	5,318	6,651	8,759	13,074	17,389	21,878	34,748	35,982
Pima County	11			0	0	5,619	20,616	49,344	78,064	106,734	181,528	181,528
Pinal County	7			0	0	543	1,991	4,767	7,541	10,311	17,536	17,536
Yuma County	24			67	133	166	233	415	596	778	2,633	15,242
All Counties in CAP	1			17,664	52,430	59,171	59,171	59,171	59,171	59,171	59,171	59,171
(blank)	0			0	0	0	0	0	0	0	0	0
Total Arizona M&I:	117			36,099	104,462	136,351	185,979	281,383	376,803	472,326	725,886	748,165

Table Att. D-4

2027 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP M&I												
Apache Junction (AZ Water Co)	Pinal County			0	0	263	751	1,689	2,626	3,562	6,000	6,000
Avra Coop	Pima County			0	0	18	51	114	177	240	404	404
AZ-American (Agua Fria)	Maricopa County			0	0	485	1,389	3,122	4,855	6,585	11,093	11,093
AZ-American (Paradise Valley)	Maricopa County			0	0	141	404	909	1,414	1,918	3,231	3,231
AZ-American (Sun City)	Maricopa County			0	0	183	524	1,179	1,833	2,487	4,189	4,189
AZ-American (Sun City West)	Maricopa County			0	0	104	297	668	1,038	1,408	2,372	2,372
AZ State Land Dept.	Maricopa County			0	0	455	1,300	2,924	4,547	6,167	10,388	10,388
ASARCO (Ray Mine)	Pima County			0	0	459	1,314	2,955	4,596	6,233	10,500	10,500
Avondale	Maricopa County			0	0	222	636	1,430	2,224	3,016	5,081	5,081
B&F Investment, LLC	La Paz County			0	0	0	0	0	0	0	0	0
Berneil Water Co (Cave Creek)	Maricopa County			0	0	4	13	28	44	59	100	100
Buckeye	Maricopa County			0	0	1	2	4	5	7	13	13
Carefree Water Co	Maricopa County			0	0	37	106	239	372	505	850	850
Casa Grande (AZ Water Co)	Pinal County			0	0	238	681	1,532	2,382	3,231	5,442	5,442
Cave Creek Water Co	Maricopa County			0	0	105	301	677	1,053	1,428	2,406	2,406
CAGRD	Maricopa County			0	0	339	970	2,180	3,390	4,598	7,746	7,746
Chandler*	Maricopa County			1,597	3,651	4,303	5,007	6,360	7,712	9,061	12,676	13,574
Chandler Heights Citrus ID	Maricopa County			0	0	7	20	44	69	93	158	158
Chaparral City Water Co	Maricopa County			0	0	325	929	2,089	3,248	4,405	7,421	7,421
Circle City Water Co	Maricopa County			0	0	86	246	553	860	1,167	1,966	1,966
Comm. Water Co (Green Valley)	Pima County			0	0	63	179	402	625	848	1,429	1,429
Coolidge (AZ Water Co)	Pinal County			0	0	44	125	281	438	594	1,000	1,000
El Mirage	Maricopa County			0	0	11	32	71	111	151	254	254
Eloy	Pinal County			0	0	95	272	611	950	1,289	2,171	2,171
Florence	Pinal County			0	0	90	256	576	896	1,216	2,048	2,048
Flowing Wells ID	Pima County			0	0	95	273	613	953	1,292	2,177	2,177
Gilbert	Maricopa County			625	1,430	1,854	2,443	3,573	4,704	5,832	8,927	10,346
Glendale	Maricopa County			277	634	1,369	2,649	5,103	7,558	10,008	16,460	17,090
Goodyear	Maricopa County			0	0	470	1,345	3,023	4,701	6,377	10,742	10,742
Green Valley DWID	Pima County			0	0	53	150	338	525	712	1,200	1,200
H2O Water Co	Maricopa County			0	0	3	9	21	32	44	74	74
Marana	Pima County			0	0	1	3	7	10	14	24	24
Maricopa County Parks & Rec	Maricopa County			0	0	29	83	186	289	392	660	660
Mesa*	Maricopa County			2,259	5,164	7,229	10,350	16,341	22,331	28,310	43,953	44,532
MDWID	Pima County			0	0	529	1,514	3,404	5,294	7,180	12,095	12,095
Oro Valley	Pima County			0	0	451	1,290	2,900	4,510	6,117	10,305	10,305
Peoria	Maricopa County			0	0	1,104	3,159	7,103	11,045	14,981	25,236	25,236
Phelps Dodge Miami	Gila County			0	0	64	182	409	636	863	1,453	1,453
Phoenix*	Maricopa County			15,168	34,683	43,149	54,069	75,028	95,981	116,898	171,514	172,564
Phoenix Memorial Park	Maricopa County			0	0	2	5	12	18	25	42	42
Pine Water Co	Gila County			0	0	4	10	23	35	48	81	81
Queen Creek Water Co	Maricopa County			0	0	15	44	98	152	207	348	348
Rio Verde Utilities	Maricopa County			0	0	36	102	229	355	482	812	812
San Tan ID	Maricopa County			0	0	5	15	33	52	70	118	118
Scottsdale*	Maricopa County			1,345	3,076	5,617	9,917	18,170	26,420	34,656	56,118	56,139
Spanish Trail Water Co	Pima County			0	0	66	190	427	665	901	1,519	1,519
Superior	Pinal County			0	0	6	18	40	62	85	143	143
Surprise	Maricopa County			0	0	449	1,283	2,885	4,486	6,084	10,249	10,249
Tempe	Maricopa County			9	21	212	563	1,237	1,912	2,585	4,340	4,361
Tonto Hills Utility Co	Maricopa County			0	0	2	4	10	16	21	36	36
Tucson	Pima County			0	0	6,276	17,953	40,366	62,772	85,140	143,422	143,422
Vail Water Co	Pima County			0	0	41	116	261	406	551	929	929

Table Att. D-4

2027 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Valley Utilities Water Co	Maricopa County			0	0	5	16	35	55	74	125	125
Water Util. Comm. Fac. Dist. (AJ)	Pinal County			0	0	65	186	418	650	881	1,485	1,485
Water Util. Greater Buckeye	Maricopa County			0	0	1	3	6	9	13	22	22
Water Util. Greater Tonopah	Maricopa County			0	0	1	4	9	14	19	32	32
White Tank Sys. (AZ Water Co.)	Maricopa County			0	0	42	121	272	424	575	968	968
San Carlos (Phelps Dodge/Globe)	Gila County			0	0	397	1,136	2,553	3,971	5,386	9,073	9,073
State Reserved	All Counties in CAP			24,075	55,048	59,171	59,171	59,171	59,171	59,171	59,171	59,171
CAP M&I Subtotal				45,356	103,707	136,891	184,179	274,944	365,678	456,259	692,785	697,401.8
Arizona M&I												
Arizona State Land Department	Yuma County			0	0	0	43	159	275	390	693	693
Arizona State Parks Board - Contact Point	Mohave County			0	0	0	0	2	5	7	13	13
Arizona State Parks Board - Windsor Beach	Mohave County			0	0	0	0	0	0	2	20	20
Arizona-American Water Company	Mohave County			0	0	0	0	0	0	29	309	309
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	53	53
Bullhead City (includes 6,000 af subcontract)	Mohave County			0	0	77	901	2,550	4,198	5,847	10,163	10,163
Bureau of Land Management	La Paz County			0	0	0	0	0	0	0	851	851
Cibola Valley Irrigation & Drainage District******* (M&I: 300af)	La Paz County	M&I/Ag	0.039	5	44	63	82	121	160	199	300	300
City of Somerton (new contract)	Yuma County			57	114	142	170	227	283	340	488	488
City of Yuma (Smucker Park)	Yuma County			0	0	0	0	0	0	0	0	0
Crystal Beach Water Conservation District	Mohave County			0	10	15	20	30	40	50	76	76
Desert Lawn Memorial Park Association, Inc.	Yuma County			0	0	0	0	0	0	0	15	15
Ehrenburg Improvement District	La Paz County			41	83	104	124	166	208	249	358	358
Fisher's Landing Water and Sewer Works, LLC	Yuma County			4	8	10	12	16	20	24	34	34
Gold Dome Mining Corporation	Yuma County			0	0	0	0	0	0	0	0	0
Gold Standard Mines Corporation	Mohave County			0	0	0	0	0	0	0	0	0
Golden Shores Water Conservation District	Mohave County			0	0	0	0	0	0	148	554	554
Hillcrest Water Company	La Paz County			0	3	6	10	16	22	29	45	45
Lake Havasu City (includes 6,000 af subcontract)	Mohave County			1,811	3,623	4,528	5,434	7,245	9,057	10,868	15,611	15,611
Marble Canyon Company, Inc.	Coconino County			0	0	0	0	0	0	2	16	16
Martinez Lake Cabin Sites (recommended)	Yuma County			2	3	4	5	7	9	10	15	15
McAlister, Maurice L.	Mohave County			0	0	0	0	0	0	0	4	4
Mohave County Water Authority (recommended 3,500af)	Mohave County			264	528	660	792	1,056	1,320	1,584	2,275	2,275
Mohave Valley Irrigation and Drainage District (5,000af M&I)	Mohave County	M&I/Ag	0.264	580	1,160	1,450	1,740	2,321	2,901	3,481	5,000	5,000
Mohave Water Conservation District (includes 3,000 af subcontract)	Mohave County			0	0	0	0	0	0	0	724	724
North Baja LLC (formerly Jamar Produce) (72af M&I)	La Paz County	M&I/Ag	0.214	8	17	21	25	33	42	50	72	72
Roy, Edward P. & Anna R.	Yuma County			0	1	1	1	1	1	1	1	1
Shepard Water Company	Yuma County			4	8	9	11	15	19	23	33	33
City of Parker	La Paz County			45	91	113	136	181	226	272	390	390
Town of Quartzsite	La Paz County			0	0	0	0	0	50	174	499	499
Verizon (formerly Continental Telephone)	La Paz County			0	1	1	1	1	1	1	1	1
Cibola National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	348	3,542
Yuma Irrigation District (5,000af M&I)	Yuma County	M&I/Ag	0.152	0	0	0	0	0	0	0	120	1,225
National Park Service	Mohave County			0	0	0	0	0	0	0	18	181
Yuma Union High School	Yuma County			0	0	0	0	0	0	0	3	29
Union Pacific Railroad (formerly Southern Pacific Co.)	Yuma County			0	0	0	0	0	0	0	1	7
Kaman, Inc.	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	828	8,424
Department of Navy MCAS	Yuma County			0	0	0	0	0	0	0	51	522
Yuma County Water Users' Association (14,701af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95af M&I Conversion)	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma (cemetery)	Yuma County			0	0	0	0	0	0	0	0	0
Yuma Mesa Irrigation & Drainage District (10,000af M&I)	Yuma County	M&I/Ag	0.063	0	0	0	0	0	0	0	241	2,450
Desert Lawn Memorial Park	Yuma County			0	0	0	0	0	0	0	3	34
North Gila Valley Irrigation District (2,500af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0

Table Att. D-4

2027 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Wellton-Mohawk Irrigation and Drainage District (5,000af M&I)	Yuma County	M&I/Ag	0.018	0	0	0	0	0	0	0	120	1,225
Chandler (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	103	1,048
Gilbert (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	163	1,657
Glendale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	72	735
Mesa (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	66	676
Phoenix (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	120	1,225
Scottsdale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	2	24
Tempe (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	2	24
Department of Army - Yuma Proving Ground	Yuma County			0	0	0	0	0	0	0	18	186
Bureau of Reclamation - Davis Dam	Mohave County			0	0	0	0	0	0	0	0	0
Imperial National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	87	886
Havasu Lake National Wildlife Refuge (2004 over use of 7,777af)	Mohave County			0	0	0	0	0	0	0	117	1,186
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	0	0
City of Parker	La Paz County			0	0	0	0	0	0	0	0	0
Miller (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
Swan (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	0	0
Arizona M&I Subtotal:				2,822	5,691	7,204	9,508	14,146	18,835	23,778	41,100	63,900.08
M&I Summary by County	M&I per County											
Coconino County	1			0	0	0	0	0	0	2	16	16
Gila County	3			0	0	464	1,328	2,985	4,642	6,296	10,606	10,606
La Paz County	14			100	237	308	378	518	708	973	3,005	6,998
Maricopa County	36			21,281	48,659	68,403	98,358	155,853	213,328	270,706	420,718	425,335
Mohave County	20			2,655	5,321	6,731	8,888	13,204	17,521	22,016	34,885	36,117
Pima County	11			0	0	8,052	23,033	51,788	80,533	109,229	184,002	184,002
Pinal County	7			0	0	800	2,289	5,147	8,004	10,856	18,288	18,288
Yuma County	24			67	133	166	242	424	606	787	2,665	15,380
All Counties in CAP	1			24,075	55,048	59,171	59,171	59,171	59,171	59,171	59,171	59,171
(blank)	0			0	0	0	0	0	0	0	0	0
Total Arizona M&I:	117			48,178	109,399	144,095	193,686	289,090	384,513	480,037	733,355	755,912

Table Att. D-5

2040 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP M&I												
Apache Junction (AZ Water Co)	Pinal County			0	350	850	1,284	2,136	2,988	3,835	6,000	6,000
Avra Coop	Pima County			0	47	114	173	288	402	516	808	808
AZ-American (Agua Fria)	Maricopa County			0	647	1,571	2,374	3,950	5,524	7,089	11,093	11,093
AZ-American (Paradise Valley)	Maricopa County			0	188	458	691	1,150	1,609	2,065	3,231	3,231
AZ-American (Sun City)	Maricopa County			0	244	593	896	1,491	2,086	2,677	4,189	4,189
AZ-American (Sun City West)	Maricopa County			0	138	336	508	845	1,181	1,516	2,372	2,372
AZ State Land Dept.	Maricopa County			0	1,170	2,844	4,296	7,148	9,997	12,830	20,076	20,076
ASARCO (Ray Mine)	Pima County			0	1,224	2,975	4,494	7,477	10,457	13,421	21,000	21,000
Avondale	Maricopa County			0	316	767	1,159	1,928	2,697	3,461	5,416	5,416
B&F Investment, LLC	La Paz County			0	0	0	0	0	0	0	0	0
Berneil Water Co (Cave Creek)	Maricopa County			0	12	28	43	71	100	128	200	200
Buckeye	Maricopa County			0	1	4	5	9	12	16	25	25
Carefree Water Co	Maricopa County			0	76	184	278	463	647	831	1,300	1,300
Casa Grande (AZ Water Co)	Pinal County			0	518	1,258	1,901	3,163	4,424	5,678	8,884	8,884
Cave Creek Water Co	Maricopa County			0	140	341	515	857	1,198	1,538	2,406	2,406
CAGRD	Maricopa County			0	452	1,097	1,658	2,758	3,857	4,950	7,746	7,746
Chandler*	Maricopa County			1,565	3,085	3,807	4,433	5,662	6,890	8,112	11,344	12,232
Chandler Heights Citrus ID	Maricopa County			0	18	45	67	112	157	201	315	315
Chaparral City Water Co	Maricopa County			0	519	1,262	1,907	3,172	4,436	5,694	8,909	8,909
Circle City Water Co	Maricopa County			0	229	557	841	1,400	1,958	2,513	3,932	3,932
Comm. Water Co (Green Valley)	Pima County			0	167	405	612	1,018	1,423	1,827	2,858	2,858
Coolidge (AZ Water Co)	Pinal County			0	117	283	428	712	996	1,278	2,000	2,000
El Mirage	Maricopa County			0	30	72	109	181	253	325	508	508
Eloy	Pinal County			0	127	308	465	773	1,081	1,387	2,171	2,171
Florence	Pinal County			0	119	290	438	729	1,020	1,309	2,048	2,048
Flowing Wells ID	Pima County			0	254	617	932	1,550	2,168	2,783	4,354	4,354
Gilbert	Maricopa County			613	1,433	2,036	2,559	3,587	4,614	5,635	8,418	9,821
Glendale	Maricopa County			272	1,453	2,890	4,137	6,585	9,031	11,464	17,761	18,383
Goodyear	Maricopa County			0	626	1,522	2,299	3,825	5,349	6,865	10,742	10,742
Green Valley DWID	Pima County			0	111	269	407	676	946	1,214	1,900	1,900
H2O Water Co	Maricopa County			0	9	21	31	52	73	94	147	147
Marana	Pima County			0	3	7	10	17	23	30	47	47
Maricopa County Parks & Rec	Maricopa County			0	39	94	142	237	331	425	665	665
Mesa*	Maricopa County			2,215	6,188	9,814	12,962	19,141	25,314	31,454	47,225	47,798
MDWID	Pima County			0	785	1,907	2,880	4,792	6,702	8,602	13,460	13,460
Oro Valley	Pima County			0	601	1,460	2,205	3,669	5,131	6,586	10,305	10,305
Peoria	Maricopa County			0	1,471	3,575	5,401	8,985	12,566	16,128	25,236	25,236
Phelps Dodge Miami	Gila County			0	169	412	622	1,035	1,447	1,857	2,906	2,906
Phoenix*	Maricopa County			14,871	32,339	43,519	53,224	72,273	91,305	110,236	158,768	159,806
Phoenix Memorial Park	Maricopa County			0	5	12	18	30	42	54	84	84
Pine Water Co	Gila County			0	9	23	34	57	80	103	161	161
Queen Creek Water Co	Maricopa County			0	20	49	74	124	173	222	348	348
Rio Verde Utilities	Maricopa County			0	47	115	174	289	404	519	812	812
San Tan ID	Maricopa County			0	14	33	51	84	118	151	236	236
Scottsdale*	Maricopa County			1,319	5,253	9,655	13,476	20,977	28,471	35,925	54,987	55,008
Spanish Trail Water Co	Pima County			0	177	430	650	1,081	1,512	1,941	3,037	3,037
Superior	Pinal County			0	17	40	61	101	142	182	285	285
Surprise	Maricopa County			0	597	1,452	2,193	3,649	5,103	6,550	10,249	10,249
Tempe	Maricopa County			9	267	626	939	1,551	2,164	2,773	4,333	4,353
Tonto Hills Utility Co	Maricopa County			0	4	10	15	25	35	45	71	71
Tucson	Pima County			0	8,404	20,422	30,854	51,331	71,790	92,139	144,172	144,172
Vail Water Co	Pima County			0	108	263	397	661	925	1,187	1,857	1,857

Table Att. D-5

2040 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Valley Utilities Water Co	Maricopa County			0	15	35	54	89	124	160	250	250
Water Util. Comm. Fac. Dist. (AJ)	Pinal County			0	170	413	625	1,039	1,454	1,866	2,919	2,919
Water Util. Greater Buckeye	Maricopa County			0	3	6	9	15	21	27	43	43
Water Util. Greater Tonopah	Maricopa County			0	4	9	14	23	32	41	64	64
White Tank Sys. (AZ Water Co.)	Maricopa County			0	56	137	207	345	482	619	968	968
San Carlos (Phelps Dodge/Globe)	Gila County			0	1,058	2,570	3,883	6,460	9,035	11,596	18,145	18,145
State Reserved	All Counties in CAP			34,811	57,401	57,401	57,401	57,401	57,401	57,401	57,401	57,401
CAP M&I Subtotal				55,675	129,044	182,292	228,518	319,251	409,903	500,070	731,186	735,751.7
Arizona M&I												
Arizona State Land Department	Yuma County			0	16	74	132	248	365	481	780	780
Arizona State Parks Board - Contact Point	Mohave County			0	0	0	0	2	5	7	13	13
Arizona State Parks Board - Windsor Beach	Mohave County			0	0	0	0	0	0	3	20	20
Arizona-American Water Company	Mohave County			0	0	0	0	0	0	36	313	313
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	53	53
Bullhead City (includes 6,000 af subcontract)	Mohave County			0	158	987	1,816	3,473	5,131	6,788	11,051	11,051
Bureau of Land Management	La Paz County			0	0	0	0	0	0	0	851	851
Cibola Valley Irrigation & Drainage District******* (M&I: 300af)	La Paz County	M&I/Ag	0.039	5	44	64	83	122	161	200	300	300
City of Somerton (new contract)	Yuma County			57	114	143	171	228	285	342	488	488
City of Yuma (Smucker Park)	Yuma County			0	0	0	0	0	0	0	0	0
Crystal Beach Water Conservation District	Mohave County			5	15	20	25	35	45	55	81	81
Desert Lawn Memorial Park Association, Inc.	Yuma County			0	0	0	0	0	0	0	15	15
Ehrenburg Improvement District	La Paz County			42	83	104	125	167	209	251	358	358
Fisher's Landing Water and Sewer Works, LLC	Yuma County			4	8	10	12	16	20	24	34	34
Gold Dome Mining Corporation	Yuma County			0	0	0	0	0	0	0	0	0
Gold Standard Mines Corporation	Mohave County			0	0	0	0	0	0	0	0	0
Golden Shores Water Conservation District	Mohave County			0	0	0	0	0	34	190	592	592
Hillcrest Water Company	La Paz County			0	6	9	12	19	25	31	48	48
Lake Havasu City (includes 6,000 af subcontract)	Mohave County			1,821	3,642	4,553	5,463	7,285	9,106	10,927	15,611	15,611
Marble Canyon Company, Inc.	Coconino County			0	0	0	0	0	0	2	16	16
Martinez Lake Cabin Sites (recommended)	Yuma County			2	3	4	5	7	9	10	15	15
McAlister, Maurice L.	Mohave County			0	0	0	0	0	0	0	4	4
Mohave County Water Authority (recommended 3,500af)	Mohave County			265	531	663	796	1,061	1,327	1,592	2,275	2,275
Mohave Valley Irrigation and Drainage District (5,000af M&I)	Mohave County	M&I/Ag	0.264	583	1,167	1,458	1,750	2,333	2,917	3,500	5,000	5,000
Mohave Water Conservation District (includes 3,000 af subcontract)	Mohave County			0	0	0	0	0	0	0	788	788
North Baja LLC (formerly Jamar Produce) (72af M&I)	La Paz County	M&I/Ag	0.214	8	17	21	25	34	42	50	72	72
Roy, Edward P. & Anna R.	Yuma County			0	1	1	1	1	1	1	1	1
Shepard Water Company	Yuma County			4	8	9	11	15	19	23	33	33
City of Parker	La Paz County			46	91	114	137	182	228	273	390	390
Town of Quartzsite	La Paz County			0	0	0	0	0	98	223	544	544
Verizon (formerly Continental Telephone)	La Paz County			0	1	1	1	1	1	1	1	1
Cibola National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	455	4,171
Yuma Irrigation District (5,000af M&I)	Yuma County	M&I/Ag	0.152	0	0	0	0	0	0	0	134	1,226
National Park Service	Mohave County			0	0	0	0	0	0	0	20	181
Yuma Union High School	Yuma County			0	0	0	0	0	0	0	3	29
Union Pacific Railroad (formerly Southern Pacific Co.)	Yuma County			0	0	0	0	0	0	0	1	7
Kaman, Inc.	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	1,124	10,309
Department of Navy MCAS	Yuma County			0	0	0	0	0	0	0	57	522
Yuma County Water Users' Association (14,701af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95af M&I Conversion)	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma (cemetery)	Yuma County			0	0	0	0	0	0	0	0	0
Yuma Mesa Irrigation & Drainage District (10,000af M&I)	Yuma County	M&I/Ag	0.063	0	0	0	0	0	0	0	267	2,452
Desert Lawn Memorial Park	Yuma County			0	0	0	0	0	0	0	4	34
North Gila Valley Irrigation District (2,500af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0

Table Att. D-5
2040 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Wellton-Mohawk Irrigation and Drainage District (5,000af M&I)	Yuma County	M&I/Ag	0.018	0	0	0	0	0	0	0	134	1,226
Chandler (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	114	1,049
Gilbert (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	181	1,658
Glendale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	80	736
Mesa (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	74	677
Phoenix (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	134	1,226
Scottsdale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	3	25
Tempe (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	3	25
Department of Army - Yuma Proving Ground	Yuma County			0	0	0	0	0	0	0	20	186
Bureau of Reclamation - Davis Dam	Mohave County			0	0	0	0	0	0	0	0	0
Imperial National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	97	887
Havasu Lake National Wildlife Refuge (2004 over use of 7,777af)	Mohave County			0	0	0	0	0	0	0	129	1,187
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	0	0
City of Parker	La Paz County			0	0	0	0	0	0	0	0	0
Miller (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
Swan (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	0	0
Arizona M&I Subtotal:				2,843	5,904	8,234	10,565	15,229	20,025	25,010	42,777	67,557.28
M&I Summary by County	M&I per County											
Coconino County	1			0	0	0	0	0	0	2	16	16
Gila County	3			0	1,237	3,005	4,540	7,552	10,562	13,556	21,212	21,212
La Paz County	14			101	242	312	383	524	763	1,029	3,168	7,674
Maricopa County	36			20,864	57,109	89,576	117,761	173,083	228,356	283,333	424,468	429,034
Mohave County	20			2,675	5,513	7,682	9,850	14,190	18,564	23,099	35,897	37,116
Pima County	11			0	11,880	28,867	43,615	72,560	101,480	130,245	203,798	203,798
Pinal County	7			0	1,417	3,443	5,202	8,654	12,104	15,534	24,307	24,307
Yuma County	24			67	149	241	332	515	698	880	3,108	17,357
All Counties in CAP	1			34,811	57,401	57,401	57,401	57,401	57,401	57,401	57,401	57,401
(blank)	0			0	0	0	0	0	0	0	0	0
Total Arizona M&I:	117			58,518	134,948	190,526	239,083	334,479	429,928	525,080	773,374	797,915

Table Att. D-6

2060 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
CAP M&I												
Apache Junction (AZ Water Co)	Pinal County			0	708	1,214	1,618	2,408	3,196	3,984	6,000	6,000
Avra Coop	Pima County			0	95	164	218	324	430	537	808	808
AZ-American (Agua Fria)	Maricopa County			0	1,310	2,245	2,991	4,451	5,909	7,366	11,093	11,093
AZ-American (Paradise Valley)	Maricopa County			0	381	654	871	1,296	1,721	2,145	3,231	3,231
AZ-American (Sun City)	Maricopa County			0	495	848	1,130	1,681	2,232	2,782	4,189	4,189
AZ-American (Sun City West)	Maricopa County			0	280	480	640	952	1,264	1,575	2,372	2,372
AZ State Land Dept.	Maricopa County			0	2,370	4,063	5,414	8,056	10,695	13,331	20,076	20,076
ASARCO (Ray Mine)	Pima County			0	2,479	4,250	5,663	8,427	11,187	13,944	21,000	21,000
Avondale	Maricopa County			0	639	1,096	1,461	2,173	2,885	3,596	5,416	5,416
B&F Investment, LLC	La Paz County			0	0	0	0	0	0	0	0	0
Berneil Water Co (Cave Creek)	Maricopa County			0	24	40	54	80	107	133	200	200
Buckeye	Maricopa County			0	3	5	7	10	13	17	25	25
Carefree Water Co	Maricopa County			0	153	263	351	522	693	863	1,300	1,300
Casa Grande (AZ Water Co)	Pinal County			0	1,049	1,798	2,396	3,565	4,733	5,899	8,884	8,884
Cave Creek Water Co	Maricopa County			0	284	487	649	965	1,282	1,598	2,406	2,406
CAGRD	Maricopa County			0	914	1,568	2,089	3,108	4,126	5,143	7,746	7,746
Chandler*	Maricopa County			451	1,956	2,935	3,716	5,243	6,769	8,293	12,301	13,188
Chandler Heights Citrus ID	Maricopa County			0	37	64	85	126	168	209	315	315
Chaparral City Water Co	Maricopa County			0	1,052	1,803	2,402	3,575	4,746	5,916	8,909	8,909
Circle City Water Co	Maricopa County			0	464	796	1,060	1,578	2,095	2,611	3,932	3,932
Comm. Water Co (Green Valley)	Pima County			0	337	578	771	1,147	1,522	1,898	2,858	2,858
Coolidge (AZ Water Co)	Pinal County			0	236	405	539	803	1,065	1,328	2,000	2,000
El Mirage	Maricopa County			0	60	103	137	204	271	337	508	508
Eloy	Pinal County			0	256	439	585	871	1,157	1,442	2,171	2,171
Florence	Pinal County			0	242	414	552	822	1,091	1,360	2,048	2,048
Flowing Wells ID	Pima County			0	514	881	1,174	1,747	2,319	2,891	4,354	4,354
Gilbert	Maricopa County			702	1,767	2,377	2,864	3,816	4,767	5,717	8,319	9,723
Glendale	Maricopa County			311	2,440	3,893	5,053	7,321	9,587	11,850	17,717	18,340
Goodyear	Maricopa County			0	1,268	2,174	2,897	4,310	5,722	7,133	10,742	10,742
Green Valley DWID	Pima County			0	224	385	512	762	1,012	1,262	1,900	1,900
H2O Water Co	Maricopa County			0	17	30	40	59	78	98	147	147
Marana	Pima County			0	6	10	13	19	25	31	47	47
Maricopa County Parks & Rec	Maricopa County			0	79	135	179	267	354	442	665	665
Mesa*	Maricopa County			291	6,095	10,178	13,437	19,810	26,175	32,534	48,875	49,448
MDWID	Pima County			0	1,589	2,724	3,630	5,401	7,170	8,937	13,460	13,460
Oro Valley	Pima County			0	1,217	2,085	2,779	4,135	5,490	6,843	10,305	10,305
Peoria	Maricopa County			0	2,979	5,107	6,805	10,126	13,443	16,757	25,236	25,236
Phelps Dodge Miami	Gila County			0	343	588	784	1,166	1,548	1,930	2,906	2,906
Phoenix*	Maricopa County			527	20,785	35,142	46,600	69,006	91,385	113,743	171,076	172,114
Phoenix Memorial Park	Maricopa County			0	10	17	23	34	45	56	84	84
Pine Water Co	Gila County			0	19	33	43	65	86	107	161	161
Queen Creek Water Co	Maricopa County			0	41	70	94	140	185	231	348	348
Rio Verde Utilities	Maricopa County			0	96	164	219	326	433	539	812	812
San Tan ID	Maricopa County			0	28	48	64	95	126	157	236	236
Scottsdale*	Maricopa County			11	6,636	11,366	15,140	22,522	29,895	37,260	56,109	56,130
Spanish Trail Water Co	Pima County			0	359	615	819	1,219	1,618	2,017	3,037	3,037
Superior	Pinal County			0	34	58	77	114	152	189	285	285
Surprise	Maricopa County			0	1,210	2,074	2,764	4,113	5,460	6,805	10,249	10,249
Tempe	Maricopa County			11	523	887	1,177	1,745	2,312	2,879	4,331	4,352
Tonto Hills Utility Co	Maricopa County			0	8	14	19	28	38	47	71	71
Tucson	Pima County			0	17,020	29,177	38,879	57,851	76,801	95,732	144,172	144,172
Vail Water Co	Pima County			0	219	376	501	745	989	1,233	1,857	1,857

Table Att. D-6

2060 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Valley Utilities Water Co	Maricopa County			0	30	51	67	100	133	166	250	250
Water Util. Comm. Fac. Dist. (AJ)	Pinal County			0	345	591	787	1,171	1,555	1,938	2,919	2,919
Water Util. Greater Buckeye	Maricopa County			0	5	9	12	17	23	29	43	43
Water Util. Greater Tonopah	Maricopa County			0	8	13	17	26	34	42	64	64
White Tank Sys. (AZ Water Co.)	Maricopa County			0	114	196	261	388	516	643	968	968
San Carlos (Phelps Dodge/Globe)	Gila County			0	2,142	3,672	4,893	7,281	9,666	12,049	18,145	18,145
State Reserved	All Counties in CAP			39,859	51,817	51,817	51,817	51,817	51,817	51,817	51,817	51,817
CAP M&I Subtotal				42,162	135,811	193,665	239,839	330,131	420,314	510,408	741,496	746,061.6
Arizona M&I												
Arizona State Land Department	Yuma County			0	16	74	132	248	365	481	780	780
Arizona State Parks Board - Contact Point	Mohave County			0	0	0	0	2	5	7	13	13
Arizona State Parks Board - Windsor Beach	Mohave County			0	0	0	0	0	0	3	20	20
Arizona-American Water Company	Mohave County			0	0	0	0	0	0	41	318	318
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	53	53
Bullhead City (includes 6,000 af subcontract)	Mohave County			0	821	1,650	2,479	4,136	5,794	7,451	11,714	11,714
Bureau of Land Management	La Paz County			0	0	0	0	0	0	0	851	851
Cibola Valley Irrigation & Drainage District******* (M&I: 300af)	La Paz County	M&I/Ag	0.039	5	44	64	83	122	161	200	300	300
City of Somerton (new contract)	Yuma County			57	114	143	171	228	285	342	488	488
City of Yuma (Smucker Park)	Yuma County			0	0	0	0	0	0	0	0	0
Crystal Beach Water Conservation District	Mohave County			6	16	21	26	36	46	56	82	82
Desert Lawn Memorial Park Association, Inc.	Yuma County			0	0	0	0	0	0	0	15	15
Ehrenburg Improvement District	La Paz County			42	83	104	125	167	209	251	358	358
Fisher's Landing Water and Sewer Works, LLC	Yuma County			4	8	10	12	16	20	24	34	34
Gold Dome Mining Corporation	Yuma County			0	0	0	0	0	0	0	0	0
Gold Standard Mines Corporation	Mohave County			0	0	0	0	0	0	0	0	0
Golden Shores Water Conservation District	Mohave County			0	0	0	0	0	69	225	627	627
Hillcrest Water Company	La Paz County			1	7	10	13	20	26	33	49	49
Lake Havasu City (includes 6,000 af subcontract)	Mohave County			1,821	3,642	4,553	5,463	7,285	9,106	10,927	15,611	15,611
Marble Canyon Company, Inc.	Coconino County			0	0	0	0	0	0	2	16	16
Martinez Lake Cabin Sites (recommended)	Yuma County			2	3	4	5	7	9	10	15	15
McAlister, Maurice L.	Mohave County			0	0	0	0	0	0	0	4	4
Mohave County Water Authority (recommended 3,500af)	Mohave County			265	531	663	796	1,061	1,327	1,592	2,275	2,275
Mohave Valley Irrigation and Drainage District (5,000af M&I)	Mohave County	M&I/Ag	0.264	583	1,167	1,458	1,750	2,333	2,917	3,500	5,000	5,000
Mohave Water Conservation District (includes 3,000 af subcontract)	Mohave County			0	0	0	0	0	0	0	835	835
North Baja LLC (formerly Jamar Produce) (72af M&I)	La Paz County	M&I/Ag	0.214	8	17	21	25	34	42	50	72	72
Roy, Edward P. & Anna R.	Yuma County			0	1	1	1	1	1	1	1	1
Shepard Water Company	Yuma County			4	8	9	11	15	19	23	33	33
City of Parker	La Paz County			46	91	114	137	182	228	273	390	390
Town of Quartzsite	La Paz County			0	0	0	0	0	110	235	556	556
Verizon (formerly Continental Telephone)	La Paz County			0	1	1	1	1	1	1	1	1
Cibola National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	455	4,171
Yuma Irrigation District (5,000af M&I)	Yuma County	M&I/Ag	0.152	0	0	0	0	0	0	0	134	1,226
National Park Service	Mohave County			0	0	0	0	0	0	0	20	181
Yuma Union High School	Yuma County			0	0	0	0	0	0	0	3	29
Union Pacific Railroad (formerly Southern Pacific Co.)	Yuma County			0	0	0	0	0	0	0	1	7
Kaman, Inc.	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	1,123	10,305
Department of Navy MCAS	Yuma County			0	0	0	0	0	0	0	57	522
Yuma County Water Users' Association (14,701af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0
Yuma Area Office (489.95af M&I Conversion)	Yuma County			0	0	0	0	0	0	0	0	0
City of Yuma (cemetery)	Yuma County			0	0	0	0	0	0	0	0	0
Yuma Mesa Irrigation & Drainage District (10,000af M&I)	Yuma County	M&I/Ag	0.063	0	0	0	0	0	0	0	267	2,452
Desert Lawn Memorial Park	Yuma County			0	0	0	0	0	0	0	4	34
North Gila Valley Irrigation District (2,500af M&I)	Yuma County	M&I/Ag	0.000	0	0	0	0	0	0	0	0	0

Table Att. D-6

2060 M&I Shortages (Based on Consumptive Use)

	County	Split C	Ratio	200000	400000	500000	600000	800000	1000000	1200000	1800000	2500000
Wellton-Mohawk Irrigation and Drainage District (5,000af M&I)	Yuma County	M&I/Ag	0.018	0	0	0	0	0	0	0	134	1,226
Chandler (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	114	1,049
Gilbert (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	181	1,658
Glendale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	80	736
Mesa (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	74	677
Phoenix (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	134	1,226
Scottsdale (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	3	25
Tempe (Salt River Pima-Maricopa Exchange)****	Maricopa			0	0	0	0	0	0	0	3	25
Department of Army - Yuma Proving Ground	Yuma County			0	0	0	0	0	0	0	20	186
Bureau of Reclamation - Davis Dam	Mohave County			0	0	0	0	0	0	0	0	0
Imperial National Wildlife Refuge	La Paz County			0	0	0	0	0	0	0	97	887
Havasu Lake National Wildlife Refuge (2004 over use of 7,777af)	Mohave County			0	0	0	0	0	0	0	129	1,187
Brooke Water Company (formerly Graham)	La Paz County			0	0	0	0	0	0	0	0	0
City of Parker	La Paz County			0	0	0	0	0	0	0	0	0
Miller (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
Swan (in MVIDD)	Mohave County			0	0	0	0	0	0	0	0	0
City of Yuma	Yuma County			0	0	0	0	0	0	0	0	0
Arizona M&I Subtotal:				2,844	6,569	8,899	11,230	15,894	20,737	25,728	43,541	68,317.66
M&I Summary by County	M&I per County											
Coconino County	1			0	0	0	0	0	0	2	16	16
Gila County	3			0	2,504	4,293	5,720	8,512	11,300	14,085	21,212	21,212
La Paz County	14			102	243	313	384	525	776	1,042	3,181	7,688
Maricopa County	36			2,303	54,561	91,393	120,788	178,271	235,685	293,041	440,362	444,928
Mohave County	20			2,676	6,177	8,346	10,514	14,854	19,263	23,803	36,648	37,867
Pima County	11			0	24,059	41,243	54,958	81,777	108,564	135,324	203,798	203,798
Pinal County	7			0	2,870	4,919	6,555	9,754	12,948	16,140	24,307	24,307
Yuma County	24			67	149	241	332	515	698	880	3,108	17,353
All Counties in CAP	1			39,859	51,817	51,817	51,817	51,817	51,817	51,817	51,817	51,817
(blank)	0			0	0	0	0	0	0	0	0	0
Total Arizona M&I:	117			45,006	142,380	202,565	251,069	346,024	441,051	536,136	784,448	808,985

Attachment E

Regional Summary of Distribution of Shortages (2008-2060)

This attachment to Appendix G contains tables produced by the Shortage Allocation Model that provide a summary of the distribution of shortages by priority within the three Lower Division states (Arizona, California, and Nevada) and also to Mexico, for the years 2008, 2017, 2026, 2027, 2040, and 2060.

Table Att. E-1

2008 Regional Summary of Shortages (Based on Consumptive Use)

	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Mexico	33,333	66,667	83,333	100,000	133,333	166,667	200,000	300,000	416,667
Nevada	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Surplus Water - SNWA	0	0	0	0	0	0	0	0	0
9th Priority (SNWA - Balance & Unused)	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	70,914
8th Priority (SNWA & Big Bend)	0	0	0	0	0	0	0	0	12,419
7th Priority (Boy Scouts, BOR, NV Dept of…)	0	0	0	0	0	0	0	0	0
6th Priority (Las Vegas Valley Water District)	0	0	0	0	0	0	0	0	0
5th Priority (PABCO & Lakeview Co.)	0	0	0	0	0	0	0	0	0
4th Priority (Henderson & Basic Management)	0	0	0	0	0	0	0	0	0
3rd Priority (Boulder City)	0	0	0	0	0	0	0	0	0
2nd Priority (Lake Mead National Rec Area)	0	0	0	0	0	0	0	0	0
1st Priority (PPR's: LMNRA & Fort Mohave)	0	0	0	0	0	0	0	0	0
SUBTOTAL	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Arizona	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,440,000	1,587,484
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	4,374	9,879	13,423	16,991	24,348	32,285	41,203	70,728	72,175
4th Priority (CAP)*	155,626	310,121	386,577	463,009	615,652	767,715	918,797	1,369,272	1,389,871
CAP 5: Arizona Ground Water Bank*	147,844	294,614	328,635	328,635	328,635	328,635	328,635	328,635	328,635
CAP 4: Excess Water for Agriculture*	0	0	38,611	111,222	256,233	400,000	400,000	400,000	400,000
CAP 3: Agriculture*	0	0	0	0	0	94	9,026	9,026	9,026
CAP 3: Tribes*	0	0	0	0	0	21	2,000	2,000	2,000
CAP 3: M&I*	0	0	0	0	0	578	55,277	55,277	55,277
CAP 2: Tribes*	0	0	0	0	0	0	0	125,115	132,083
CAP 2: M&I*	0	0	0	0	0	0	77,918	376,404	388,855
2/3 Priority (includes CAP 1)	0	0	0	0	0	0	0	0	125,438
CAP 1: Tribes*	0	0	0	0	0	0	0	0	9,857
CAP 1: M&I*	0	0	0	0	0	0	0	0	4,337
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,440,000	1,587,484
California	0	0	0	0	0	0	0	0	412,516
Surplus (BLM, Needles, Coachella, Navy, MWD)	0	0	0	0	0	0	0	0	0
7th Priority (unused & surplus - Agriculture)	0	0	0	0	0	0	0	0	0
6th Priority (unused & surplus - IID, CVWD, PVID)	0	0	0	0	0	0	0	0	0
5th Priority (unused & surplus - MWD)	0	0	0	0	0	0	0	0	0
4th Priority (MWD)	0	0	0	0	0	0	0	0	412,516
3rd Priority (IID, CVWD, PVID)	0	0	0	0	0	0	0	0	0
2nd Priority (Reservation Division)	0	0	0	0	0	0	0	0	0
1st Priority (PVID)	0	0	0	0	0	0	0	0	0
Present Perfected Rights (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	0	0	0	0	0	0	0	0	412,516
TOTAL	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000

*CAP losses are not displayed to CAP as a whole, however losses are accounted for in the shortage distribution within CAP.

Table Att. E-2

2017 Regional Summary of Shortages (Based on Consumptive Use)

	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Mexico	33,333	66,667	83,333	100,000	133,333	166,667	200,000	300,000	416,667
Nevada	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Surplus Water - SNWA	0	0	0	0	0	0	0	0	0
9th Priority (SNWA - Balance & Unused)	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	70,914
8th Priority (SNWA & Big Bend)	0	0	0	0	0	0	0	0	12,419
7th Priority (Boy Scouts, BOR, NV Dept of…)	0	0	0	0	0	0	0	0	0
6th Priority (Las Vegas Valley Water District)	0	0	0	0	0	0	0	0	0
5th Priority (PABCO & Lakeview Co.)	0	0	0	0	0	0	0	0	0
4th Priority (Henderson & Basic Management)	0	0	0	0	0	0	0	0	0
3rd Priority (Boulder City)	0	0	0	0	0	0	0	0	0
2nd Priority (Lake Mead National Rec Area)	0	0	0	0	0	0	0	0	0
1st Priority (PPR's: LMNRA & Fort Mohave)	0	0	0	0	0	0	0	0	0
SUBTOTAL	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Arizona	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,397,578	1,533,925
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	6,222	14,019	17,921	21,862	30,992	40,787	50,788	79,350	79,350
4th Priority (CAP)*	153,778	305,981	382,079	458,138	609,008	759,213	909,212	1,304,575	1,304,575
CAP 5: Arizona Ground Water Bank*	0	0	0	0	0	0	0	0	0
CAP 4: Excess Water for Agriculture*	146,088	277,891	277,891	277,891	277,891	277,891	277,891	277,891	277,891
CAP 3: Agriculture*	0	998	6,637	9,026	9,026	9,026	9,026	9,026	9,026
CAP 3: Tribes*	0	2,576	17,134	23,300	23,300	23,300	23,300	23,300	23,300
CAP 3: M&I*	0	9,216	61,311	83,375	83,375	83,375	83,375	83,375	83,375
CAP 2: Tribes*	0	0	0	40,488	92,623	144,529	196,363	328,486	328,486
CAP 2: M&I*	0	0	0	1,150	92,341	183,130	273,795	512,767	512,767
2/3 Priority (includes CAP 1)	0	0	0	0	0	0	0	13,653	149,999
CAP 1: Tribes*	0	0	0	0	0	0	0	1,064	11,691
CAP 1: M&I*	0	0	0	0	0	0	0	468	5,144
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,397,578	1,533,925
California	0	0	0	0	0	0	0	42,422	466,075
Surplus (BLM, Needles, Coachella, Navy, MWD)	0	0	0	0	0	0	0	0	0
7th Priority (unused & surplus - Agriculture)	0	0	0	0	0	0	0	0	0
6th Priority (unused & surplus - IID, CVWD, PVID)	0	0	0	0	0	0	0	0	0
5th Priority (unused & surplus - MWD)	0	0	0	0	0	0	0	0	0
4th Priority (MWD)	0	0	0	0	0	0	0	42,422	450,412
3rd Priority (IID, CVWD, PVID)	0	0	0	0	0	0	0	0	15,663
2nd Priority (Reservation Division)	0	0	0	0	0	0	0	0	0
1st Priority (PVID)	0	0	0	0	0	0	0	0	0
Present Perfected Rights (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	0	0	0	0	0	0	0	42,422	466.075
TOTAL	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000

*CAP losses are not displayed to CAP as a whole, however losses are accounted for in the shortage distribution within CAP.

Table Att. E-3

2026 Regional Summary of Shortages (Based on Consumptive Use)

	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Mexico	33,333	66,667	83,333	100,000	133,333	166,667	200,000	300,000	416,667
Nevada	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Surplus Water - SNWA	0	0	0	0	0	0	0	0	0
9th Priority (SNWA - Balance & Unused)	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	70,914
8th Priority (SNWA & Big Bend)	0	0	0	0	0	0	0	0	12,419
7th Priority (Boy Scouts, BOR, NV Dept of…)	0	0	0	0	0	0	0	0	0
6th Priority (Las Vegas Valley Water District)	0	0	0	0	0	0	0	0	0
5th Priority (PABCO & Lakeview Co.)	0	0	0	0	0	0	0	0	0
4th Priority (Henderson & Basic Management)	0	0	0	0	0	0	0	0	0
3rd Priority (Boulder City)	0	0	0	0	0	0	0	0	0
2nd Priority (Lake Mead National Rec Area)	0	0	0	0	0	0	0	0	0
1st Priority (PPR's: LMNRA & Fort Mohave)	0	0	0	0	0	0	0	0	0
SUBTOTAL	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Arizona	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,394,205	1,530,879
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	6,816	14,647	18,565	23,334	33,166	43,041	53,173	81,629	81,629
4th Priority (CAP)*	153,184	305,353	381,435	456,666	606,834	756,959	906,827	1,297,791	1,297,791
CAP 5: Arizona Ground Water Bank*	0	0	0	0	0	0	0	0	0
CAP 4: Excess Water for Agriculture*	72,075	72,075	72,075	72,075	72,075	72,075	72,075	72,075	72,075
CAP 3: Agriculture*	2,694	7,998	9,026	9,026	9,026	9,026	9,026	9,026	9,026
CAP 3: Tribes*	37,477	111,238	125,540	125,540	125,540	125,540	125,540	125,540	125,540
CAP 3: M&I*	33,278	98,774	111,474	111,474	111,474	111,474	111,474	111,474	111,474
CAP 2: Tribes*	0	0	26,494	50,582	102,474	154,352	206,141	336,744	336,744
CAP 2: M&I*	0	0	17,754	65,136	155,903	246,644	337,229	573,541	573,541
2/3 Priority (includes CAP 1)	0	0	0	0	0	0	0	14,785	151,460
CAP 1: Tribes*	0	0	0	0	0	0	0	1,137	11,646
CAP 1: M&I*	0	0	0	0	0	0	0	500	5,124
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,394,205	1,530,879
California	0	0	0	0	0	0	0	45,795	469,120
Surplus (BLM, Needles, Coachella, Navy, MWD)	0	0	0	0	0	0	0	0	0
7th Priority (unused & surplus - Agriculture)	0	0	0	0	0	0	0	0	0
6th Priority (unused & surplus - IID, CVWD, PVID)	0	0	0	0	0	0	0	0	0
5th Priority (unused & surplus - MWD)	0	0	0	0	0	0	0	0	0
4th Priority (MWD)	0	0	0	0	0	0	0	45,795	450,412
3rd Priority (IID, CVWD, PVID)	0	0	0	0	0	0	0	0	18,708
2nd Priority (Reservation Division)	0	0	0	0	0	0	0	0	0
1st Priority (PVID)	0	0	0	0	0	0	0	0	0
Present Perfected Rights (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	0	0	0	0	0	0	0	45,795	469,120
TOTAL	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000

*CAP losses are not displayed to CAP as a whole, however losses are accounted for in the shortage distribution within CAP.

Table Att. E-4

2027 Regional Summary of Shortages (Based on Consumptive Use)

	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Mexico	33,333	66,667	83,333	100,000	133,333	166,667	200,000	300,000	416,667
Nevada	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Surplus Water - SNWA	0	0	0	0	0	0	0	0	0
9th Priority (SNWA - Balance & Unused)	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	70,914
8th Priority (SNWA & Big Bend)	0	0	0	0	0	0	0	0	12,419
7th Priority (Boy Scouts, BOR, NV Dept of…)	0	0	0	0	0	0	0	0	0
6th Priority (Las Vegas Valley Water District)	0	0	0	0	0	0	0	0	0
5th Priority (PABCO & Lakeview Co.)	0	0	0	0	0	0	0	0	0
4th Priority (Henderson & Basic Management)	0	0	0	0	0	0	0	0	0
3rd Priority (Boulder City)	0	0	0	0	0	0	0	0	0
2nd Priority (Lake Mead National Rec Area)	0	0	0	0	0	0	0	0	0
1st Priority (PPR's: LMNRA & Fort Mohave)	0	0	0	0	0	0	0	0	0
SUBTOTAL	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Arizona	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,393,837	1,530,547
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	6,819	14,654	18,650	23,477	33,313	43,199	53,339	81,782	81,782
4th Priority (CAP)*	153,181	305,346	381,350	456,523	606,687	756,801	906,661	1,297,146	1,297,146
CAP 5: Arizona Ground Water Bank*	0	0	0	0	0	0	0	0	0
CAP 4: Excess Water for Agriculture*	33,158	33,158	33,158	33,158	33,158	33,158	33,158	33,158	33,158
CAP 3: Agriculture*	3,672	8,397	9,026	9,026	9,026	9,026	9,026	9,026	9,026
CAP 3: Tribes*	63,334	144,815	155,660	155,660	155,660	155,660	155,660	155,660	155,660
CAP 3: M&I*	45,356	103,707	111,474	111,474	111,474	111,474	111,474	111,474	111,474
CAP 2: Tribes*	0	0	27,546	51,672	103,564	155,438	207,224	337,661	337,661
CAP 2: M&I*	0	0	25,417	72,705	163,470	254,204	344,785	580,808	580,808
2/3 Priority (includes CAP 1)	0	0	0	0	0	0	0	14,909	151,620
CAP 1: Tribes*	0	0	0	0	0	0	0	1,144	11,637
CAP 1: M&I*	0	0	0	0	0	0	0	503	5,120
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,393,837	1,530,547
California	0	0	0	0	0	0	0	46,163	469,453
Surplus (BLM, Needles, Coachella, Navy, MWD)	0	0	0	0	0	0	0	0	0
7th Priority (unused & surplus - Agriculture)	0	0	0	0	0	0	0	0	0
6th Priority (unused & surplus - IID, CVWD, PVID)	0	0	0	0	0	0	0	0	0
5th Priority (unused & surplus - MWD)	0	0	0	0	0	0	0	0	0
4th Priority (MWD)	0	0	0	0	0	0	0	46,163	450,412
3rd Priority (IID, CVWD, PVID)	0	0	0	0	0	0	0	0	19,041
2nd Priority (Reservation Division)	0	0	0	0	0	0	0	0	0
1st Priority (PVID)	0	0	0	0	0	0	0	0	0
Present Perfected Rights (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	0	0	0	0	0	0	0	46,163	469,453
TOTAL	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000

*CAP losses are not displayed to CAP as a whole, however losses are accounted for in the shortage distribution within CAP.

Table Att. E-5

2040 Regional Summary of Shortages (Based on Consumptive Use)

	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Mexico	33,333	66,667	83,333	100,000	133,333	166,667	200,000	300,000	416,667
Nevada	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Surplus Water - SNWA	0	0	0	0	0	0	0	0	0
9th Priority (SNWA - Balance & Unused)	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	70,914
8th Priority (SNWA & Big Bend)	0	0	0	0	0	0	0	0	12,419
7th Priority (Boy Scouts, BOR, NV Dept of…)	0	0	0	0	0	0	0	0	0
6th Priority (Las Vegas Valley Water District)	0	0	0	0	0	0	0	0	0
5th Priority (PABCO & Lakeview Co.)	0	0	0	0	0	0	0	0	0
4th Priority (Henderson & Basic Management)	0	0	0	0	0	0	0	0	0
3rd Priority (Boulder City)	0	0	0	0	0	0	0	0	0
2nd Priority (Lake Mead National Rec Area)	0	0	0	0	0	0	0	0	0
1st Priority (PPR's: LMNRA & Fort Mohave)	0	0	0	0	0	0	0	0	0
SUBTOTAL	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Arizona	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,388,281	1,525,531
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	6,866	14,920	19,748	24,620	34,508	44,530	55,355	85,403	85,403
4th Priority (CAP)*	153,134	305,080	380,252	455,380	605,492	755,470	904,645	1,286,087	1,286,087
CAP 5: Arizona Ground Water Bank*	0	0	0	0	0	0	0	0	0
CAP 4: Excess Water for Agriculture*	0	0	0	0	0	0	0	0	0
CAP 3: Agriculture*	3,600	5,937	5,937	5,937	5,937	5,937	5,937	5,937	5,937
CAP 3: Tribes*	86,201	142,140	142,140	142,140	142,140	142,140	142,140	142,140	142,140
CAP 3: M&I*	55,675	91,804	91,804	91,804	91,804	91,804	91,804	91,804	91,804
CAP 2: Tribes*	0	12,705	30,871	56,016	107,890	159,717	211,266	338,579	338,579
CAP 2: M&I*	0	37,240	90,488	136,714	227,447	318,099	408,266	638,823	638,823
2/3 Priority (includes CAP 1)	0	0	0	0	0	0	0	16,791	154,042
CAP 1: Tribes*	0	0	0	0	0	0	0	1,270	11,647
CAP 1: M&I*	0	0	0	0	0	0	0	559	5,125
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,388,281	1,525,531
California	0	0	0	0	0	0	0	51,719	474,468
Surplus (BLM, Needles, Coachella, Navy, MWD)	0	0	0	0	0	0	0	0	0
7th Priority (unused & surplus - Agriculture)	0	0	0	0	0	0	0	0	0
6th Priority (unused & surplus - IID, CVWD, PVID)	0	0	0	0	0	0	0	0	0
5th Priority (unused & surplus - MWD)	0	0	0	0	0	0	0	0	0
4th Priority (MWD)	0	0	0	0	0	0	0	51,719	450,412
3rd Priority (IID, CVWD, PVID)	0	0	0	0	0	0	0	0	24,056
2nd Priority (Reservation Division)	0	0	0	0	0	0	0	0	0
1st Priority (PVID)	0	0	0	0	0	0	0	0	0
Present Perfected Rights (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	0	0	0	0	0	0	0	51,719	474,468
TOTAL	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000

*CAP losses are not displayed to CAP as a whole, however losses are accounted for in the shortage distribution within CAP.

Table Att. E-6

2060 Regional Summary of Shortages (Based on Consumptive Use)

	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000
Mexico	33,333	66,667	83,333	100,000	133,333	166,667	200,000	300,000	416,667
Nevada	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Surplus Water - SNWA	0	0	0	0	0	0	0	0	0
9th Priority (SNWA - Balance & Unused)	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	70,914
8th Priority (SNWA & Big Bend)	0	0	0	0	0	0	0	0	12,419
7th Priority (Boy Scouts, BOR, NV Dept of…)	0	0	0	0	0	0	0	0	0
6th Priority (Las Vegas Valley Water District)	0	0	0	0	0	0	0	0	0
5th Priority (PABCO & Lakeview Co.)	0	0	0	0	0	0	0	0	0
4th Priority (Henderson & Basic Management)	0	0	0	0	0	0	0	0	0
3rd Priority (Boulder City)	0	0	0	0	0	0	0	0	0
2nd Priority (Lake Mead National Rec Area)	0	0	0	0	0	0	0	0	0
1st Priority (PPR's: LMNRA & Fort Mohave)	0	0	0	0	0	0	0	0	0
SUBTOTAL	6,667	13,333	16,667	20,000	26,667	33,333	40,000	60,000	83,333
Arizona	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,388,281	1,525,531
Surplus Contracts	0	0	0	0	0	0	0	0	0
4th Priority (River Users)	7,410	16,857	22,049	27,285	37,903	48,700	59,645	89,740	89,740
4th Priority (CAP)*	152,590	303,143	377,951	452,715	602,097	751,300	900,355	1,281,750	1,281,750
CAP 5: Arizona Ground Water Bank*	0	0	0	0	0	0	0	0	0
CAP 4: Excess Water for Agriculture*	0	0	0	0	0	0	0	0	0
CAP 3: Agriculture*	4,123	5,359	5,359	5,359	5,359	5,359	5,359	5,359	5,359
CAP 3: Tribes*	98,701	128,312	128,312	128,312	128,312	128,312	128,312	128,312	128,312
CAP 3: M&I*	42,162	54,811	54,811	54,811	54,811	54,811	54,811	54,811	54,811
CAP 2: Tribes*	0	18,528	31,742	56,594	108,215	159,775	211,283	338,579	338,579
CAP 2: M&I*	0	81,000	138,854	185,028	275,320	365,503	455,597	686,126	686,126
2/3 Priority (includes CAP 1)	0	0	0	0	0	0	0	16,791	154,042
CAP 1: Tribes*	0	0	0	0	0	0	0	1,270	11,647
CAP 1: M&I*	0	0	0	0	0	0	0	559	5,125
1st Priority (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	160,000	320,000	400,000	480,000	640,000	800,000	960,000	1,388,281	1,525,531
California	0	0	0	0	0	0	0	51,719	474,468
Surplus (BLM, Needles, Coachella, Navy, MWD)	0	0	0	0	0	0	0	0	0
7th Priority (unused & surplus - Agriculture)	0	0	0	0	0	0	0	0	0
6th Priority (unused & surplus - IID, CVWD, PVID)	0	0	0	0	0	0	0	0	0
5th Priority (unused & surplus - MWD)	0	0	0	0	0	0	0	0	0
4th Priority (MWD)	0	0	0	0	0	0	0	51,719	450,412
3rd Priority (IID, CVWD, PVID)	0	0	0	0	0	0	0	0	24,056
2nd Priority (Reservation Division)	0	0	0	0	0	0	0	0	0
1st Priority (PVID)	0	0	0	0	0	0	0	0	0
Present Perfected Rights (PPR's)	0	0	0	0	0	0	0	0	0
SUBTOTAL	0	0	0	0	0	0	0	51,719	474,468
TOTAL	200,000	400,000	500,000	600,000	800,000	1,000,000	1,200,000	1,800,000	2,500,000

*CAP losses are not displayed to CAP as a whole, however losses are accounted for in the shortage distribution within CAP.

Attachment F

Supporting Documentation to the Shortage Allocation Model

This attachment to Appendix G contains tables that comprise supporting documentation to the Shortage Allocation Model as follows:

Table Att. F-1:	Provides a list of Present Perfected Rights who are the first entitlement holders to receive Colorado River water in a shortage year in date order regardless of state lines.
Table Att. F-2:	Information from Exhibit B of the Quantification Settlement Agreement, which displays quantified entitlements for Imperial Irrigation District and Coachella Valley Water District, which are referenced in the Shortage Allocation Model.
Table Att. F-3:	This table shows a comparison of the shortage results generated in the Shortage Allocation Model based on different modeling assumptions used in the Draft EIS and the Final EIS.

Table Att. F-1
Present Perfected Right Holders

	Priority Date	PPR Number	State	Diversion Entitlement	CU Entitlement
Lake Mead National Recreation Area	5/3/1929	82	NV	500	
Molina	1928	15	AZ	318	
Sonny Gowan (Grannis)	1928	32	CA	180	
Diehl*	1928	59	CA	1	0.6
Stallard*	1928	66	CA	1	0.6
Estrada*	1928	77	CA	1	0.6
Corrington*	1928	79	CA	1	0.6
Tolliver*	1928	80	CA	1	0.6
Randolph*	1926	65	CA	1	0.6
Keefe*	1926	67	CA	1	0.6
Gila Monster Farms (formerly Sturges)	1925	16	AZ	780	
Chagnon	1925	41	CA	120	
Faubion*	1925	48	CA	1	0.6
Earle*	1925	58	CA	1	0.6
Whittle*	1925	78	CA	1	0.6
Beauchamp*	1924	51	CA	1	0.6
McGee*	1924	63	CA	1	0.6
Stallard*	1924	64	CA	1	0.6
Hadlock*	1924	72	CA	1	0.6
Stephenson	1923	30	CA	240	
Draper, G.*	1923	46	CA	1	0.6
Dudley*	1922	49	CA	1	0.6
Colorado River Sportsmen's League	1921	36	CA	96	
Andrade	1921	38	CA	66	
Conger*	1921	45	CA	1	0.6
Vaulin*	1920	70	CA	1	0.6
Salisbury*	1920	71	CA	1	0.6
McDonough*	1919	47	CA	1	0.6
Cate*	1919	62	CA	1	0.6
Milpitas	1918	34	CA	108	
Cocopah Indian Reservation	9/27/1917	1	AZ	7,681	
Schneider*	1917	56	CA	1	0.6
Douglas*	1916	50	CA	1	0.6
Clark*	1916	52	CA	1	0.6
Graham*	1916	61	CA	1	0.6
Cocopah Indian Reservation	1915	8	AZ	1,140	
Powers (Power, R.E. & P.)	1915	7	AZ	960	
Lawrence	1915	42	CA	120	
Lawrence*	1915	53	CA	1	0.6
Milpitas	1914	37	CA	69	
Graham, J.*	1914	54	CA	1	0.6
Morgan	1913	33	CA	150	
Zozaya	1912	17	AZ	720	
Reid*	1912	60	CA	1	0.6
Fitz*	1912	75	CA	1	0.6
Fort Mohave Indian Reservation	2/2/1911	3	AZ	75,566	
Brooke Water Company (formerly Graham)	1910	9	AZ	360	
Geiger*	1910	55	CA	1	0.6
Williams*	1909	76	CA	1	0.6
Chemehuevi Indian Reservation	2/2/1907	22	CA	11,340	
North Gila Valley Unit	7/8/1905	6	AZ	24,500	
Yuma Axiliary Project (Unit B)	7/8/1905	5	AZ	6,800	
City of Parker	1905	20	AZ	630	400

Table Att. F-1
Present Perfected Right Holders

	Priority Date	PPR Number	State	Diversion Entitlement	CU Entitlement
Cooper	1905	40	CA	60	
Reservation Division/Yuma Project (non-Indian portion)	1905	28	CA	38,270	
Reynolds	1904	39	CA	36	
Ferguson, C.*	1903	68	CA	1	0.6
Ferguson, W.*	1903	69	CA	1	0.6
Streeter*	1903	73	CA	1	0.6
Draper, J.*	1903	74	CA	1	0.6
Hulet	1902	10	AZ	1,080	
Holpal (formerly Hurschler)	1902	11	AZ	1,050	
Miller	1902	12	AZ	240	
McKellips and Granite Reef Farms	1902	13	AZ	810	
Sherill & Lafollette	1902	14	AZ	1,080	
Swan	1902	18	AZ	960	
Yuma County Water Users' Association	1901	4	AZ	254,200	
Imperial Irrigation District & CVWD lands	1901	27	CA	2,600,000	
Milton and Jean Phillips	1900	19	AZ	42	
Atchison, Topeka, and Santa Fe Railway Co.	1896	44	CA	1,260	273
Martinez*	1895	57	CA	1	0.6
City of Yuma	1893	21	AZ	2,333	1,478
Picacho Development Corp and CA Dept of Parks and Rec	1893	31	CA	120	
Fort Mohave Indian Reservation	9/18/1890	3	AZ	27,969	
Fort Mohave Indian Reservation	9/18/1890	25	CA	16,720	
Fort Mohave Indian Reservation	9/18/1890	81	NV	12,534	
Simons	1889	35	CA	60	
City of Needles (includes Parker Dam & Gov Camp)	1885	43	CA	1,500	950
Fort Yuma Indian Reservation	1/9/1884	23	CA	71,616	
Fort Yuma Indian Reservation	1/9/1884	3	AZ	6,350	
Palo Verde Irrigation District	1877	26	CA	219,780	
Colorado River Indian Reservation	5/15/1876	24	CA	5,860	
Colorado River Indian Reservation	11/16/1874	24	CA	40,241	
Colorado River Indian Reservation	11/16/1874	2	AZ	51,986	
Colorado River Indian Reservation	11/22/1873	2	AZ	252,016	
Colorado River Indian Reservation	10/22/1873	24	CA	10,745	
Colorado River Indian Reservation	3/3/1865	2	AZ	358,400	
Yuma Associates LTD and Winterhaven Water District (formerly Wavers)	1856	29	CA	780	
California Total				3,019,573	
Arizona Total				1,077,971	
Nevada Total				13,034	
TOTAL PPRs in Region				4,110,578	

Source: Consolidated Decree. Supreme Court of the United States. 2006
*One Acre-Foot PPRs

Table Att. F-2
Exhibit B of the QSA

In Thousands of Acre-feet

Calendar Year	2 Priority 1, 2 and 3b	IID Priority 3a: IID Priority 3a Quantified Amount	IID Priority 3a Reductions: 3 IID Reduction: MWD 1988 Agreement Transfer	IID Reduction: SDCWA Transfer	4 IID Reduction: AAC Lining IID, SDCWA & SLR	5,6IID Reduction: SDCWA Mitigation Transfer	7Intra-Priority 3 Transfer IID/CVWD	6 IID Reduction: MWD Transfer with Salton Sea Restoration	8IID Reduction: Conditional ISG Backfill	9IID Reduction: Misc. PPRs	IID Reductions: Total Amount (sum of columns 4 through 11)	10 IID Net Consumptive Use Amount (difference between column 3 and column 12)	CVWD Priority 3a: CVWD Priority 3a Quantified Amount	CVWD Reductions: 4 CVWD Reduction: CC Lining, SDCWA & SLR	9 CVWD Reduction: Misc. PPRs	11 CVWD Reductions: Total Amount (sum of columns 15 + 16)	CVWD Additions: 7 Intra-Priority 3 Transfer IID / CVWD	3 Intra-Priority 3 Transfer MWD / CVWD	CVWD Net Consumptive Use Amount (columns 14 - 17 plus columns 18 + 19)	Total Priority 1-3 Use Plus PPR Consumptive Use (sum of columns 2+13+20 plus 11+16)	12 ISG Bench-marks	12 Annual Targets
2003	420	3,100	110	10	0	5	0	0	0	11.5	136.5	2,963.5	330	0	3	3	0	20	347	3,745.0	3,740	3,740
2004	420	3,100	110	20	0	10	0	0	0	11.5	151.5	2,948.5	330	0	3	3	0	20	347	3,730.0		3,707
2005	420	3,100	110	30	0	15	0	0	0	11.5	166.5	2,933.5	330	0	3	3	0	20	347	3,715.0		3,674
2006	420	3,100	110	40	0	20	0	0	9	11.5	190.5	2,909.5	330	26	3	29	0	20	321	3,665.0	3,640	3,640
2007	420	3,100	110	50	0	25	0	0	0	11.5	196.5	2,903.5	330	26	3	29	0	20	321	3,659.0		3,603
2008	420	3,100	110	50	67.7	25	4	20	0	11.5	288.2	2,811.8	330	26	3	29	4	20	325	3,571.3		3,566
2009	420	3,100	110	60	67.7	30	8	40	0	11.5	327.2	2,772.8	330	26	3	29	8	20	329	3,536.3	3,530	3,530
2010	420	3,100	110	70	67.7	35	12	60	0	11.5	366.2	2,733.8	330	26	3	29	12	20	333	3,501.3		3,510
2011	420	3,100	110	80	67.7	40	16	80	0	11.5	405.2	2,694.8	330	26	3	29	16	20	337	3,466.3		3,490
2012	420	3,100	110	90	67.7	45	21	100	0	11.5	445.2	2,654.8	330	26	3	29	21	20	342	3,431.3	3,470	3,470
2013	420	3,100	110	100	67.7	70	26	100	0	11.5	485.2	2,614.8	330	26	3	29	26	20	347	3,396.3		3,462
2014	420	3,100	110	100	67.7	90	31	100	0	11.5	510.2	2,589.8	330	26	3	29	31	20	352	3,376.3		3,455
2015	420	3,100	110	100	67.7	110	36	100	0	11.5	535.2	2,564.8	330	26	3	29	36	20	357	3,356.3		3,448
2016	420	3,100	110	100	67.7	130	41	100	0	11.5	560.2	2,539.8	330	26	3	29	41	20	362	3,336.3		3,440
2017	420	3,100	110	100	67.7	150	45	91	0	11.5	575.2	2,524.8	330	26	3	29	45	20	366	3,325.3		
2018	420	3,100	110	130	67.7	0	63	0	0	11.5	382.2	2,717.8	330	26	3	29	63	20	384	3,536.3		
2019	420	3,100	110	160	67.7	0	68	0	0	11.5	417.2	2,682.8	330	26	3	29	68	20	389	3,506.3		
2020	420	3,100	110	193	67.7	0	73	0	0	11.5	454.7	2,645.3	330	26	3	29	73	20	394	3,473.8		
2021	420	3,100	110	205	67.7	0	78	0	0	11.5	472.2	2,627.8	330	26	3	29	78	20	399	3,461.3		
2022	420	3,100	110	203	67.7	0	83	0	0	11.5	474.7	2,625.3	330	26	3	29	83	20	404	3,463.8		
2023	420	3,100	110	200	67.7	0	88	0	0	11.5	477.2	2,622.8	330	26	3	29	88	20	409	3,466.3		
2024	420	3,100	110	200	67.7	0	93	0	0	11.5	482.2	2,617.8	330	26	3	29	93	20	414	3,466.3		
2025	420	3,100	110	200	67.7	0	98	0	0	11.5	487.2	2,612.8	330	26	3	29	98	20	419	3,466.3		
2026	420	3,100	110	200	67.7	0	103	0	0	11.5	492.2	2,607.8	330	26	3	29	103	20	424	3,466.3		
2027	420	3,100	110	200	67.7	0	103	0	0	11.5	492.2	2,607.8	330	26	3	29	103	20	424	3,466.3		
2028	420	3,100	110	200	67.7	0	103	0	0	11.5	492.2	2,607.8	330	26	3	29	103	20	424	3,466.3		
2029-2037	420	3,100	110	200	67.7	0	103	0	0	11.5	492.2	2,607.8	330	26	3	29	103	20	424	3,466.3		
2038-2047	420	3,100	110	200	67.7	0	103	0	0	11.5	492.2	2,607.8	330	26	3	29	103	20	424	3,466.3		
2048-2077	420	3,100	110	200	67.7	0	100	0	0	11.5	489.2	2,610.8	330	26	3	29	100	20	421	3,466.3		

1Exhibit B is independent of increases and reductions as allowed under the Inadvertent Overrun and Payback Policy.
2Any higher use covered by MWD, any lesser use will produce water for MWD and help satisfy ISG Benchmarks and Annual Targets.
3IID/MWD 1988 Conservation Program conserves up to 110,000 AFY and the amount is based upon periodic verification. Of amount conserved, up to 20,000 AFY to CVWD (column 19), which does not count toward ISG Benchmarks and Annual Targets, and remainder to MWD.
4Ramp-up amounts may vary based upon construction progress, and final amounts will be determined by the Secretary pursuant to the Allocation Agreement.
5Any amount identified in Exhibit B for mitigation purposes will only be from non-Colorado River sources and these amounts may be provided by exchange for Colorado River water.

Table Att. F-2
Exhibit B of the QSA

In Thousands of Acre-feet

		IID Priority 3a											CVWD Priority 3a									
			Reductions											Reductions			Additions					
Calendar Year	2 Priority 1, 2 and 3b	IID Priority 3a Quantified Amount	3 IID Reduction: MWD 1988 Agreement Transfer	IID Reduction: SDCWA Transfer	4 IID Reduction: AAC Lining IID, SDCWA & SLR	5,6IID Reduction: SDCWA Mitigation Transfer	7Intra-Priority 3 Transfer IID/CVWD	6 IID Reduction: MWD Transfer with Salton Sea Restoration	8IID Reduction: Conditional ISG Backfill	9IID Reduction: Misc. PPRs	IID Reductions: Total Amount (sum of columns 4 through 11)	10 IID Net Consumptive Use Amount (difference between column 3 and column 12)	CVWD Priority 3a Quantified Amount	4 CVWD Reduction: CC Lining, SDCWA & SLR	9 CVWD Reduction: Misc. PPRs	11 CVWD Reductions: Total Amount (sum of columns 15 + 16)	7 Intra-Priority 3 Transfer IID / CVWD	3 Intra-Priority 3 Transfer MWD / CVWD	CVWD Net Consumptive Use Amount (columns 14 - 17 plus columns 18 + 19)	Total Priority 1-3 Use Plus PPR Consumptive Use (sum of columns 2+13+20 plus 11+16)	12 ISG Bench-marks	12 Annual Targets

6Water would be transferred to MWD subject to satisfaction of certain conditions and to appropriate Federal approvals. These transfers may also be subject to state approvals. Schedules are subject to adjustments with mutual consent. After 2006, these quantities will count toward the ISG Benchmarks (column 22) and Annual Targets (column 23) only if and to the extent that water is transferred into the Colorado River Aqueduct for use by MWD and/or SDCWA.

7MWD can acquire if CVWD declines the water. Any water obtained by MWD will be counted as additional agricultural reduction to help satisfy the ISG Benchmarks and Annual Targets. MWD will provide CVWD 50,000 AFY of the 100,000 AFY starting in year 46.

8IID has agreed to provide transfer amounts to meet the minimum ISG benchmarks, not to exceed a cumulative total of 145,000 AF. Maximum transfer amounts are 25,000 AF in 2006, 50,000 AF plus the unused amount from 2006 in 2009, and 70,000 AF plus the unused amounts from 2006 and 2009 in 2012. In addition to the maximum transfer amounts IID has also committed that no more than 72,500 AF of reduced inflow to the Salton Sea would result from these additional transfers.

9Up to the amount shown, as agreed upon reduction to IID or CVWD to cover collectively the sum of individual Miscellaneous PPRs, Federal reserved rights and Decreed rights. This is a reduction that counts towards ISG Benchmarks and Annual Targets.

10For purposes of Subparagraph 8(b)(2)(i) and (ii) and 8(c)(1) and (4) the Secretary will take into account: (i) the satisfaction of necessary conditions to certain transfers (columns 7 and 9) not within IID's control: (ii) the amounts of conserved water as determined, where such amounts may vary (columns 4, 6, 9 and 10); and (iii) with respect to column 7, reductions by IID will be considered in determining IID's compliance regardless of whether the conserved water is diverted into the Colorado River Aqueduct.

11For purposes of Subparagraph 8(c)(1) and (4) the Secretary will take into account: (i) the satisfaction of necessary conditions to certain transfers (columns 15 and 16) not within CVWD's control; and (ii) the amounts of conserved water as determined, where such amounts may vary (column 15).

12All consumptive use of priorities 1 through 3 plus 14,500 AF of PPRs must be within 25,000 AF of the amount stated.

13Assumes SDCWA does not elect termination in year 35.

14Assumes SDCWA and IID mutually consent to renewal term of 30 years.

Notes:

Substitute transfers can be made provided the total volume of water to be transferred remains equal or greater than amounts shown consistent with applicable Federal approvals.

The shaded columns represent amounts of water that may vary.

Table Att. F-3
Comparison of Shortage Results in DEIS and FEIS

	River Users			CAP			AZ 2/3			Ak-Chin			San Carlos		
	DEIS	FEIS	Difference (DEIS - FEIS)	DEIS	FEIS	Difference (DEIS - FEIS)	DEIS	FEIS	Difference (DEIS - FEIS)	DEIS	FEIS	Difference (DEIS - FEIS)	DEIS	FEIS	Difference (DEIS - FEIS)
2017															
500,000	24,517	17,921	6,596	375,483	382,079	-6,596	0	0	0		0	0	0	0	0
1,200,000	58,841	50,788	8,053	901,159	909,212	-8,053	0	0	0	14,065	2,032	12,033	25,229	37,467	-12,238
2,500,000	84,825	79,350	5,475	1,299,101	1,304,575	-5,474	149,999	149,999	0	39,191	39,191	0	43,500	39,000	4,500
2060															
500,000	29,919	22,049	7,870	370,081	377,951	-7,870	0	0	0	0	0	0	0	0	0
1,200,000	71,806	59,645	12,161	888,194	900,355	-12,161	0	0	0	15,092	3,783	11,309	26,625	37,881	-11,256
2,500,000	102,584	89,740	12,844	1,268,906	1,281,750	-12,844	154,042	154,042	0	39,147	39,147	0	43,500	39,000	4,500

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Appendix H

Socioeconomics Data

This appendix includes detailed information that supports the analysis contained in Section 4.14 (Socioeconomics) of the EIS. The analysis in Section 4.14 is based on a network of models. The Shortage Allocation Model (described in Appendix G of the Final EIS) was used to generate shortages, which served as input to an agricultural model. The agricultural model contains crop budgets and crop growing patterns that were used to assess the effect of shortages on crop acres and production. Arizona agricultural cropping patterns and crop budgets included in the analysis are displayed on Tables H-1 through H-19. The change in gross dollar output determined in the agricultural model were used as an input to the economic model "IMPLAN", which produced a detailed breakdown of estimated changes in employment, income, and tax revenues for each county by shortage amount and year evaluated (Tables H-20 through H-147).

Table of Contents

List of Tables

H.1 Introduction

This appendix supports the agricultural analysis in Section 4.14 (Socioeconomics) of the EIS. Indian and non-Indian agricultural shortages were generated in the Shortage Allocation Model. The results are incorporated in an agricultural model, which determines the quantity of acres within a district which will go out of production based on crop budgets and production patterns. The agricultural model produces the estimated reduction in crops by acre and a reduction in gross dollar output. The change in gross dollar output is then used as an input to IMPLAN to ascertain changes in employment, personal income, and tax revenues by county. The output of both the Shortage Allocation Model and the agricultural model must be summarized by county in order for IMPLAN to operate.

Listed below are the counties analyzed in IMPLAN. For informational purposes, the irrigation districts and Indian communities contained within those counties are also listed below. Pinal, Maricopa, and Pima Counties contain the majority of Central Arizona Project irrigation districts and Indian communities. Mohave, La Paz, and Yuma Counties contain the majority of individual entitlement holders along the Colorado River. When an irrigation district, Indian community, or entitlement holder crosses a county line, the analysis is distributed proportionately to the estimated use in each county:

- Mohave
- La Paz
- Yuma
- Pinal: Maricopa-Stanfield Irrigation & Drainage District (MSIDD)
  Central Arizona Irrigation and Drainage District (CAIDD)
  San Carlos Irrigation and Drainage District (SCIDD)
  Hohokam Irrigation and Drainage District (HIDD)
  New Magma Irrigation and Drainage District (NMIDD)
  Tohono O'odham Nation (TON) – Chui Chu District
  Gila River Indian Community (GRIC)
- Maricopa: Queen Creek Irrigation District (QCID)
  Harquahala Valley Irrigation District (HVID)
  Tonopah Irrigation District (TID)
  Salt River Pima-Maricopa Community

Fort McDowell Yavapai Nation

- Pima: Tohono O'odham Nation - Schuk Toak and San Xavier Districts

H.2 Arizona Cropping Patterns

Historic cropping patterns for the major districts in Arizona are summarized in Table H-1.

Table H-1
Cropping Patterns for Shortage Analysis (acres)

Irrigation Districts[1]	Cotton	Grains	Forage	Vegetables	Trees	Totals
MSIDD	27,862	18,154	8,711	3,106	3,886	61,719
CAIDD	28,546	22,823	2,957	3,116	2,281	59,723
HIDD	12,817	8,627	3,632	632	0	25,708
NMIDD	9,042	5,107	5,449	1,808	1,855	23,261
QCID	5,258	3,847	2,532	2,632	368	14,637
HVID	13,419	3,109	3,709	3,709	505	24,451
TID	2,453	22	546	0	0	3,021
Totals	99,397	61,689	27,536	15,003	8,895	212,520

[1] See Section H.1 for Irrigation District names and acronyms.

H.3 Crop Budgets for Arizona Counties

H.3.1 Partial Crop Budgeting and Impacts Upon Crop Selection due to Water Cost and Water Shortages

This analysis is referred to as partial crop budgeting for two reasons. The first reason is that only aggregated costs and returns are presented for each crop, with essentially little detail regarding the composition of the values. Secondly, as explained below, not all costs of production are taken into consideration; the emphasis is primarily on variable or cash costs. Partial crop budget tables are located at the end of this text.

Partial crop budgets were generated for upland cotton, forage crops, and food and feed grains. This analysis focuses on these categories of crops because these crops are historically the first affected by water availability. Such crops may be subject to elimination from a crop rotation in any given year as the availability of irrigation water changes.

Theoretical economic production assumptions were applied in developing the partial budgets. The first assumption is that farmers will continue to produce a particular crop only as long as the returns from the crop cover all variable costs and contribute something toward fixed costs. For the partial crop budget analysis, the intent is to identify only the variable production costs or only those costs which a farmer in Arizona is assumed to include when making the decision whether to continue to produce a particular crop in the face of declining water availability. The goal of the partial crop budget analysis is to estimate a set of cost and return values that represent typical farm operations in various districts although it is recognized that each farmer is faced with unique production costs, realized yields, and crop prices. The partial crop budgets provide what is assumed to be the typical costs and returns faced by a range of farmers in the counties included in this analysis. The outcome provided by the partial budgets is identification of the cost of irrigation water at which farmers, on the average, would decide to fallow fields of a particular crop because the returns failed to cover the variable costs of production. It is assumed that, if each farmer's production costs and prices were used, on the average, the impacts would be similar to those resulting from this analysis.

University of Arizona 1998 crop enterprise budgets were used as the starting point for the partial crop budget analysis. Costs of farming inputs (equipment maintenance, fertilizer application, fuel, etc.) were adjusted to reflect 2005 costs using cost indices available from the National Agricultural Statistics Service. Average commodity prices and yields over a five-year period, from 2001 to 2005, were the basis for gross revenues. The total cash cost for land preparation and growing expenses including irrigation water costs, and total harvest and post-harvest costs developed by the University of Arizona were used in this analysis. Costs which were specifically excluded from the analysis include farm pickup use costs for a particular crop, taxes, housing, insurance on farm equipment, capital replacement on machinery and vehicles, interest on equity in machinery and vehicles, property taxes, opportunity interest on land, water assessment, returns to management, and profit.

The values derived are not indicative of the profitability of a particular crop. The values are intended to represent a marginal analysis relative to farmers' growing decisions. For example, the crop profitability decision value for wheat in Maricopa County is shown to be $59.55 per acre. The $59.55 represents the revenues above variable expenses that contribute to payment of fixed costs of the farming operation. To the $59.55 is added the current estimated irrigation water cost. Total estimated irrigation water cost plus the profitability decision value is then divided by the acre-feet of water applied per acre to calculate the threshold value. The threshold value for wheat in Maricopa County is $23.96. The threshold value is the maximum amount a farmer would pay for water to irrigate wheat or at what point he would decide to not include wheat in his rotation. In this study, a farmer is assumed not to consider all economic costs when deciding whether to grow a particular crop. This assumption is based on historic agricultural production practices and decision making in the Lower Basin states. In addition, the economic costs associated with total farm production are unique to each farm operation. The values used in this analysis represent average conditions for farms in the counties included in this study.

Tables H-3 through H-20 show the partial budgeting results. In summary, the estimated maximum average amount a farmer would pay for irrigation water per acre foot is shown in Table H-2, below.

Table H-2
Estimated Maximum Average Amount a
Farmer Would Pay for Irrigation Water

Crop	County	Max Amount Paid for Irrigation Water ($/af)
Wheat	Pinal	$25.84
	Maricopa	$23.96
	Pima[1]	$25.84
	La Paz	$10.98
	Mojave	$44.88
	Yuma	$16.77
Cotton	Pinal	$70.48
	Maricopa	$40.56
	Pima[1]	$70.48
	La Paz	$42.23
	Mojave	$54.84
	Yuma	$46.43
Alfalfa Hay	Pinal	$66.55
	Maricopa	$40.35
	Pima[1]	$66.55
	La Paz	$56.83
	Mojave	$32.70
	Yuma	$69.37

[1] *Partial farm budget information not available for Pima County. Assumed maximum amount paid for irrigation water would be similar to that of Pinal County.*

The differences in the wheat estimates between counties are due mainly to yield differences and required water assumptions. For cotton, the differences in estimates between counties are also due to yield differences and required water assumptions. In Pinal County, the first crop projected to drop out of production is wheat, followed by alfalfa, and then cotton, given increasing irrigation water costs or water shortages and assuming that all other variables remained unchanged.

Table H-3
Hay and Forage Production Profitability in Maricopa County—Partial Budget

	Total
Crops sales revenues—Alfalfa Hay (yield in tons = 8.3, price per ton = $102.20)	$850.30
Total cash growing costs (includes $112.50 for irrigation water)	$319.62
Cash harvest costs	$207.97
Interest on operating costs at 10%	$15.98
Total cash expenses	$543.56
General and office overhead—5% of operating expenses	$27.18
General farm maintenance—3% of operating expense	$16.31
Share of stand establishment	$73.13
Total variable costs	$660.18
Crop returns over variable costs	$190.13
Annual crop water use— 90 acre-inches or 7.50 af	
Returns to crop and water over variable costs	$302.63
Maximum average amount a farmer would pay for irrigation water per af	$40.35

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-4
Food and Feed Grain Production Profitability in Maricopa County—Partial Budget

	Total
Crops sales revenues—Durum Wheat (yield in pounds = 5,578, price per pound = $0.071)	$396.04
Total cash growing costs (includes $8.33 for irrigation water)	$220.70
Cash harvest costs	$79.83
Interest on operating costs at 10%	$11.03
Total cash expenses	$311.57
General and office overhead—5% of operating expenses	$15.58
General farm maintenance—3% of operating expense	$9.35
Total variable costs	$336.49
Crop returns over variable costs	$59.55
Annual crop water use— 34 acre-inches or 2.83 af	
Returns to crop and water over variable costs	$67.88
Maximum average amount a farmer would pay for irrigation water per af	$23.96

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-5
Upland Cotton Production Profitability in Maricopa County—Partial Budget

	Total
Crops sales revenues—Cotton Lint (yield in pounds = 1,298, price per pound = $0.636)	$825.53
Crops sales revenues—Cottonseed (yield in tons = 1.14, price per ton = $142.00)	$161.88
Total revenues	$987.41
Total cash growing costs (includes $30.00 for irrigation water)	$453.41
Cash harvest costs	$275.07
Interest on operating costs at 10%	$22.67
Total cash expenses	$751.15
General and office overhead—5% of operating expenses	$37.56
General farm maintenance—3% of operating expense	$22.53
Total variable costs	$811.24
Crop returns over variable costs	$176.17
Annual crop water use— 61 acre-inches or 5.08 af	
Returns to crop and water over variable costs	$206.17
Maximum average amount a farmer would pay for irrigation water per af	$40.56

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-6
Hay and Forage Production Profitability in Pinal County—Partial Budget

	Total
Crops sales revenues—Alfalfa Hay (yield in tons = 8.86, price per ton = $102.20)	$905.49
(grazing = 250 hd, cents per hd = $0.13)	$32.50
Total revenues	$937.99
Total cash growing costs (includes $237.00 for irrigation water)	$354.89
Cash harvest costs	$231.87
Interest on operating costs at 10%	$17.74
Total cash expenses	$604.51
General and office overhead—5% of operating expenses	$30.23
General farm maintenance—3% of operating expense	$18.14
Share of stand establishment	$84.22
Total variable costs	$737.09
Crop returns over variable costs	$200.90
Annual crop water use— 79 acre-inches or 6.58 af	
Returns to crop and water over variable costs	$437.90
Maximum average amount a farmer would pay for irrigation water per af	$66.55

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-7
Food and Feed Grain Production Profitability in Pinal County—Partial Budget

	Total
Crops sales revenues—Durum Wheat (yield in pounds = 5,812, price per pound = $0.071)	$412.65
Total cash growing costs (includes $96.00 for irrigation water)	$317.06
Cash harvest costs	$74.26
Interest on operating costs at 10%	$15.85
Total cash expenses	$407.18
General and office overhead—5% of operating expenses	$20.36
General farm maintenance—3% of operating expense	$12.22
Total variable costs	$439.75
Crop returns over variable costs	$27.10
Annual crop water use— 32 acre-inches or 2.67 af	
Returns to crop and water over variable costs	$68.90
Maximum average amount a farmer would pay for irrigation water per af	$25.84

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-8
Upland Cotton Production Profitability in Pinal County—Partial Budget

	Total
Crops sales revenues—Cotton Lint (yield in pounds = 1,361, price per pound = $0.636)	$865.60
Crops sales revenues—Cottonseed (yield in tons = 1.2, price per ton = $142.00)	$170.40
Total revenues	$1,036.00
Total cash growing costs (includes $30.00 for irrigation water)	$519.23
Cash harvest costs	$280.94
Interest on operating costs at 10%	$25.96
Total cash expenses	$826.13
General and office overhead—5% of operating expenses	$41.31
General farm maintenance—3% of operating expense	$24.78
Total variable costs	$892.22
Crop returns over variable costs	$143.78
Annual crop water use— 49 acre-inches or 4.08 af	
Returns to crop and water over variable costs	$287.78
Maximum average amount a farmer would pay for irrigation water per af	$70.48

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-9
Hay and Forage Production Profitability in Cochise County—Partial Budget

	Total
Crops sales revenues—Alfalfa Hay (yield in tons = 7.84, price per ton = $102.20)	$801.25
(grazing = 250 hd, cents per hd = $0.13)	$32.50
Total revenues	$833.75
Total cash growing costs (includes $243.63 for irrigation water)	$585.30
Cash harvest costs	$102.67
Interest on operating costs at 10%	$29.26
Total cash expenses	$717.23
General and office overhead—5% of operating expenses	$35.86
General farm maintenance—3% of operating expense	$21.52
Share of stand establishment	$84.22
Total variable costs	$858.83
Crop returns over variable costs	($25.08)
Annual crop water use— 68 acre-inches or 5.67 af	
Returns to crop and water over variable costs	$218.55
Maximum average amount a farmer would pay for irrigation water per af	$38.57

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-10
Food and Feed Grain Production Profitability in Cochise County—Partial Budget

	Total
Crops sales revenues—Durum Wheat (yield in pounds = 6,210, price per pound = $0.071)	$440.91
Total cash growing costs (includes $107.04 for irrigation water)	$427.90
Cash harvest costs	$68.57
Interest on operating costs at 10%	$21.39
Total cash expenses	$517.87
General and office overhead—5% of operating expenses	$25.89
General farm maintenance—3% of operating expense	$15.54
Total variable costs	$559.29
Crop returns over variable costs	$118.38
Annual crop water use— 28 acre-inches or 2.33 af	
Returns to crop and water over variable costs	$11.34
Maximum average amount a farmer would pay for irrigation water per af	$4.86

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-11
Upland Cotton Production Profitability in Cochise County—Partial Budget

	Total
Crops sales revenues—Cotton Lint (yield in pounds = 1,032, price per pound = $0.636)	$656.35
Crops sales revenues—Cottonseed (yield in tons = 0.91, price per ton = $142.00)	$129.22
Total revenues	$785.57
Total cash growing costs (includes $132.57 for irrigation water)	$527.74
Cash harvest costs	$183.44
Interest on operating costs at 10%	$26.39
Total cash expenses	$737.57
General and office overhead—5% of operating expenses	$36.88
General farm maintenance—3% of operating expense	$22.13
Total variable costs	$796.57
Crop returns over variable costs	($11.00)
Annual crop water use— 37 acre-inches or 3.08 af	
Returns to crop and water over variable costs	$121.57
Maximum average amount a farmer would pay for irrigation water per af	$39.43

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-12
Hay and Forage Production Profitability in La Paz County—Partial Budget

	Total
Crops sales revenues—Alfalfa Hay (yield in tons = 7.9, price per ton = $102.20)	$804.31
(grazing = 250 hd, cents per hd = $0.13)	$32.50
Total revenues	$836.81
Total cash growing costs (includes $243.63 for irrigation water)	$187.67
Cash harvest costs	$171.67
Interest on operating costs at 10%	$9.38
Total cash expenses	$368.73
General and office overhead—5% of operating expenses	$18.44
General farm maintenance—3% of operating expense	$11.06
Share of stand establishment	$84.22
Total variable costs	$482.44
Crop returns over variable costs	$354.37
Annual crop water use— 79 acre-inches or 6.58 af	
Returns to crop and water over variable costs	$374.16
Maximum average amount a farmer would pay for irrigation water per af	$56.83

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-13
Food and Feed Grain Production Profitability in La Paz County—Partial Budget

	Total
Crops sales revenues—Durum Wheat (yield in pounds = 5,642, price per pound = $0.071)	$400.58
Total cash growing costs (includes $0 for irrigation water)	$266.05
Cash harvest costs	$61.90
Interest on operating costs at 10%	$13.30
Total cash expenses	$341.26
General and office overhead—5% of operating expenses	$17.06
General farm maintenance—3% of operating expense	$10.24
Total variable costs	$368.56
Crop returns over variable costs	$32.03
Annual crop water use— 35 acre-inches or 2.92 af	
Returns to crop and water over variable costs	$32.03
Maximum average amount a farmer would pay for irrigation water per af	$10.98

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-14
Hay and Forage Production Profitability in Yuma County—Partial Budget

	Total
Crops sales revenues—Alfalfa Hay (yield in tons = 9.1, price per ton = $102.20)	$933.09
(grazing = 250 hd, cents per hd = $0.13)	$32.50
Total revenues	$965.59
Total cash growing costs (includes $25.83 for irrigation water)	$153.29
Cash harvest costs	$224.07
Interest on operating costs at 10%	$7.66
Total cash expenses	$385.02
General and office overhead—5% of operating expenses	$19.25
General farm maintenance—3% of operating expense	$11.55
Share of stand establishment	$84.22
Total variable costs	$500.04
Crop returns over variable costs	$465.54
Annual crop water use— 85 acre-inches or 7.08 af	
Returns to crop and water over variable costs	$491.37
Maximum average amount a farmer would pay for irrigation water per af	$69.37

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-15
Food and Feed Grain Production Profitability in Yuma County—Partial Budget

	Total
Crops sales revenues—Durum Wheat (yield in pounds = 5,976, price per pound = $0.071)	$424.30
Total cash growing costs (includes $0 for irrigation water)	$246.97
Cash harvest costs	$83.09
Interest on operating costs at 10%	$12.35
Total cash expenses	$342.41
General and office overhead—5% of operating expenses	$17.12
General farm maintenance—3% of operating expense	$10.27
Total variable costs	$369.80
Crop returns over variable costs	$54.49
Annual crop water use— 39 acre-inches or 3.25 af	
Returns to crop and water over variable costs	$54.49
Maximum average amount a farmer would pay for irrigation water per af	$16.77

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-16
Upland Cotton Production Profitability in Yuma County—Partial Budget

	Total
Crops sales revenues—Cotton Lint (yield in pounds = 1,286, price per pound = $0.636)	$817.90
Crops sales revenues—Cottonseed (yield in tons = 1.13, price per ton = $142.00)	$160.46
Total revenues	$978.36
Total cash growing costs (includes $0 for irrigation water)	$684.90
Cash harvest costs	$337.21
Interest on operating costs at 10%	$34.24
Total cash expenses	$1,056.35
General and office overhead—5% of operating expenses	$52.82
General farm maintenance—3% of operating expense	$31.69
Total variable costs	$1,140.85
Crop returns over variable costs	($162.50)
Annual crop water use— 42 acre-inches or 3.50 af	
Returns to crop and water over variable costs	($162.50)
Maximum average amount a farmer would pay for irrigation water per af	($46.43)

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-17
Hay and Forage Production Profitability in Mohave County—Partial Budget

	Total
Crops sales revenues—Alfalfa Hay (yield in tons = 7.9, price per ton = $102.20)	$804.31
(grazing = 200 hd, cents per hd = $0.13)	$26.00
Total revenues	$830.31
Total cash growing costs (includes $21.33 for irrigation water)	$307.84
Cash harvest costs	$172.90
Interest on operating costs at 10%	$15.39
Total cash expenses	$496.13
General and office overhead—5% of operating expenses	$24.81
General farm maintenance—3% of operating expense	$14.88
Share of stand establishment	$84.22
Total variable costs	$620.04
Crop returns over variable costs	$210.27
Annual crop water use— 85 acre-inches or 7.08 af	
Returns to crop and water over variable costs	$231.60
Maximum average amount a farmer would pay for irrigation water per af	$32.70

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-18
Food and Feed Grain Production Profitability in Mohave County—Partial Budget

	Total
Crops sales revenues—Durum Wheat (yield in pounds = 5,642, price per pound = $0.071)	$400.58
Total cash growing costs (includes $10.46 for irrigation water)	$185.19
Cash harvest costs	$51.09
Interest on operating costs at 10%	$9.26
Total cash expenses	$245.54
General and office overhead—5% of operating expenses	$12.28
General farm maintenance—3% of operating expense	$7.37
Total variable costs	$265.18
Crop returns over variable costs	$135.40
Annual crop water use— 39 acre-inches or 3.25 af	
Returns to crop and water over variable costs	$145.86
Maximum average amount a farmer would pay for irrigation water per af	$44.88

Note: Dollar values are on a per acre basis. Information is for October 2006.

Table H-19
Upland Cotton Production Profitability in Mohave County—Partial Budget

	Total
Crops sales revenues—Cotton Lint (yield in pounds = 1,354, price per pound = $0.636)	$861.14
Crops sales revenues—Cottonseed (yield in tons = 1.19, price per ton = $142.00)	$168.98
Total revenues	$1,030.12
Total cash growing costs (includes $15.06 for irrigation water)	$441.54
Cash harvest costs	$250.24
Interest on operating costs at 10%	$22.08
Total cash expenses	$713.85
General and office overhead—5% of operating expenses	$35.69
General farm maintenance—3% of operating expense	$21.42
Total variable costs	$770.96
Crop returns over variable costs	$259.16
Annual crop water use— 60 acre-inches or 5.00 af	
Returns to crop and water over variable costs	$274.22
Maximum average amount a farmer would pay for irrigation water per af	$54.84

Note: Dollar values are on a per acre basis. Information is for October 2006.

H.4 County Level Changes in Employment and Personal Income

H.4.1 Summary Table

Tables H-20 through H-25 summarize the changes in employment and personal income for both Indian and non-Indian agricultural lands due to shortages of Colorado River water. The summaries are shown by level of shortage and by selected years. For years in which there is no probability of a particular shortage level, impacts are negligible and not displayed. Shortages generated in 2008 are not displayed because there was no probability of shortage in that year.

Table H-20
Estimated Changes in Employment as a Result of Shortages to
Non-Indian Agricultural Lands for Selected Shortage Amounts and Years

Shortage Amount (af)	Year				
	2017	2026	2027	2040	2060
400,000	(542.1)	(183.1)	–[1]	–	–
500,000	(558.0)	(193.8)	(115.6)	(43.6)	(42.6)
600,000	(568.3)	(204.3)	(126.1)	(54.1)	(53.1)
800,000	(582.4)	(225.0)	(147.1)	(75.1)	(74.1)
1,000,000	(604.0)	(246.9)	(168.7)	(96.7)	(95.7)
1,200,000	–	(267.0)	(188.8)	(116.8)	(115.9)
1,800,000	–	-	(279.2)	(215)	(214.0)
2,500,000	–	–	(702.0)	–	–

Note: (1) "-" indicates no shortage occurring.

Table H-21
Estimated Changes in Personal Income as a Result of Shortages to
Non-Indian Agricultural Lands for Selected Shortage Amounts and Years

Shortage Amount (af)	Year				
	2017	2026	2027	2040	2060
400,000	(21,964,019)	(5,496,528)	–	–	–
500,000	(22,462,821)	(5,756,137)	(3,457,141)	(1,319,106)	(1,285,565)
600,000	(22,727,809)	(6,012,420)	(3,713,424)	(1,575,389)	(1,541,848)
800,000	(22,917,311)	(6,518,601)	(4,224,574)	(2,086,539)	(2,052,998)
1,000,000	(23,452,351)	(7,060,878)	(4,761,878)	(2,623,843)	(2,590,302)
1,200,000	–	(7,670,878)	(5,371,882)	(3,233,847)	(3,207,736)
1,800,000	–		(7,918,762)	(5,967,401)	(5,933,915)
2,500,000	–	–	(17,964,440)	–	–

Table H-22
Estimated Changes in Employment as a Result of Shortages to
Indian Agricultural Lands for Selected Shortage Amounts and Years

Shortage Amount (af)	Year				
	2017	2026	2027	2040	2060
400,000	(35.3)	(241.7)	–	–	–
500,000	(69.3)	(366.9)	(406.6)	(379.5)	(354.8)
600,000	(209.2)	(395.3)	(431.3)	(405.8)	(381.0)
800,000	(277.5)	(457.5)	(510.2)	(459)	(435.5)
1,000,000	(332.9)	(522.7)	(572.7)	(552.7)	(505.9)
1,200,000	–	(837.7)	(822.7)	(660.2)	(625.3)
1,800,000	–	-	(991.4)	(965.8)	(930.8)
2,500,000	–	–	(991.4)	–	–

Table H-23
Estimated Changes in Personal Income as a Result of Shortages to
Indian Agricultural Lands for Selected Shortage Amounts and Years

Shortage Amount (af)	Year				
	2017	2026	2027	2040	2060
400,000	(669,931)	(7,988,482)	–	–	–
500,000	(1,378,239)	(12,346,618)	(13,871,323)	(12,037,627)	(10,984,230)
600,000	(5,478,477)	(12,748,932)	(13,805,806)	(13,000,127)	(11,942,514)
800,000	(7,928,674)	(15,116,537)	(17,112,204)	(15,581,677)	(14,429,519)
1,000,000	(10,021,660)	(17,948,570)	(20,195,927)	(19,644,211)	(18,032,542)
1,200,000	–	(32,003,686)	(31,521,386)	(24,260,825)	(22,756,330)
1,800,000	–	–	(38,528,376)	(37,524,339)	(36,017,747)
2,500,000	–	–	(38,528,376)	–	–

Table H-24
Estimated Changes in Employment as a Result of Shortages to
Agricultural Lands for Selected Shortage Amounts and Years

Shortage Amount (af)	Year				
	2017	2026	2027	2040	2060
400,000	(577.4)	(424.8)	–	–	–
500,000	(627.3)	(560.7)	(522.2)	(418.9)	(397.4)
600,000	(777.5)	(599.6)	(557.4)	(459.9)	(434.1)
800,000	(859.9)	(682.5)	(657.3)	(534.1)	(509.6)
1,000,000	(936.9)	(769.6)	(741.4)	(649.4)	(601.6)
1,200,000	–	(1,104.7)	(1,011.5)	(777.0)	(741.2)
1,800,000	–	–	(1,270.6)	(1,180.8)	(1,144.8)
2,500,000	–	–	(1,693.4)	–	–

Table H-25
Estimated Changes in Personal Income as a Result of Shortages to
Agricultural Lands for Selected Shortage Amounts and Years

Shortage Amount (af)	Year				
	2017	2026	2027	2040	2060
400,000	(22,633,950)	(13,485,010)	–	–	–
500,000	(23,841,060)	(18,102,755)	(17,328,464)	(13,356,733)	(12,269,795)
600,000	(28,196,286)	(18,761,352)	(17,519,230)	(14,575,516)	(13,484,362)
800,000	(30,845,985)	(21,635,138)	(21,336,778)	(17,668,216)	(16,482,517)
1,000,000	(33,474,011)	(25,009,444)	(24,957,805)	(22,268,054)	(20,622,844)
1,200,000	–	(39,674,564)	(36,893,268)	(27,494,672)	(25,964,066)
1,800,000	–	–	(46,447,138)	(43,491,740)	(41,951,662)
2,500,000	–	–	(56,492,816)	–	–

H.4.2 2017 Tables

The estimated change in employment and income as a result of shortages on Indian and Non-Indian agricultural lands are displayed in Tables H-26 through H-105 for each county by shortage amount and year evaluated.

Table H-26
Estimated Change In Employment and Income as a Result of a
400,000 af shortage to Non-Indian Agricultural Lands in Arizona—2017

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	(108.6)	(50.5)	(159.1)	(3.144.695)	(1,807,440)	(4.952.135)
Pinal	(177.0)	(183.3)	(360.3)	(10,459,635)	(5,833,577)	(16,293,212)
Mohave	(4.1)	(2.8)	(6.9)	(237,307)	(83,518)	(320,825)
La Paz	(3.4)	(1.8)	(5.1)	(104,770)	(39,827)	(144,598)
Yuma	(7.1)	(3.5)	(10.6)	(157,049)	(96,200)	(253,249)
Total	(300.2)	(241.9)	(542.1)	(14,103,456)	(7,860,562)	(21,964,019)

Table H-27
Estimated Change In Employment and Income as a Result of a
500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2017

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	(108.6)	(50.5)	(159.2)	(3,144.695)	(1,807,440)	(4,952,135)
Pinal	(179)	(186.5)	(365.6)	(10,598,009)	(5,939,280)	(16,537,289)
Mohave	(7.7)	(3.5)	(11.2	(289,494)	(102,518)	(69,941)
La Paz	(4.6)	(2.4)	(7.0)	(142,568)	(54,195	(196,764)
Yuma	(8.5)	(6.4)	(15.0)	(215,957)	(168,664)	(384,621)
Total	(308.4)	(249.3)	(558.0)	(14,390,723)	(8,072,097)	(22,462,821)

Table H-28
Estimated Change In Employment and Income as a Result of a
600,000 af shortage to Non-Indian Agricultural Lands in Arizona—2017

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	(108.6)	(50.5)	(159.2)	(3,144,695)	(1,807,440)	4,952,135
Pinal	(179.0)	(186.5)	(365.6)	(10,598,009)	(5,939,280)	16,537,289
Mohave	11.3)	(4.1)	(15.4	(341,756)	(121,544)	(463,300)
La Paz	5.8)	(3.1)	(8.8)	(180,292)	(68,537)	(248,829)
Yuma	(9.9)	(9.4)	19.3	(274,983)	(241,273)	(516,256)
Total	(314.6)	(253.6)	(568.3)	(14,539,735)	(8,178,074)	(22,717,809)

Table H-29
Estimated Change In Employment and Income as a Result of a
800,000 af shortage to Non-Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(108.6)	(50.5)	(159.2)		(3,144,695)	(1,807,440)	(4,952,135)
Pinal	(176.5)	(186.5)	(358.8)		(10,421,849)	(5,804,713)	(16,226,562)
Mohave	(18.4)	(5.4)	(23.8)		(446,243)	(159,584)	(605,828)
La Paz	(8.2)	(4.3)	12.5)		(255,960)	(97,301)	(353,260)
Yuma	12.7)	(15.4)	(28.1)		(393,035)	(779,526)	(779,526)
Total	(324.4)	(257.9)	(582.4)		(14,661,782)	(8,255,529)	(22,917,311)

Table H-30
Estimated Change In Employment and Income as a Result of a
1,000,000 af shortage to Non-Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(108.6)	(50.5)	(159.2)		(3,144,695)	(1,807,440)	(4,952,135)
Pinal	(176.5)	(182.3)	(358.8)		(10,421,849)	(5,804,713)	(16,226,562)
Mohave	(25.6)	(6.7)	(32.3)		(550,731)	(197,625)	(748,356)
La Paz	(10.5)	(6.5)	(16,9)		(339,619)	(142,884)	(482,503)
Yuma	(15.5)	(21.3	(36.8)		(511,087)	(531,708)	(1,042,795)
Total	(336.7)	(267.3)	(604.0)		(14,967,981)	(8,484,370)	(23,452,351)

Table H-31
Estimated Change In Employment and Income as a Result of a
1,200,000 af shortage to Non-Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(108.6)	(50.5)	(159.2)		(3,144,695)	(1,807,440)	(4,952,135)
Pinal	(176.5)	(182.3)	(358.8)		(10,421,849)	(5,804,713)	(16,226,562)
Mohave	(31.4)	(8.7)	(40.1)		(697,175)	(255,426)	(952,600)
La Paz	(12.2)	(11.0)	(23.2)		(443,513)	(236,452)	(679,965)
Yuma	(17.6)	(25.3)	(42.9)		(15,322,534)	(8,736,544)	(1,247,815)
Total	(346.3)	(277.8)	(624.2)		(15,322,534)	(8,736,544)	(24,059,077)

Table H-32
Estimated Change In Employment and Income as a Result of a
1,800,000 af shortage to Non-Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

Table H-33
Estimated Change In Employment and Income as a Result of a
2,500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

Table H-34
Estimated Change In Employment and Income as a Result of a
400,000 af Shortage to Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(3.2)	(0.9)	(4.1)		(57,706)	(31,711)	(89,416)
Pinal	–	–	–		–	–	–
Pima	(24.2)–	(4.6))	(28.9)		(358,232)	(157,416)	(515,647))
Mohave	–	–	–		–	–	–
La Paz	(1.5)	(0.8)	(1.5)		(47,001)	(17,867)	(64,868)
Yuma	–	–	–		–	–	–
Total	(28.9)	(6.3)	(35.3)		(462,939)	(206,994)	(669,931)

Table H-35
Estimated Change In Employment and Income as a Result of a
500,000 af Shortage to Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(21.4)	(5.8)	(27.2)		(383,787)	(210,898)	(594,685)
Pinal	–	–	–		–	–	–
Pima	(32.9)	(6.3)	(32.9)		(487,150)	(214,065)	(515,647)
Mohave	–	–	–		–	–	–
La Paz	(1.9)	(1.0	2.9		(76,175)	(22,679)	(82,340)
Yuma	–	–	–		–	–	–
Total	(56.2)	(13.2)	(56.2)		(930,598)	(447,642)	(1,378,239)

Table H-36
Estimated Change In Employment and Income as a Result of a
600,000 af Shortage to Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(56.0)	(15.0)	(71.0)		(1,002,712)	(551,008)	(1,553,720))
Pinal	(58.5)	(24.5)	(82.9)		(1,959,296)	(783,798)	(2,743,004)
Pima	(41.8)	(9.5))	(51.3)		(744,163)	(323,577)	(1,067,740)
Mohave	–	–	–		–	–	–
La Paz	(2.2)	(1.7)	(3.9)		(76,175)	(35,572)	(111,746)
Yuma	(0.1)	–	(0.1)		(1,417)	(849)	(2,267)
Total	(158.6)	(50.7)	(209.2)		(3,783,763)	(1,694,714)	(5,478,477)

Table H-37
Estimated Change In Employment and Income as a Result of a
800,000 af Shortage to Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(83.2)	(22.3)	(105.5)		(1,490,470)	(819,041)	(2,309,510)
Pinal	(70.4)	(34.0)	(104.4)		(2,793,733)	(1,095,346)	(3,889.079)
Pima	(41.8)	(13.6)	(61.0)		(1,075,014)	(462,244)	(1,537,258)
Mohave	–	–	–		–	–	–
La Paz	(2.2)	(4.6)	(6.0)		(110,808)	(66,762)	(177,570)
Yuma	(0.1)	(0.2)	(0.6)		(9,540)	(5,717)	(15,257)
Total	(204.2)	(73.0)	(277.5)		(5,479,565)	(2,449,110)	(7,928,674)

Table H-38
Estimated Change In Employment and Income as a Result of a
1,000,000 af Shortage to Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(110.7)	(29.6)	(140.4)		(1,983,478)	(1,089,957)	(3,073,435)
Pinal	(77.8)	(44.2)	(122.0)		(3,705,037)	(1,426,260)	(5,131,297)
Pima	(47.2)	(13.6)	(61)		(1,075,014)	(462,244)	(1,537,258)
Mohave	–	–	–		–	–	–
La Paz	(3.4)	(4.6)	(8.1)		(145,922)	(98,384)	(244,306)
Yuma	(0.8)	(0.6)	(1.4)		(19,769)	(15,568)	(35,364)
Total	(240.1)	(92.6)	(332.9)		(6,929,247)	(3,092,413)	(10,021,660)

Table H-39
Estimated Change In Employment and Income as a Result of a
1,200,000 af Shortage to Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(130.6)	(37.1)	(167.6)		(2,496,359)	(1,361,242)	(3,857,601)
Pinal	(136.7)	(141.3)	(278.0)		(8,073,866)	(4,497,037)	(12,570,903)
Pima	(58.6)	(19.8)	(78.4)		(1,550,723)	(674,158)	(2,224,881)
Mohave	–	–	–		–	–	–
La Paz	(4.0)	(6.2)	(10.2)		(180,984)	(129,963)	(310,947)
Yuma	(1.1)	(1.2)	(2.3)		(31,896)	(30,451)	(62,347)
Total	(331.0)	(205.6)	(536.5)		(12,333,828)	(6,692,851)	(19,026,679)

Table H-40
Estimated Change In Employment and Income as a Result of a
1,800,000 af Shortage to Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Pima	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

Table H-41
Estimated Change In Employment and Income as a Result of a
2,500,000 af Shortage to Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Pima	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

H.4.3 2026 Tables

Table H-42
Estimated Change In Employment and Income as a Result of a
400,000 af shortage to Non-Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(37.4)	(10.4)	(47.4)		(669,446)	(367,872)	(1,037,319)
Pinal	(79.8)	(32.9)	(113.2)		(2,674,458)	(1,069,769)	(3,744,227)
Mohave	(4.0)	(1.4)	(6.8)		(234,587)	(82,548)	(317,135)
La Paz	(3.4)	(0.5)	(5.1)		(104,770)	(39,828)	(144,598)
Yuma	(7.1)	(1.7)	(10.6)		(157,049)	(96,200)	(253,249)
Total	(131.7)	(46.6)	(183.1)		(3,840,310)	(1,656,217)	(5,496,528)

Table H-43
Estimated Change In Employment and Income as a Result of a
500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(37.4)	(10.1)	(47.4)		(669,446)	(367,872)	(1,037,319)
Pinal	(79.8)	(33.3)	(113.2)		(2674,458)	(1,069,769)	(3,744,227)
Mohave	(7.8)	(3.5)	(11.2)		(290,370)	(102,836)	(393,206)
La Paz	(4.6)	(2.4)	(7.0)		(142,568)	(54,195)	(196,764)
Yuma	(8.5)	(6.4)	(15.0)		(215,957)	(168,664)	(384,621)
Total	(138.1)	(55.7)	(193.8)		(3,992,799)	(1,763,336)	(5,756,137)

Table H-44
Estimated Change In Employment and Income as a Result of a
600,000 af shortage to Non-Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(37.4)	(10.1)	(47.4)		(699,446)	(367,872)	(1,037,319)
Pinal	(79.8)	(33.3)	(113.2)		(2,674,458)	(1,069,769)	(3,744,227)
Mohave	(11.4)	(4.1)	(15.5)		(342,772)	(121,914)	(464,685)
La Paz	(5.8)	(3.1)	(8.9)		(181,093)	(68,841)	(249,933)
Yuma	(9.9)	(9.4)	(19.3)		(274,983)	(241,273)	(516,256)
Total	(144.3)	(60.0)	(204.3)		(4,142,752)	(1,869,669)	(6,012,420)

Table H-45
Estimated Change In Employment and Income as a Result of a
800,000 af shortage to Non-Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(37.4)	(10.1)	(47.4)		(669,446)	(367,872)	(1,037,319)
Pinal	(79.8)	(33.3)	(113.2)		(2,674,458)	(1,069,769)	(3,744,227)
Mohave	(18.3)	(5.4)	(23.7)		(444,107)	(158,806)	(602,913)
La Paz	(8.2)	(4.3)	(12.6)		(256,942)	(97,674)	(354,616)
Yuma	(12.7)	(15.4)	(28.1)		(393,035)	(386,491)	(779,526)
Total	(156.4)	(68.5)	(225.0)		(4,437,988)	(2,080,612)	(6,518,601)

Table H-46
Estimated Change In Employment and Income as a Result of a
1,000,000 af shortage to Non-Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(37.4)	(10.1)	(47.4)		(669,446)	(367,872)	(1,037,319)
Pinal	(79.8)	(33.3)	(113.2)		(2,674,458)	(1,069,769)	(3744,227)
Mohave	(25.7)	(6.7)	(32.4)		(552,413)	(198,237)	(750,649)
La Paz	(10.5)	(6.6)	(17.1)		(341,397)	(144,487)	(3,744,227)
Yuma	(15.5)	(21.3	(36.8)		(511,087)	(531,708)	(1,042,795)
Total	(168.9)	(78.0)	(246.9)		(4,748,801)	(2,312,073)	(7,060,874)

Table H-47
Estimated Change In Employment and Income as a Result of a
1,200,000 af shortage to Non-Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(37.4)	(10.1)	(47.4)		(669,446)	(367,872)	(1,037,319)
Pinal	(79.8)	(33.3)	(113.2)		(2,674,458)	(1,069,769)	(3,744,227)
Mohave	(31.5)	(8.7)	(40.2)		(700,735)	(256,885)	(957,620)
La Paz	(12.2)	(11.1)	(23.2)		(445,582)	(238,315)	(683,897)
Yuma	(17.6)	(25.3)	(42.9)		(615,302)	(632,513)	(1,247,815)
Total	(178.5)	(88.5)	(267.0)		(5,105,523)	(2565,354)	(7670,878)

Table H-48
Estimated Change In Employment and Income as a Result of a
1,800,000 af shortage to Non-Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	
Mohave	-	-	-		-	-	-
La Paz	-	-	-		-	-	-
Yuma	-	-	-		-	-	-
Total	-	-	-		-	-	-

Table H-49
Estimated Change In Employment and Income as a Result of a
2,500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

Table H-50
Estimated Change In Employment and Income as a Result of a
400,000 af Shortage to Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(81.8)	(54.5)	(136.3)		(3,196,822)	(1,912,788)	(5,109,610)
Pinal	(37.0)	(15.5)	(52.5)		(1,240,197)	(496,072)	(1,736,269)
Pima	(42.7)	(10.2)	(52.9)		(796,916)	(345,687)	(1,142,603)
Mohave	–	–	–		–	–	–
La Paz	-	–	-		-	-	-
Yuma	-	–	-		-	-	-
Total	(161.5)	(80.1)	(241.7)		(5,233,935)	(2,754,547)	(7,988,482)

Table H-51
Estimated Change In Employment and Income as a Result of a
500,000 af Shortage to Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(141.8)	(77.1)	(218.8)		(4,597,707)	(2,722,517)	(7,320,224)
Pinal	(64.9)	(27.1)	(92.1)		(2,678,090)	(1,053,574)	(3,732,272)
Pima	(44.5)	(11.4)	(56.0)		(903,686)	(390,436)	(1,294,122)
Mohave	–	–	–		–	–	–
La Paz	-	-	-		-	-	-
Yuma	-	-	-		-	-	-
Total	(251.2)	(115.6)	(366.9)		(8,180,090)	(4,166,527)	(12,346,618)

Table H-52
Estimated Change In Employment and Income as a Result of a
600,000 af Shortage to Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(156.2)	(80.9)	(237.1)		(4,855,882)	(2,864,389)	(7,720,271)
Pinal	(69.4)	(32.7)	(102.2)		(2,678,697)	(1,053,574)	(3,732,272)
Pima	(44.5)–	(11.4)	(56.0)		(903,686)	(390,436)	(1,294,122)
Mohave	–	–	–		–	–	–
La Paz	-	-	-		-	-	-
Yuma	-	-	-		(1,417)	(849)13,084)	(2,267)
Total	(270.1)	(125.0)	(395.3)		(8,439,682)	(4,309,248)	(12,748,932)

Table H-53
Estimated Change In Employment and Income as a Result of a
800,000 af Shortage to Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(186.1)	(88.9)	(275.0)		(5,391,576)	(3,158,764)	(8,550,339)
Pinal	(75.9)	(41.6)	(117.4)		(3,470,334)	(1,341,034)	(4,811,368)
Pima	(49.2)	(15.4)	(64.5)		(1,216,738)	(522,835)	(1,739,573)
Mohave	–	–	–		–	–	–
La Paz	-	–	-		-	-	-
Yuma	(0.4)	(0.2)	(0.6)		(9,540)	(5,717))	(15,257)
Total	(311.6)	(146.1)	(395.3)		(10,088,188)	(5,028,350)	(15,116,537)

Table H-54
Estimated Change In Employment and Income as a Result of a
1,000,000 af Shortage to Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(190.3)	(90.0)	(280.3)		(5,465,869)	(3,199,588)	(8,665,458)
Pinal	(82.4)	(50.5)	(133.0)		(3,470,334)	(1,633,615)	(5,909,685)
Pima	(78.1)	(29.9)	(108.0)		(1,216,738)	(1,021,752)	(5,909,685)
Mohave	–	–	–		–	–	–
La Paz	-	–	-		-	-	-
Yuma	(0.8)	(0.6)	(1.4)		(19,796)	(15,568)	(35,364
Total	(351.6)	(171.0)	(522.7)		(12,078,946)	(5,870,523)	(17,948,570)

Table H-55
Estimated Change In Employment and Income as a Result of a
1,200,000 af Shortage to Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(214.3)	(112.7)	(327.0)		(6,878,873)	(4,006,751)	(10,855,625)
Pinal	(162.2)	(183.8)	(346)		(9,833,478)	(5,841,186)	(15,674,664)
Pima	(113.8)	(48.5)	(162.4)		(3,721,370)	(1,659,680)	(5,381,050)
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	(1.1)	(1.2)	(2.3)		(31,896)	(30,451)	(62,347)
Total	(491.4)	(346.2)	(837.7)		(20,465,617)	(11,534,427)	(32,003,686)

Table H-56
Estimated Change In Employment and Income as a Result of a
1,800,000 af Shortage to Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	-	-	-		-	-	-
Pinal	-	-	-		-	-	-
Pima	-	-	-		-	-	-
Mohave	–	–	–		–	–	–
La Paz	-	-	-		-	-	-
Yuma	-	-	-		-	-	-
Total	-	–	-		-	-	-

Table H-57
Estimated Change In Employment and Income as a Result of a
2,500,000 af Shortage to Indian Agricultural Lands in Arizona—2026

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Pima	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

H.4.4 2027 Tables

Table H-58
Estimated Change In Employment and Income as a Result of a
400,000 af shortage to Non-Indian Agricultural Lands in Arizona—2027

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	–	–	–	–	–	–
Pinal	–	–	–	–	–	–
Mohave	–	–	–	–	–	–
La Paz	–	–	–	–	–	–
Yuma	–	–	–	–	–	–
Total	–	–	–	–	–	–

Table H-59
Estimated Change In Employment and Income as a Result of a
500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2027

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	(17.2)	(4.6)	(21.8)	(307,969)	(169,234)	(477,203)
Pinal	(42.7)	(17.9)	(60.6)	(1,432,396)	(572,951)	(2,005,347)
Mohave	(7.8)	(3.5)	(11.2)	(290,370)	(102,837)	(393,206)
La Paz	(4.6)	(2.4)	(7.0)	(142,568)	(54,195)	(196,764)
Yuma	(8.5)	(6.4)	(15.0)	(215,957)	(168,664)	(384,621)
Total	(80.8)	(34.8)	(115.8)	(2,389,260)	(1,067,881)	(3,457,141)

Table H-60
Estimated Change In Employment and Income as a Result of a
600,000 af shortage to Non-Indian Agricultural Lands in Arizona—2027

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	(17.2)	(4.6)	(21.8)	(307,969)	(169,234)	(477,203)–
Pinal	(42.7)	(17.9)	(60.6)	(1,432,396)	(572,951)	(2,005,347)
Mohave	(11.4)	(4.1)	(15.5)	(342,772)	(121,914)	(464,685)
La Paz	(5.8)	(3.1)	(8.9)	(181,093)	(68,841)	(249,933)
Yuma	(9.9)	(9.4)	(19.3)	(274,983)	(241,271)	(516,256)
Total	(87.0)	(39.1)	(126.1)	(2,539,213)	(1,174,213)	(3,713,424)

Table H-61
Estimated Change In Employment and Income as a Result of a
800,000 af shortage to Non-Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(17.2)	(4.6)	(21.8)		(307,969)	(169,234)	(477,203)
Pinal	(42.7)	(17.9)	(60.6)		(1,432,396)	(572,951)	(2,005,347)
Mohave	(18.5)	(5,4)	(24.0)		(447,750)	(160,234)	(607,882)
La Paz	(8.2)	(4.3)	(12.6)		(256,942)	(97,674)	(354,616)
Yuma	(12.7)	(15.4)	(28.1)		(393.035)	(386,491)	(779,526)
Total	(99.3)	(47.6)	(147.1)		(2,838,092)	(1,386,483)	(4,224,574)

Table H-62
Estimated Change In Employment and Income as a Result of a
1,000,000 af shortage to Non-Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(17.2)	(6.6)	(21.8)		(307,969)	(169,234)	(477,203)
Pinal	(42.7)	(17.9)	(60.6)		(1,432,396)	(572,951)	(2,005,347)
Mohave	(25.7)	(6.7)	(32.4)		(552,413)	(198,237)	(750,649)
La Paz	(10.5)	(6.6)	(17.7)		(341,397)	(144,487)	(485,884)
Yuma	(15.5)	(21.3)	(36.8)		(511,087)	(531,708)	(1,042,795)
Total	(111.6)	(57.1)	(168.7)		(3,145,262)	(1,616,617)	(4,761,878)

Table H-63
Estimated Change In Employment and Income as a Result of a
1,200,000 af shortage to Non-Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(17.2)	(4.6)	(21.8)		(307,969)–	(169,234)	(683,897)
Pinal	(42.7)	(17.9)	(60.6)		(1,432,396)	(572,951)	(2,005,347)
Mohave	(31.5)	(8.7)	(40.2)		(700,735)	(256,885)	(957,620)
La Paz	(12.2)	(11.1)	(23.3)		(445,582)	(486,619)	(1,207,911)
Yuma	(17.6)	(25.3)	(42.9)		(615,302)	(632,513)	(1,247,815)
Total	(121.2)	(67.6)	(188.8)		(3,501,984)	(1869,898)	(5,371,882)

Table H-64
Estimated Change In Employment and Income as a Result of a
1,800,000 af shortage to Non-Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(17.2)	(4.6)	(21.8)		(307,969)	(169,234)	(477,203)
Pinal	(42.7)	(17.9)	(60.6)		(1,432,396)	(572,951)	(2,005,347)
Mohave	(43.7)	(15.6)	(59.3)		(1,182,325)	(454,329)	(1,636,654)
La Paz	(16.8)	(23.2)	(40.0)		(721,292)	(488,619)	(1,207,911)
Yuma	(54.1)	(43.3)	97.5)		(1,457,393)	(1,134,254)	(2,591,647)
Total	(174.5)	(104.6)	(279.2)		(5,101.375)	(2,817,387)	(7,918,762)

Table H-65
Estimated Change In Employment and Income as a Result of a
2,500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(17.2)	(4.6)	(21.8)		(307,969)	(169,234)	(477,203)
Pinal	(42.7)	(17.9)	(60.6)		(1,432,396)	(572,951)	(2,005,347)
Mohave	(17.2)	(15.6)	(59.3)		(1,182,325)	(454,329)	(1,636,654)
La Paz	(16.8)	(23.2)	(40.0)		(721,292)	(488,619)	(1,207,911)
Yuma	(341.2)	(179.1)	(520.3)		(7,738,710))	(4,898,615)	(12,637,325)
Total	(461.6)	(240.4)	(702.0)		(11,382,692)	(6,581,748)	(17,964,440)

Table H-66
Estimated Change In Employment and Income as a Result of a
400,000 af Shortage to Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Pima	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

Table H-67
Estimated Change In Employment and Income as a Result of a
500,000 af Shortage to Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(166.3)	(88.6)	(254.9)		(5,287,882)	(3,132,356	(8,420,237)
Pinal	(64.9)	(27.1)	(92.1)		(2,893,043)	(1,131,408)	(4,024,451)
Pima	(44.8)	(11.9)	(56.7)		(939,139)	(405,156)	(1,344,295)
Mohave	–	–	–		–	–	–
La Paz	(1.9)	(1.1)	(2.9)		(59,661)	(22,679)	(82,340)
Yuma	-	–	–		–	–	–
Total	(277.9)	(128.7)	(406.6)		(9,179,725)	(4,691,599)	(13,871,323)

Table H-68
Estimated Change In Employment and Income as a Result of a
600,000 af Shortage to Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(178.2)	(90.2)	(268.4)		(5,417,985)	(3,195,798)	(8,613,782)
Pinal	(69.4)	(32.7)	(102.2)		(2,678,697)	(1,053,574)	(3,732,272)
Pima	(44.8)	(11.9)	(56.7)–		(940,157)	(405,582)	(1,345,739)–
Mohave	–	–	–		–	–	–
La Paz	(2.2)	(1.7)	(3.9)		(76,175)	(35,572)	(111,746)
Yuma	(0.1)	-	(0.1)		(1,417)	(849)	(2,267)
Total	(297.4)	(136.5)	(431.3)		(9,114,131)	(4,691,375)	(13,805,806)

Table H-69
Estimated Change In Employment and Income as a Result of a
800,000 af Shortage to Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(199.0)	(98.4)	(297.4)		(5,987,056)	(3,495,381)	(9,482,436)
Pinal	(75.9)	(41.6)	(117.4)		(3,470,334)	(1,341,034)	(4,811,368)
Pima	(65.3)	(23.4)	(88.8)		(1,826,051)	(799,522)	(2,625,436)
Mohave	–	–	–		–	–	–
La Paz	(2.8)	(3.2)	(6.0)		(110,808)	(66,762)	(177,570)
Yuma	(0.4)	(0.2)	(0.6)		(9,540)	(5,717)	(15,257)
Total	(343.4)	(166.8)	(510.2)		(11,403,789)	(8,026,685)	(17,112,204)

Table H-70
Estimated Change In Employment and Income as a Result of a
1,000,000 af Shortage to Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(211.3)	(110.0)	(321.3)		(6,717,901)	(3,910,207)	(10,628,108)
Pinal	(82.4)	(50.5)	(133.0)		(4,276,070)	(1,633,615)	(5,909,685)
Pima	(78.5)	(30.3)	(108.9)		(2,343,850)	(1,034,614)	(3,378,464)
Mohave	–	–	–		–	–	–
La Paz	(3.4)	(4.6)	(8.1)		(145,922)	(98,384)	(244,306)
Yuma	(0.8)	(0.6)	(1.4)		(19,796)	(15,568)	(35,364)
Total	(376.4)	(196)	(572.7)		(13,503,539)	(9,419,500)	(20,195,927)

Table H-71
Estimated Change In Employment and Income as a Result of a
1,200,000 af Shortage to Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(228.9)	(126.4)	(355.3)		(7,618,460)	(4,476,504)	(12,094,964)
Pinal	(162.2)	(183.8)	(346.0)		(9,833,478)	(1,633,615)	(4,811,368)
Pima	(78.5)	(30.3)	(108.9)		(2,343,850)	(1,034,614)	(3,378,464)
Mohave	–	–	–		–	–	–
La Paz	(4.0)	(6.2)	(10.2)		(180,984)	(129,963)	(310,947)
Yuma	(1.1)	(1.2)	(2.3)		(31,896)	(30,451)	(62,347)
Total	(474.7)	(347.9)	(822.7)		(20,008,668)	(17,531,261)	(31,521,386))

Table H-72
Estimated Change In Employment and Income as a Result of a
1,800,000 af Shortage to Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(274.8)	(169.1)	(443.9)		(9,964,882)	(5,952,004)	(15,916,887)
Pinal	(170.7)	(198.1)	(368.7)		(10,420,784)	(6,289,824)	(16,710,607)
Pima	(112.9)	(48.3)	(161.1)		(3,693,056)	(1,647,183)	(5,340,239)
Mohave	–	–	–		–	–	–
La Paz	(5.0)	(8.6)	(13.6)		(2259,074)	(180,276)	(439,350)
Yuma	(1.7)	(2.4)	(4.1)		(61,070)	(60,224)	(121,293)
Total	(565.1)	(426.5)	(991.4)		(24,398,866)	(21,305,395)	(38,528,376)

Table H-73
Estimated Change In Employment and Income as a Result of a
2,500,000 af Shortage to Indian Agricultural Lands in Arizona—2027

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(274,8(	(169.1)	(443.9)		(9,964,882)	(5,952,004)	(15,916,887)
Pinal	(170.7)	(198.1)	(368.7)		(10,420,784)	(6,289,824)	(16,710,607)
Pima	(112.9)	(48.3)	(161.1)		(3,693,056)	(1,647,183)	(5,340,239)
Mohave	–	–	–		–	–	–
La Paz	(5.0)–	(8.6)	(13.6)		(2259,074)	(180,276)	(439,350)
Yuma	(1.7)	(2.4)	(4.1)		(61,070)	(60,224)	(121,293)
Total	(565.1)	(426.5)	(991.4)		(24,398,866)	(21,305,395)	(38,528,376)

H.4.5 2040 Tables

Table H-74
Estimated Change In Employment and Income as a Result of a
400,000 af shortage to Non-Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

Table H-75
Estimated Change In Employment and Income as a Result of a
500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	(7.3)	(3.0)	(10.4)		(246,083)	(98,432)	(344,515)
Mohave	(7.8)	(3.5)	(11.2)		(290,370)	(102,837)	(393,206)
La Paz	(4.6)	(2.4)	(7.0)		(142,568)	(54,195)	(196,764)
Yuma	(8.5)	(6.4)	(15.0)		(215,957)	(168,664)	(384,621)
Total	(28.2)	(15.3)	(43.6)		(894,978)	(424,128)	(1,319,106)

Table H-76
Estimated Change In Employment and Income as a Result of a
600,000 af shortage to Non-Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	(7.3)	(3.0)	(10.4)		(246,083)	(98,432)	(344,515)
Mohave	(11.4)	(4.1)	(15.5)		(342,772)	(121,914)	(464,685)
La Paz	(5.8)	(3.1)	(8.9)		(181,093)	(68,841)	(249,933)
Yuma	(9.9)	9.4)	(19.3)		(274,983)	(241,273)	(516,256)
Total	(34.4)	(19.6)	(54.1)		(1,044,931)	(530,460)	(1,575,389)

Table H-77
Estimated Change In Employment and Income as a Result of a
800,000 af shortage to Non-Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	(7.3)	(3.0)	(10.4)		(246,083)	(98,432)	(344,515)
Mohave	(18.5)	(5.4)	(24.0)		(447,750)	(160,133)	(607,882)
La Paz	(8.2)	(4.3)	(12.6)		(246,083)	(97,674)	(354,616)
Yuma	(12.7)	(17.4)	(28.1)		(393,035)	(386,491)	(779,526)
Total	(46.7)	(28.1)	(75.1)		(1,343,810)	(742,730)	(2,086,539)

Table H-78
Estimated Change In Employment and Income as a Result of a
1,000,000 af shortage to Non-Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	(7.3)	(3.0)–	(10.4)		(246,083)	(98,432)	(344,515)
Mohave	(25.7)	(6.7)	(32.4)		(552,413)	(198,237)	(750,649)
La Paz	(10.5)	(6.6)	(17.1)		(341,397)	(144,487)	(485,884)
Yuma	(15.5)	(21.3)	(36.8)		(511,087)	(531,708)	(1,042,795)
Total	(59.0)	(37.6)	(96.7)		(1,650,980)	(972,864)	(2,623,843)

Table H-79
Estimated Change In Employment and Income as a Result of a
1,200,000 af shortage to Non-Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	(7.3)	(3.0)	(10.4)		(246,083)	(98,432)	(344,515)
Mohave	(31.5)	(8,7)	(40.2)		(700,735)	(256,885)	(957,620)
La Paz	(12.2)	(11.1)	(23.2)		(445,582)	(283,315)	(683,897)
Yuma	(17.6)	(25.3)	(42.9)		(615,302)	(632,513)	(1,247,815)
Total	(68.6)	(48.1)	(116.8)		(2,007,702)	(1,226,145)	(3,233,847)

Table H-80
Estimated Change In Employment and Income as a Result of a
1,800,000 af shortage to Non-Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	(7.3)	(3.0)	(10.4)		(246,083)	(98,432)	(344,515)
Mohave	(43.7)	(15.6)	(59.3)		(1,182,325)	(454,329)	(1,636,654)
La Paz	(16.8)	(23.2)	(40.0)		(721,292)	(486,619)	(1,207,911)
Yuma	(59.4)	(45.8)	(105.3)		(1,574,116)	(1,204,205)	(2,778,321)
Total	(127.2)	(87.6)	(215.0)		(3,723,816)	(2,243,585)	(5,967,401)

Table H-81
Estimated Change In Employment and Income as a Result of a
2,500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

Table H-82
Estimated Change In Employment and Income as a Result of a
400,000 af Shortage to Indian Agricultural Lands in Arizona—2040

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	–	–	–	–	–	–
Pinal	–	–	–	–	–	–
Pima	–	–	–	–	–	–
Mohave	–	–	–	–	–	–
La Paz	–	–	–	–	–	–
Yuma	–	–	–	–	–	–
Total	–	–	–	–	–	–

Table H-83
Estimated Change In Employment and Income as a Result of a
500,000 af Shortage to Indian Agricultural Lands in Arizona—2040

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	(146.1)	(65.1)	(211.2)	(4,021,215)	(2,326,029)	(6,347,244)
Pinal	73.6)	(38.4)	(112.0)	(3,186,707)	(1,238,044)	(4,424,750)
Pima	(42.8)	(10.5)	(53.4)	(825,688)	(357,606)	(1,183,293)
Mohave	–	–	–	–	–	–
La Paz	(1.9)	(1.1)	2.9)	(59,661)	(22,679)	(82,340)
Yuma	-	-	-	-	-	-
Total	(264.4)	(115.1)	(379.5)	(8,093,271)	(3,944,358)	(12,037,627)

Table H-84
Estimated Change In Employment and Income as a Result of a
600,000 af Shortage to Indian Agricultural Lands in Arizona—2040

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	(159.3)	(67.8)	(227.0)	(4,207,370)	(2,424,192)	(26,631,562)
Pinal	(77.2)	(43.4)	(120.6)	(3,632,464)	(1,399,907)	(5,032,372)
Pima	(43.3)	(10.9)	(54.2)	(853,090)	(369,090)	(1,222,180)
Mohave	–	–	–	–	–	–
La Paz	(2.2)	(1.7)	(3.9)	(76,175)	(35,572)	(111,746)
Yuma	(0.1)	-	(0.1)	(1,417)	(849)	(2,267)
Total	(282.1)	(123.8)	(405.8)	(8770,516)	(4,229,610)	(13,000,127)

Table H-85
Estimated Change In Employment and Income as a Result of a
800,000 af Shortage to Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(174.9)	(75.9)	(250.8)		(4,795,878)	(2,726,885)	(7,522,762)
Pinal	(84.5)	(53.8)	(138.2)		(4,459,924)	(1,736,385)	(6,196,309)
Pima	(48.7)	(14.7)	(63.4)		(1,168,495)	(501,284)	(1,669,779)
Mohave	–	–	–		–	–	–
La Paz	(2.8)	(3.2)	(6.0)		(110,808)	(66,762)	(177,570)
Yuma	(0.4)	(0.2)	(0.6)		(9,540)	(5,717)	(15,257)
Total	(311.3)	(147.8)	(459.0)		(10,544,645)	(5,037,033)	(15,581,677)

Table H-86
Estimated Change In Employment and Income as a Result of a
1,000,000 af Shortage to Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(189.7)	(89.7)	(279.4)		(5,608,426)	(3,212,536)	(8,820,962)
Pinal	(61.6)	(80.3)	(180.7)		(5,556,848)	(2,574,315)	(8,131,163)
Pima	(100.4)	(21.5)	(83.1)		(1,679,453)	(732,963)	(2,412,416)
Mohave	–	–	–		–	–	–
La Paz	(3.4)	(4.6)	(8.1)		(145,922)	(98,384)	(244,306)
Yuma	(0.8)	(0.6)	(1.4)		(19,796)	(15,568)	(35,364)
Total	(355.9)	((196.7)	(552.7)		(13,010,445)	(6,633,766)	(19,644,211)

Table H-87
Estimated Change In Employment and Income as a Result of a
1,200,000 af Shortage to Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(207.3)	(106.2)	(313.6)		(6512,873)	(3,781,279)	(10,294,152)
Pinal	(119.2)	(111.9)	(231.1)		(6,862,348)	(3,571,572)	(10,433,920)
Pima	(74.7)	(28.3)	(103.0)		(2,193,230)	(966,229)	(3,159,459)
Mohave	–	–	–		–	–	–
La Paz	(4.0)	(6.2)	(8.1)		(180,984)	(129,963)	(310,947)
Yuma	(1.1)	(1.2)	(2.3)		(31,896)	(30,451)	(62,347)
Total	((406.3)	(253.8)	(660.2)		(15,781,331)	(8,479,494)	(24,260,825)

Table H-88
Estimated Change In Employment and Income as a Result of a
1,800,000 af Shortage to Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	252.5)	148.3)	(400.9)		(8,825,586)	(5,235,581)	(14,061,167)
Pinal	(179.8)	(213.4)	(393.3)		(11,056,936)	(6,775,773)	(17,832,708)
Pima	(108.1)	(45.8)	(153.9)		(3,507,077)	(1,562,744)	(5,069,821)
Mohave	–	–	–		–	–	–
La Paz	(5.0)	(8.6)	(1367)		(259,074)	(180,276)	(439,350)
Yuma	(1.7)	(2.4)	(4.1)		(61,070)	(30,451)	(62,347)
Total	(547.1)	(418.5)	(965.8)		(23,709,743)	(13,814,598)	(37,524,339)

Table H-89
Estimated Change In Employment and Income as a Result of a
2,500,000 af Shortage to Indian Agricultural Lands in Arizona—2040

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Pima	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

H.4.6 2060 Tables

Table H-90
Estimated Change In Employment and Income as a Result of a
400,000 af shortage to Non-Indian Agricultural Lands in Arizona—2060

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	–	–	–	–	–	–
Pinal	–	–	–	–	–	–
Mohave	–	–	–	–	–	–
La Paz	–	–	–	–	–	–
Yuma	–	–	–	–	–	–
Total	–	–	–	–	–	–

Table H-91
Estimated Change In Employment and Income as a Result of a
500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2060

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	–	–	–	–	–	–
Pinal	(6.6)	(2.8)	(9.4)	(222,125)	(88,849)	(310,974)
Mohave	(7.8)	(3.5)	(11.2)	(290,370)	(102,837)	(393,206)
La Paz	(4.6)	(2.4)	(7.0)	(142,568)	(54,195)	(196,764)
Yuma	(8.5)	(6.4)	(15.0)	(215,957)	(168,664)	(384,621)
Total	(27.5)	(15.1)	(42.6)	(871,020)	(414,545)	(1,285,565)

Table H-92
Estimated Change In Employment and Income as a Result of a
600,000 af shortage to Non-Indian Agricultural Lands in Arizona—2060

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	–	–	–	–	–	–
Pinal	(6.6)	(2.8)	(9.4)	(222,125)	(88,849)	(310,974)
Mohave	(11.4)	(4.1)	(15.5)	(342,772)	(121,914)	(464,685)
La Paz	(5.8)	(3.1)	(8.9)	(181,093)	((68,841)	(249,933)
Yuma	(9.9)	(9.4)	(19.3)	(274,983)	(241,273)	(516,256)
Total	(33.7)	(19.4)	(53.1)	(1,020,973)	(520,877)	(1,541,848)

Table H-93
Estimated Change In Employment and Income as a Result of a
800,000 af shortage to Non-Indian Agricultural Lands in Arizona—2060

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	(6.6)	(2.8)	(9.4)		(222,125)	(88,849)	(310,974)
Mohave	(18.5)	(5.4)	(24.0)		447,750	(160,133)	(607,882)
La Paz	(8.2)	(4.3)	(12.6)		(256,942)	(97,674)	(354,616)
Yuma	(2.7)	(15.4)	(28.1)		(393,035)	(386,491)	(779,526)
Total	(46.0)	(27.9)	(74.1)		(1,319,852)	(733,147)	(2,052,998)

Table H-94
Estimated Change In Employment and Income as a Result of a
1,000,000 af shortage to Non-Indian Agricultural Lands in Arizona—2060

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	(6.6)	(2.8)	(9.4)		(222,125)	(88,849)	(310,974)
Mohave	(25.7)	(6.7)	(32.4)		(552,413)	(198,237)	(750,648)
La Paz	(10.5)	(6.6)	(17.1)		(341,397)	(144,487)	(485,884)
Yuma	(15.5)	(21.3)	(36.8)		(511,087)	(531,708)	(1,042,795)
Total	(58.3)	(37.4)	(95.7)		(1,627,022)	(963,281)	(2,590,302)

Table H-95
Estimated Change In Employment and Income as a Result of a
1,200,000 af shortage to Non-Indian Agricultural Lands in Arizona—2060

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	(6.6)	(2.8)	(9.4)		(222,125)	(88,849)	(310,974)
Mohave	(31.5)	(8.7)	(40.2)		700,735	256,885)	(957,620)
La Paz	(12.2)	(11.1)	(23.3)		(445,582)	(238,315)	(683,897)
Yuma	(17.6)	(25.3)	(43.0)		(620,096)	(635,149)	(1,042,795)
Total	(67.9)	(47.9)	(115.9)		(3,699,892)	(1,219,198)	(3,207,736)

Table H-96
Estimated Change In Employment and Income as a Result of a
1,800,000 af shortage to Non-Indian Agricultural Lands in Arizona—2060

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	(6.6)	(2.8)	(9.4)		(222,125)	(88,849)	(310,974)
Mohave	(43.7)	(15.6)	(59.3)		(1,182,235)	(454,329)	(1,636,654)
La Paz	(16.8)	(23.2)	(40.0)		(721,292)	(486,619)	(683,897)
Yuma	(59.5)	(45.8)	(105.3)		(1,574,150)	(1,204,255)	(2,778,376)
Total	(126.6)	(87.4)	(214.0)		(3,699,892)	(2,234,022)	(5,933,915)

Table H-97
Estimated Change In Employment and Income as a Result of a
2,500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2060

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

Table H-98
Estimated Change In Employment and Income as a Result of a
400,000 af Shortage to Indian Agricultural Lands in Arizona—2060

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Pima	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

Table H-99
Estimated Change In Employment and Income as a Result of a
500,000 af Shortage to Indian Agricultural Lands in Arizona—2060

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	(134.9)	(57.9)	(192.8)	(3,605,593)	(2,071,498)	(5,677,452)
Pinal	(72.0)	(36.2)	(108.2)	(2,992,272)	(1,167,440)	(4,159,712)
Pima	(41.4)	(9.5)	(50.9)	(742,138)	(322,589)	(1,064,726)
Mohave	–	–	–	–	–	–
La Paz	(2.2)	(1.1)	(2.9)	(59,661)	(22,679)	(82,340)
Yuma	-	-	-			
Total	(250.2)	(104.7)	(354.8)	(7,440,024)	(3,584,206)	(10,984,230)

Table H-100
Estimated Change In Employment and Income as a Result of a
600,000 af Shortage to Indian Agricultural Lands in Arizona—2060

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	(148.1)	(60.9)	(208.7)	(3,799,711)	(2,174,774)	(5,974,485)
Pinal	(75.5)	(41.0)	(116.5)	(3,421,898)	(1,323,446)	(4,745,344)
Pima	(41.9)	(9.9)	(51.8)	(773,105)	(335,567)	(1,108,672)
Mohave	–	–	–	–	–	–
La Paz	(2.2)	(1.7)	(3.9)	(876,175)	(35,572)	(111,746)
Yuma	(01)	-	(0.1)	(1,417)	(849)	(2,267)
Total	(267.8)	(113.2)	(381.0)	((8,072,306)	(3,870,208)	(11,942,514)

Table H-101
Estimated Change In Employment and Income as a Result of a
800,000 af Shortage to Indian Agricultural Lands in Arizona—2060

	Employment			Income		
County	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Maricopa	(167.3)	(68.7)	(236.0)	(4,375,668)	(2,475,624)	(6,851,292)
Pinal	(82.0)	(49.9)	(131.9)	(4,218,613)	(1,612,751)	(5,851,292)
Pima	(47.3)	(13.7)	(61.0)	(1,086,936)	(467,101)	(1,554,036)
Mohave	–	–	–	–	–	–
La Paz	(2.8)	(3.2)	(6.0)	(110,808)	(66,762)	(177,570)
Yuma	(0.4)	(0.2)	(0.6)	(9,540)	(5,717)	(15,257)
Total	(299.8)	(135.7)	(435.5)	(9,801,565)	(4,627,955)	(14,429,519)

Table H-102
Estimated Change In Employment and Income as a Result of a
1,000,000 af Shortage to Indian Agricultural Lands in Arizona—2060

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(180.4)	(81.1)	(261.5)		(5,133,941)	(2,914,166)	(8,048,107)
Pinal	(96.0)	(73.1)	(169,0)		(5,256,237)	(2,344,681)	(7,600,918)
Pima	(47.1)	(18.8)	(65.9)		(1,465,083)	(638,763)	(7,600,918)
Mohave	–	–	–		–	–	–
La Paz	(3.4)	(4.6)	(8.1)		(145,922)	(98,384)	(244,306)
Yuma	(0.8)	(0.6)	(1.4)		(19,796)	(15,568)	(35,364)
Total	(327.7)	(178.2)	(505.9)		(12,020,979)	(6,011,562)	(18,032,542)

Table H-103
Estimated Change In Employment and Income as a Result of a
1,200,000 af Shortage to Indian Agricultural Lands in Arizona—2060

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(198.0)	(97.5)	(295.6)		(6,037,651)	(3,482,445)	(9,520,096)
Pinal	(114.9)	(104.6)	(219.5)		(66,560,954)	(3,341,340)	(9,902,295)
Pima	(71.2)	(26.5)	(97.7)		(2,056,496)	(904,148)	(2,960,645)
Mohave	–	–	–		–	–	–
La Paz	(4.0)	(6.2)	(10.2)		(180,984)	(129,963)	(310,947)
Yuma	(1.1)	(1.2)	(2.3)		(31,896)	(30,451)	(62,347)
Total	(398.2)	(236.0)	(625.3)		(14,867,981)	(7,888,347)	(22,756,330)

Table H-104
Estimated Change In Employment and Income as a Result of a
1,800,000 af Shortage to Indian Agricultural Lands in Arizona—2060

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	(243.2)	(139.7)	(382.9)		(8,350,095)	(4,936,579)	(13,286,674)
Pinal	(175.5)	(206.2)	(381.6)		(10,755,039)	(6,545,157)	(17,300,196)
Pima	(104.6)	(43,9)	(148.6)		(3,369,095)	(1,500,423)	(4,870,234)
Mohave	–	–	–		–	–	–
La Paz	(5.0)	(8.6)	(13.6)		(259,074)	(182,276)	(439,350)
Yuma	(1.7)	(2.4))	(4.1)		(61,070)	(60,224)	(121,293)
Total	(530.0)	(400.8)	(930.8)		(22,795,089)	(13,222,659)	(36,017,747)

Table H-105
Estimated Change In Employment and Income as a Result of a
2,500,000 af Shortage to Indian Agricultural Lands in Arizona—2060

	Employment				Income		
County	Direct	Indirect + Induced	Total		Direct	Indirect + Induced	Total
Maricopa	–	–	–		–	–	–
Pinal	–	–	–		–	–	–
Pima	–	–	–		–	–	–
Mohave	–	–	–		–	–	–
La Paz	–	–	–		–	–	–
Yuma	–	–	–		–	–	–
Total	–	–	–		–	–	–

H.5 County Level Changes in Tax Revenue

H.5.1 Summary Tables

Tables H-106 through H-107 summarize the changes in Tax Revenue as a result of shortage to Indian and non-Indian agricultural lands. The summaries are shown by level of shortage and by selected years. For years in which there is no probability of a particular shortage level, impacts are negligible and not displayed. Shortages generated in 2008 are not displayed because there was no probability of shortage in that year.

Table H-106
Estimated Changes in Tax Revenues as a Result of Shortages to
Non-Indian Agricultural Lands for Selected Shortage Amounts and Years

Shortage Amount (af)	Year				
	2017	2026	2027	2040	2060
400,000	(7,540,614)	(1,916,810)	–	–	–
500,000	(7,708,603)	(2,002,340)	(1,193,599)	(441,586)	(429,807)
600,000	(7,792,562)	(2,086,731)	(1,277,990)	(525,977)	(514,198)
800,000	(7,853,475)	(2,253,320)	(1,446,304)	(694,291)	(682,512)
1,000,000	(8,095,358)	(2,431,832)	(1,623,091)	(871,078)	(859,299)
1,200,000	(8,161,205)	(2,630,341)	(1,821,600)	(1,069,587)	(1,060,226)
1,800,000	–	(3,457,940)	(2,649,199)	(1,958,230)	(1,946,469)
2,500,000	–	–	(5,934,205)	–	–

Table H-107
Estimated Changes in Tax Impacts as a Result of Shortages to
Indian Agricultural Lands for Selected Shortage Amounts and Years

Shortage Amount (af)	Year				
	2017	2026	2027	2040	2060
400,000	(236,807)	(2,666,626)	–	–	–
500,000	(486,410)	(3,928,252)	(4,337,093)	(4,114,091)	(3,766,207)
600,000	(1,924,884)	(4,308,056)	(4,661,288)	(4,452,866)	(4,102,823)
800,000	(2,774,543)	(5,128,425)	(5,782,239)	(5,334,975)	(6,358,789)
1,000,000	(3,503,468)	(6,080,379)	(6,808,337)	(6,688,004)	(6,945,123)
1,200,000	(6,597,108)	(10,840,482)	(10,666,914)	(8,221,182)	(7,728,773)
1,800,000	–	(11,159,957)	(12,932,488)	(12,645,448)	(12,152,341)
2,500,000	–	–	(12,932,488)	–	–

H.5.2 2017 Tables

The estimated change in tax impact as a result of shortages on Indian and Non-Indian agricultural lands are displayed in Tables H-108 through H-147 for each county by shortage amount and year evaluated.

Table H-108
Estimated Change In Tax Impact as a Result of a 400,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2017

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(1,655,892)	(31,620)
Pinal	(5,648,411)	-
Mohave	(105,818)	–
La Paz	(47,736)	(21,415)
Yuma	(82,757)	-
Pima	–	(183,052)
Total	(7,540,614)	(236,087

Table H-109
Estimated Change In Tax Impact as a Result of a 500,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2017

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(1,655,892)	(210,299)
Pinal	(5,732,527)	-
Mohave	(130,532)	–
La Paz	(64,957)	(27,183)
Yuma	(124,695)	-
Pima	–	(248,928)
Total	(7,708,603)	(486,410

Table H-110
Estimated Change In Tax Impact as a Result of a 600,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2017

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(1,655,892)	(549,443)
Pinal	(5,732,527)	(963,301)
Mohave	(155,280)	–
La Paz	(82,145)	(36,820)
Yuma	(166,718)	(741)
Pima	–	(374,579)
Total	(7,792,562)	(1,924,884)

Table H-111
Estimated Change In Tax Impact as a Result of a 800,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2017

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(1,655,892)	(816,714)
Pinal	(5,625,441)	(1,361,977)
Mohave	(204,760)	–
La Paz	(116,620)	(58,359)
Yuma	(250,762)	(4,989)
Pima	–	(532,504)
Total	(7,853,475)	(2,774,543)

Table H-112
Estimated Change In Tax Impact as a Result of a 1,000,000 af shortage to Non-Indian and Indian Agricultural Lands in Arizona—2017

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(1,655,892)	(1,086,861)
Pinal	(5,625,441)	(1,792,443)
Mohave	(254,240)	–
La Paz	(159,141)	(80,197)
Yuma	(400,644)	(11,463)
Pima	–	(532,504)
Total	(8,095,358)	(3,503,468)

Table H-113
Estimated Change In Tax Impact as a Result of a 1,200,000 af shortage to Non-Indian and Indian Agricultural Lands in Arizona—2017

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(1,655,892)	(1,357,833)
Pinal	(5,625,441)	(4,358,092)
Mohave	(321,310)	–
La Paz	(223,755)	(102,004)
Yuma	(334,807)	(20,076)
Pima	–	(759,103)
Total	((9,057,531)	(6,597,108)

Table H-114
Estimated Change In Tax Impact as a Result of a 1,800,000 af shortage to Non-Indian and Indian Agricultural Lands in Arizona—2017

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	–
Pinal	–	–
Mohave	–	–
La Paz	–	–
Yuma	–	–
Pima	–	–
Total	–	–

Table H-115
Estimated Change In Tax Impact as a Result of a 2,500,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2017

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	–
Pinal	–	–
Mohave	–	–
La Paz	–	–
Yuma	–	–
Pima	–	–
Total	–	–

H.5.3 2026 Tables

Table H-116
Estimated Change In Tax Impact as a Result of a 400,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2026

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(366,828)	(1,657,116)
Pinal	(1,314,914)	(609,751)
Mohave	(104,575)	–
La Paz	(47,736)	-
Yuma	(82,757)	-
Pima	–	(399,759)
Total	(1,916,809)	(2,666,626)

Table H-117
Estimated Change In Tax Impact as a Result of a 500,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2026

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(366,828)	(2,407,484)
Pinal	(1,314,914)	(1,070,044)
Mohave	(130,946)	–
La Paz	(64,957)	-
Yuma	(124,695)	–
Pima	–	(1,070,044)
Total	(2,002,340)	(3,928,252)

Table H-118
Estimated Change In Tax Impact as a Result of a 600,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2026

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(366,828)	(2,548,953)
Pinal	(1,314,914)	(1,307,638)
Mohave	(155,761)	–
La Paz	(82,510)	-
Yuma	(166,718)	(741)
Pima	–	(450,724)
Total	(2,086,731)	(4,308,056)

Table H-119
Estimated Change In Tax Impact as a Result of a 800,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2026

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(366,828)	(2,842,490)
Pinal	(1,314,914)	(1,681,578)
Mohave	(203,748)	–
La Paz	(117,068)	-
Yuma	(250,762)	(4,989)
Pima	–	(599,368)
Total	(2,253,320)	(5,128,425)

Table H-120
Estimated Change In Tax Impact as a Result of a 1,000,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2026

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(366,828)	(2,883,200)
Pinal	(1,314,914)	(2,062,179)
Mohave	(255,036)	–
La Paz	(160,247)	-
Yuma	(250,762)	(11,463)
Pima	–	(1,123,537)
Total	(2,431,832)	(6,080,379)

Table H-121
Estimated Change In Tax Impact as a Result of a 1,200,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2026

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(366,828)	(3,600,287)
Pinal	(1,314,914)	(5,427,747)
Mohave	(322,913)	–
La Paz	(225,042)	–
Yuma	(400,644)	(11,463)
Pima	–	(1,792,372)
Total	(2,630,341)	(10,840,482)

Table H-122
Estimated Change In Tax Impact as a Result of a 1,800,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2026

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(366,828)	(4,840,247)
Pinal	(1,314,914)	(5,784,767)
Mohave	(539,741)	–
La Paz	(396,513)	(-
Yuma	(839,944)	(38,981)
Pima	–	(495,965)
Graham	–	–
Total	(3,457,950)	(11,159,960)

Table H-123
Estimated Change In Tax Impact as a Result of a 2,500,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2026

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	–
Pinal	–	–
Mohave	–	–
La Paz	–	–
Yuma	–	–
Pima	–	–
Total	–	–

H.5.4 2027 Tables

Table H-124
Estimated Change In Tax Impact as a Result of a 400,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2027

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	–
Pinal	–	–
Pima	–	–
Mohave	–	–
La Paz	–	–
Yuma	–	–
Total	–	–

Table H-125
Estimated Change In Tax Impact as a Result of a 500,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2027

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(168,754)	(2,772,452)
Pinal	(704,247)	(1,070,044)
Pima	–	(467,414)
Mohave	(130,946)	–
La Paz	(64,957)	(27,183)
Yuma	(124,695)	-
Total	(1,193,599)	(4,337,093)

Table H-126
Estimated Change In Tax Impact as a Result of a 600,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2027

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(168,754)	(2,848,189)
Pinal	(704,247)	(1,307,638)
Pima	–	(467,900)
Mohave	(155,761)	–
La Paz	(82,510)	(36,820)
Yuma	(166,718)	(741)
Total	(1,277,990)	(4,661,288)

Table H-127
Estimated Change In Tax Impact as a Result of a 800,000 af shortage to Non-Indian and Indian Agricultural Lands in Arizona—2027

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(168,754)	(3,147,490)
Pinal	(704,247)	(1,681,578)
Pima	–	(889,913)
Mohave	(205,473)	–
La Paz	(117,068)	(58,359)
Yuma	(250,762)	(4,989)
Total	(1,446,304)	(5,782,329)

Table H-128
Estimated Change In Tax Impact as a Result of a 1,000,000 af shortage to Non-Indian and Indian Agricultural Lands in Arizona—2027

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(168,754)	(3,518,103)
Pinal	(704,247)	(2,062,179)
Pima	–	(1,136,395)
Mohave	(255,036)	–
La Paz	(160,247)	(80,197)
Yuma	(334,807)	(11,463)
Total	(1623,091)	(6,808,337)

Table H-129
Estimated Change In Tax Impact as a Result of a 1,200,000 af shortage to Non-Indian and Indian Agricultural Lands in Arizona—2027

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(168,754)	(3,980,692)
Pinal	(704,247)	(5,427,747)
Pima	–	(1,136,395)
Mohave	(322,913)	–
La Paz	(225,042)	(102,004)
Yuma	(400,644)	(20,076)
Total	(1,821,600)	(10,666,914)

Table H-130
Estimated Change In Tax Impact as a Result of a 1,800,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2027

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(168,754)	(5,185,979)
Pinal	(704,247)	(5,784,767)
Pima	–	(1,778,643)
Mohave	(539,741)	–
La Paz	(396,513)	(144,118)
Yuma	(839,944)	(38,981)
Total	(2,649,199)	(12,932,488)

Table H-131
Estimated Change In Tax Impact as a Result of a 2,500,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2027

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	(168,754)	(5,185,979)
Pinal	(704,247)	(5,784,767)
Pima	–	(1,778,643)
Mohave	(539,741)	–
La Paz	(396,513)	(144,118)
Yuma	(4,124,950)	(38,981)
Total	(5,934,205)	(12,932,488)

H.5.5 2040 Tables

Table H-132
Estimated Change In Tax Impact as a Result of a 400,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2040

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	–
Pinal	–	–
Pima	–	–
Mohave	–	–
La Paz	–	–
Yuma	–	–
Total	–	–

Table H-133
Estimated Change In Tax Impact as a Result of a 500,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2040

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(2,126,044)
Pinal	(120,988)	(1,547,603)
Pima	–	(413,261)
Mohave	(130,946)	–
La Paz	(64,957)	(27,183)
Yuma	(124,695)	-
Total	(441,586)	(4,114,091))

Table H-134
Estimated Change In Tax Impact as a Result of a 600,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2040

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(2,230,801)
Pinal	(120,988)	(1,758,163)
Pima	–	(426,341)
Mohave	(155,761)	–
La Paz	(82,510)	(36,820)
Yuma	(166,718)	(741)
Total	(525,977)	(4,452,866)

Table H-135
Estimated Change In Tax Impact as a Result of a 800,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2040

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(2,533,532)
Pinal	(120,988)–	(2,161,202)
Pima	–	(576,893)
Mohave	(205,473)	–
La Paz	(117,068)	(58,359)
Yuma	(250,762)	(4,989)
Total	(694,291)	(5,334,975)

Table H-136
Estimated Change In Tax Impact as a Result of a 1,000,000 af shortage to Non-Indian and Indian Agricultural Lands in Arizona—2040

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(2,948,199)
Pinal	(120,988)–	(2,828,015)
Pima	–	(820,130)
Mohave	(255,036)	–
La Paz	(160,247)	(80,197)
Yuma	(334,807)	(11,463)
Total	(871,078)	(6,688,004)

Table H-137
Estimated Change In Tax Impact as a Result of a 1,200,000 af shortage to Non-Indian and Indian Agricultural Lands in Arizona—2040

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(3,412,786)
Pinal	(120,988)–	(3,621,618)
Pima	–	(1,064,698)
Mohave	(322,913)	–
La Paz	(255,042)	(102,004)
Yuma	(400,644)	(20,076)
Total	(1,069,587)	(8,221,182)

Table H-138
Estimated Change In Tax Impact as a Result of a 1,800,000 af shortage to Non-Indian and Indian Agricultural Lands in Arizona—2040

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(4,600,757)
Pinal	(120,988)–	(6,171,479)
Pima	–	(1,690,113)
Mohave	(539,741)	–
La Paz	(396,513)	(144,118)
Yuma	(900,988)	(38,981)
Total	(1,958,230)	(12,645,448)

Table H-139
Estimated Change In Tax Impact as a Result of a 2,500,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2040

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	–
Pinal	–	–
Pima	–	–
Mohave	–	–
La Paz	–	–
Yuma	–	–
Total	–	–

H.5.6 2060 Tables

Table H-140
Estimated Change In Tax Impact as a Result of a 400,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2060

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	–
Pima	–	–
Pinal	–	–
Mohave	–	–
La Paz	–	–
Yuma	–	–
Total	–	–

Table H-141
Estimated Change In Tax Impact as a Result of a 500,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2060

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(1,909,885)
Pinal	(109,209)	(1,455,759)
Pima	–	(373,380)
Mohave	(130,946)	–
La Paz	(64,957)	(27,183)
Yuma	(124,695)	-
Total	(429,807)	(3,766,207)

Table H-142
estimated Change In Tax Impact as a Result of a 600,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2060

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(2,018,402)
Pinal	(109,209)	(1,658,699)
Pima	–	(388,161)
Mohave	(155,761)	–
La Paz	(82,510)	(36,820)
Yuma	(166,718)	(741)
Total	(514,198)	(4,102,823)

Table H-143
Estimated Change In Tax Impact as a Result of a 800,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2060

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(2,319,075)
Pinal	(109,209)	(3,438,404)
Pima	–	(537,962)
Mohave	(205,473)	–
La Paz	(117,068)	(58,359)
Yuma	(250,762)	(4,989)
Total	(682,512)	(6,358,789)

Table H-144
Estimated Change In Tax Impact as a Result of a 1,000,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2060

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(2,704,470)
Pinal	(109,209)	(3,438,404)
Pima	–	(710,589)
Mohave	(255,036)	–
La Paz	(160,247)	(80,197)
Yuma	(334,807)	(11,463)
Total	(859,299)	(6,945,123)

Table H-145
Estimated Change In Tax Impact as a Result of a 1,200,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2060

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(3,168,679)
Pinal	(109,209)	(3,438,404)
Pima	–	(999,610)
Mohave	(322,913)	–
La Paz	(225,042)	(102,004)
Yuma	(403,062)	(20,076)
Total	(1,060,226)	(7,728,773)

Table H-146
Estimated Change In Tax Impact as a Result of a 1,800,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2060

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	(4,356,512)
Pinal	(109,209)	(6,340,527)
Pima	–	(1,624,772)
Mohave	(539,741)	–
La Paz	(396,513)	(144,118)
Yuma	(901,006)	(38,981)
Total	(1,946,469)	(12,152,341)

Table H-147
Estimated Change In Tax Impact as a Result of a 2,500,000 af
shortage to Non-Indian and Indian Agricultural Lands in Arizona—2060

County	Non-Indian Agricultural Land Total	Indian Agricultural Lands Total
Maricopa	–	–
Pinal	–	–
Pima	–	–
Mohave	–	–
La Paz	–	–
Yuma	–	–
Total	–	–

H.6 Analysis of Potential Positive and Negative Economic Effects of a Voluntary Conservation Program

This additional assessment considers potential positive and negative economic effects of a voluntary conservation program. Section 14.4 in the EIS discussed the potential socioeconomic effects of the proposed federal action. The associated impact analyses considered the potential impacts from voluntary or involuntary water delivery reductions. The voluntary water delivery reductions would be associated with a voluntary water conservation program as postulated under the Conservation Before Shortage Alternative proposal. The involuntary water delivery reductions would occur as a result of a Shortage Condition.

The assessment provided in the Draft EIS (February 2007) did not attempt to quantify the economic benefits of a voluntary conservation fallowing program. Under such a program, there is an assumption that some of the effects that would result from the voluntary reduction in agricultural production might be offset by payments made to farm owners. Reclamation did not include this type of quantitative assessment due to the many uncertainties regarding how such a program would be implemented, including the geographic extent of the participants, the level of participation, the economic characteristic and demographics of the affected area, crop types that would be affected, and payment amounts made to farm owners and operators to forego crop production. This section was added to the Final EIS to describe some of the socioeconomic effects that may result in the event a voluntary fallowing program is implemented.

H.6.1 Methodology and Study Approach

For this assessment, the positive regional economic gains could include the payments to operators and resulting investments in equipment, land improvements, and non-farm related expenditures made in the local economy. The adverse economic effects could include the loss of farm-related expenditures on labor and other inputs necessary to grow, harvest, transport and sale of crops. To better understand the economics of these types of programs, a literature search for documented programs was conducted and the information gathered from existing programs was used as the bases for this assessment.

H.6.1.1 Existing Studies

There is limited documentation on previous or existing voluntary conservation programs. Two recent studies that estimated the socioeconomic effects of voluntary land fallowing programs include programs occurring on lands within the Palo Verde Irrigation District (PVID) and the Imperial Irrigation District (IID) (Local Entity and San Diego County Water Authority 2004, and Palo Verde Irrigation District 2002). The documentation available for these two programs was reviewed along with other studies that estimated payments that farmers would accept to forego crop production (Colby et al. 2006). Information contained in these studies was used as input to the subject semi-quantitative assessment of the socioeconomic effects of a voluntarily conservation program.

H.6.1.2 Water Delivery Reduction Volumes Considered

A water delivery reduction volume of 500 kaf was selected for purposes of this assessment because shortage related water delivery reductions of this magnitude had the greatest probability of occurrence during the interim period (2008 through 2026) as shown in Tables 4.4-5 and 4.4-6 in this Final EIS. The probability of occurrence for this level of shortage range from 14 percent in 2017 to 19 percent in 2026.

H.6.1.3 Potentially Affected Land Acreage

A 500 kaf water delivery reduction to the Lower Division states in 2017 could potentially result in fallowing of up to 86,000 acres of farm land (Table 4.14-1 in Section 14.4 of this Final EIS). Reclamation's Shortage Allocation Model (Section 4.2 and Appendix G) was used to estimate the distribution of water delivery reduction among the Lower Division states and Mexico, and among the Colorado River water users within each of the three Lower Division states (Arizona, California, and Nevada).

The 500 kaf shortage value was evaluated by the Shortage Allocation Model and the amount of shortage that would be allocated to various agricultural users was generated. The output from the Shortage Allocation Model was used as input to another spreadsheet model developed by Reclamation that estimates changes in agricultural production and production value. Based on the amount of shortage realized in each county, the model estimates the amount of land that would be fallowed using the relative profitability of each crop. The model assumes that the least profitable crops are fallowed first. Once all of the irrigated land associated with the least profitable crop is fallowed, the model assumes that fallowing of the next-least profitable crop would commence. For the 500 kaf shortage evaluated in this discussion, approximately 86,000 acres would be removed from crop production consisting of 25,000 acres of cotton, 48,000 acres of grain, and 13,000 acres of forage crops.

H.6.1.4 Payment Structures

The documents reviewed showed that previous and existing voluntary conservation programs have incorporated a wide range of payment mechanisms and payment amounts to gain the participation of farm owners, water districts, and communities. For example, farmers in Arizona were thought to forgo crop production if they could receive a minimum per acre payment of $68.15, $29.78, and $365.03 for cotton, grain, and forage crops, respectively. These payments are reported per acre of land payments (net return over variable costs per acre) to forgo production of the specified crop for one season on that particular acreage (Colby et al. 2006). Other fallowing programs include a one-time up front payment to farmers to ensure they participate in the fallowing program. For example, the PVID program included an entry payment of $3,170 per acre and an annual payment of $550 per acre (PVID 2002). In contrast, the IID program included one-time up front payments of $308 to $277 per acre (Local Entity and San Diego County Water Authority 2004).

For purposes of this assessment, the following two scenarios were evaluated:

- Scenario 1 estimated the socioeconomic costs and benefits based on crop payments to Arizona farmers indicated above; and

- Scenario 2 estimated the socioeconomic costs and benefits by applying the one-time and annual payments reported for the PVID program.

H.6.1.5 Program Administration

Establishing a voluntary fallowing program would require instituting some form of program administration. The cost of managing a voluntary fallowing program was not included in this assessment because the geographic location and timing of a program and the administrative costs are not known.

H.6.1.6 Regional Economic Offsets

It is difficult to estimate the amount of payments made to operators to forego crop production that would then be spent within the regional economy and thereby offset the losses in employment and income that would occur as a result of voluntarily fallowing croplands. The amount of offset would be driven by farm-related expenditures and expenditures made for other goods and services within the regional economy. Based on information reported in the studies conducted on the IID and PVID fallowing programs, participants in the voluntary fallowing program were expected to spend a portion of their payments for on-farm improvements and/or management activities that could benefit the regional economy. Expenditures could be made on land management activities such as weed control, land preparation, erosion control, new equipment purchases or other capital improvements, and debt retirement. The studies did not identify how payments may be divided among these improvements and activities.

An additional factor that would affect the degree to which payments could benefit regional economic activity is land ownership. Landowners not residing within the local area are less likely to spend any substantial portion of the payments within the local economy. As an example, the PVID study concluded that 40 percent of landowners participating in the PVID program were considered absentee (PVID 2002). Based on information reported in the 2002 Census of Agriculture (USDA 2002) approximately 26 percent of farms in Arizona were operated by off-farm operators. For purposes of this analysis, it was assumed that 74 percent of payments made to farmers would be spent within the local economy.

H.6.2 Comparison of Costs and Benefits

A comparison of the potential costs and benefits of two hypothetical voluntary conservation programs follows.

H.6.2.1 Voluntary Fallowing Program Based on Payments to Forgo Production of Specific Crop Types

A 500 kaf shortage is estimated to result in the loss of approximately 627 jobs and some $23.8 million in personal income. It may be reasonable to assume that the compensation to farmers under a voluntary fallowing program could potentially offset some of these losses. Application of the multipliers derived from this analysis of loss of agricultural production indicate that expenditures made by operators in the regional economy as a result of payments made to fallow land could create an estimated 100 jobs and approximately $4 million in personal income. Again, these expenditures could potentially partially offset the estimated losses in employment and income reported in this Final EIS.

H.6.2.2 Voluntary Fallowing Program Based on an Entry Payment and Per Acre Payment to Forgo Crop Production

A voluntary fallowing program based on the PVID program entry payment and annual payments would generate 2,500 additional jobs and $95.6 million in personal income. A program with operator payments of this magnitude would be expected to offset the employment and income losses for a 500 kaf shortage reported in this Final EIS.

H.6.3 Conclusions

The compensation to farmers under a voluntary fallowing program could potentially offset some of the adverse socioeconomic effects of reducing agricultural production. The degree to which these payments would offset the adverse socioeconomic effects of fallowing agricultural lands would depend on the payment schemes and amounts associated with a particular program.

Instituting a voluntary fallowing program could result in positive economic effects. However, as suggested by the results of the two scenarios described above, estimating the socioeconomic effects of implementing a program with a reasonable degree of certainty is difficult without additional detail regarding payment amounts, geographic location, and timing. There are many variables that need to be considered and these will vary widely by region, program size, length of program, and the participating entities.

H.7 References

Palo Verde Irrigation District. 2002. Socioeconomic Assessment of the Proposed Palo Verde Irrigation District Land Management, Crop Rotation and Water Supply Program, Final Report. Blythe, California. Prepared by M.Cubed, Oakland, California.

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Colby, Bonnie, Katie Pittenger, and Lana Jones. 2006. Voluntary Irrigation Forebearance to Mitigate Drought Impacts: Economic Considerations. October.

US Department of Agriculture, National Agricultural Statistics Service. 2002. Census of Agriculture, Arizona State and County Data.

Appendix I

Public Outreach, Coordination, and Consultation Efforts

This appendix provides documentation of the public outreach, coordination, and consultation efforts undertaken by Reclamation with regard to the proposed federal action and the preparation of this EIS. Reclamation discussed the development of the proposed federal action with various agencies and organizations at agency/organization regular meetings; public conferences and events sponsored by the agency/organizations; and at meetings sponsored by Reclamation. The entities included the Basin States' water resource departments, water agencies within these states, contractors and associations for federal hydroelectric power, and non-governmental organizations. Reclamation also consulted with Indian tribes and Mexico. The coordination activities with each agency, entity or group are summarized in Chapter 6, Volume I of this EIS.

Table of Contents

List of Tables

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I.1 Public Outreach, Coordination and Consultation Efforts

Table I-1
Consultation and Coordination Regarding the EIS

Agency or Organization Invited to or Requesting Meetings	Meeting Dates
Federal Agencies	
National Oceanographic and Atmospheric Administration	Various planning meetings
Bureau of Indian Affairs – Cooperating Agency	Various plan formulation and evaluation meetings
Fish and Wildlife Service – Cooperating Agency	Various plan formulation and evaluation meetings
National Park Service – Cooperating Agency	Various plan formulation and evaluation meetings
United States Department of State	Various planning meetings
United States Section of the International Boundary and Water Commission – Cooperating Agency	Various plan formulation and evaluation meetings
Western Area Power Administration – Cooperating Agency	Various plan formulation and evaluation meetings
State And Local Water And Power Agencies	
Arizona Department of Water Resources	3/27/06, 4/13/06, 4/24/06, 5/15/06, 6/7/06, 6/16/06, 8/22/06, 10/31/06, 2/21/07, 3/6/07, 7/30/07
California Department of Water Resources	3/27/06, 4/13/06, 7/30/07
Coachella Valley Water District	3/27/06, 4/13/06, 7/30/07
Colorado Department of Natural Resources	3/27/06, 4/13/06, 4/24/06, 5/15/06, 6/7/06, 6/16/06, 8/22/06, 10/31/06, 7/30/07
Colorado River Board of California	3/27/06, 4/13/06, 4/24/06, 5/15/06, 6/7/06, 6/16/06, 8/22/06, 10/31/06, 2/21/07, 3/06/07, 7/30/07
Colorado River Commission of Nevada	3/27/06, 4/13/06, 4/24/06, 5/15/06, 6/7/06, 6/16/06, 8/22/06, 10/31/06, 2/21/07, 3/6/07, 7/30/07
Colorado River Energy Distributors Association	4/24/06, 5/15/06, 6/7/06, 6/16/06, 10/31/06, 2/21/07
Colorado Water Conservation Board	3/27/06, 4/13/06, 8/22/06, 3/6/07, 7/30/07
Imperial Irrigation District	3/27/06, 4/13/06, 6/16/06, 2/21/07, 7/30/07
Las Vegas Valley Water District	3/27/06, 4/13/06, 4/24/06, 5/15/06, 6/7/06, 6/16/06, 8/22/06, 10/31/06
Metropolitan Water District, California	3/27/06, 4/13/06, 4/18/06, 4/24/06, 5/15/06, 6/7/06, 6/16/06, 8/22/06, 10/31/06, 2/21/07, 3/06/07, 7/30/07
Nevada Department of Justice	6/16/06
New Mexico Interstate Stream Commission	3/27/06, 4/13/06, 4/24/06, 5/15/06, 8/22/06, 2/21/07, 7/30/07
Office of the State Engineer, Wyoming	3/27/06, 4/13/06, 4/24/06, 5/15/06, 6/7/06, 8/22/06, 10/31/06, 7/30/07
Palo Verde Irrigation District	3/27/06, 4/13/06, 7/30/07
San Diego County Water Authority	3/27/06, 4/13/06, 7/30/07
Southern Nevada Water Authority	4/13/06, 6/16/06, 2/21/07, 3/06/07, 7/30/07
Upper Colorado River Commission	3/27/06, 4/24/06, 5/15/06, 6/16/06, 2/21/07, 7/30/07
Utah Attorney General's Office	4/13/06, 7/30/07
Utah Division of Water Resources	3/27/06,4/13/06, 4/24/06, 5/15/06, 6/7/06, 6/16/06, 8/22/06, 2/21/07, 7/30/07
Wyoming Water Association	6/7/06

Table I-1
Consultation and Coordination Regarding the EIS

Agency or Organization Invited to or Requesting Meetings	Meeting Dates
Non-Governmental Environmental Organizations	
Defenders of Wildlife	4/28/06, 5/8/06, 6/9/06, 6/14/06, 6/16/06,10/19/06, 11/16/06, 11/19/06, 2/23/07, 4/20/07, 6/15/07, 8/9/07
Environmental Defense	4/28/06, 5/8/06, 6/9/06, 6/14/06, 6/16/06, 10/19/06, 11/16/06, 11/19/06, 2/23/07, 4/20/07, 6/15/07, 8/9/07, 8/24/07
Living Rivers	4/28/06, 5/8/06, 6/9/06, 6/14/06, 6/16/06, 11/16/06, 11/19/06, 2/23/07
National Wildlife Federation	4/28/06, 5/8/06, 6/9/06, 6/14/06, 6/16/06, 10/19/06, 11/16/06, 11/19/06, 2/23/07, 6/15/07
The Nature Conservancy	4/28/06, 5/8/06, 6/9/06, 6/14/06, 6/18/06, 10/19/06, 11/16/06, 11/19/06, 2/23/07, 4/20/07, 6/15/07, 8/9/07, 8/24/07
Pacific Institute	4/28/06, 5/8/06, 6/9/06, 6/14/06, 6/16/06, 10/19/06, 11/16/06, 11/19/06, 2/23/07, 4/20/07, 6/15/07, 8/9/07, 8/24/07
Sierra Club	4/28/06, 5/8/06, 6/9/06, 6/14/06, 6/16/06, 2/23/07, 4/20/07, 6/15/07
Sonoran Institute	11/19/06, 2/23/07, 6/15/07, 8/9/07, 8/24/07
Utah Water & Sierra Club Southwest Water Committee	10/19/06, 11/16/06, 11/19/06
United Mexican States Agencies	
National Water Commission	2/8/06, 6/23/06, 9/25-29/06, 2/13/07, 3/14/07, 10/17/07
International Boundary and Water Commission, Mexican Section	2/8/06, 6/23/06, 9/25-29/06, 2/13/07, 3/6/07, 3/14/07, 10/17/07
Secretariat of Foreign Relations	2/8/06, 6/23/06, 2/13/07, 10/17/07

Table I-2
Conferences and Events Regarding the EIS

Date	Event Name	Organizer	Purpose
March 2005	RiverWare™ User Group Meeting		
June 2005	NRLC Conference		
July 22, 2005	Arizona Colorado River Shortage Sharing Stakeholder Workshop	Arizona Department of Water Resources	To discuss Shortage Implementation in Arizona, to develop recommendations to the Director regarding Colorado River Shortage implementation criteria
October 2005	Colorado River Symposium		
October 2005	Western Water Law	Western Law Institute, CLE International	
October 31, 2005	National Research Council	Scoping Meeting on Colorado River	
January 23, 2006	Water Expo 2006	Pamela Justice	To address the issue of conservation with an emphasis on Colorado River shortage sharing
March 1, 2006	Water Education Foundation Tour		Highlight key points: 1922 Colorado River Compact, United States water deliveries to Mexico, Reclamation's water quantity and quality requirements, shortage criteria negotiations, Quantification Settlement Agreement
March 7-8, 2006	2006 RiverWare™ User Group Meeting	Center for Advanced Decision Support for Water and Environmental Systems (CADSWES)	Technical Support to the Basin States Regarding Drought Conditions on the Colorado River
March 20, 2006	Imperial Briefing		
March 25-26, 2006	Guides Training Seminar (GTS)	Grand Canyon River Guides (GCRG)	To give a presentation on Glen Canyon Dam operations and Colorado River Basin hydrology
April 5, 2006	Colorado River Fish and Wildlife Council Annual Meeting	Rod Stone	Present a brief plot on Lake Mead elevation, Lower Basin status on snowpack, shortage project, Management Strategies EIS, lower Colorado River operations and conditions
April 6, 2006	Federal Interagency Hydrologic Modeling Conference	The JFIC Committee	
April 7, 2006	Southwestern Water Conservation District 24th Annual Water Seminar		
May 3-5, 2006	2006 Arizona Water and Pollution Control Association Annual Conference	AWPCA	Present the state of the Colorado River system
May 3-5, 2006	APWA Spring Conference	Michele Ruemler	Provide a forum for the development and exchange of ideas, information and technology which enhances the delivery of public services
May 24-25, 2006	Glen Canyon Dam Technical Work Group Meeting	Linda Whetton	To inform, discuss and take possible action
June 16, 2006	2007 AOP Consult Meeting		Present draft project alternatives
June 20-21, 2006	Arizona Water Conference	CLE	Colorado River Issues
June 26, 2006	IID Board Meeting	IID	Water Department Workshop
July 3-4, 2006	Environmentally Sustainable Water Resources Management Methodologies	Institute of Science and Technology Jawaharlal Nehru Technological University	Talk about river basin management, reservoir operations and stakeholder participation in water management

Table I-2
Conferences and Events Regarding the EIS

Date	Event Name	Organizer	Purpose
July 4-7, 2006	India Workshop	Balaji Rajagopalan	To share research experiences and expertise in laying a foundation for a sustained collaboration with India on a topic of water resources management
August 10, 2006	Counsel of State Governments West Colorado River Basin Forum Keynote		
September 12, 2006	East Valley Water Forum Quarterly Meeting	East Valley Water Forum	Update on the Colorado River, the management plan, and the drought planning efforts
September 18, 2006	Imperial Dam Advisory Board Meeting	Imperial Dam Advisory Board	Board Meeting
December 5-7, 2006	Tribal Lands Climate Conference	The Cocopah Indian tribe and the National Wildlife Federation	To collect first-hand, on-the-ground accounts about the natural resources that have sustained changes due to carbon emissions and climate change related events
February 22-23, 2007	Water Challenges – Opportunities for Action: 24th Annual Executive Briefing	Water Education Foundation	To give the busy water professional the information needed to make decisions affected by water policy in 2007
March 13, 2007	Danger on the Delta: Is Southern California Betting its Future on an Unstable Water System?	The Aquarium of the Pacific's Marine Conservation Research Institute (MCRI)	To explore the implications of a major earthquake in the Delta region on Southern California's water supply and what Southern California can do to mitigate the impacts
April 10, 2007	East Valley Water Forum	Bureau of Reclamation	Colorado River Operations; Current Conditions; Proposed Operational Guidelines
April 10, 2007	Lake Mead Water Quality Forum	Southern Nevada Water Authority	Virtual Tour of SNWA's River Mountains Laboratory
April 10-11, 2007	Colorado River Fish and Wildlife Council Annual Meeting	Colorado Fish and Wildlife Council	Overview of operations – Lake Powell, Lake Mead, Lake Mohave, and Lake Havasu; current and future conditions at Lake Mead; need of additional operational guidelines
April 11, 2007	Regular Meeting of the Colorado River Board	The Colorado River Board	Overview of protection of existing rights; Draft EIS
April 24, 2007	Reclamation Phoenix Area Office Congressional Briefing	Bureau of Reclamation	Briefing session for Congressional Staff Members serving Arizona and southwest New Mexico to present information on Reclamation's activities in water delivery and release issues throughout Arizona and southwest New Mexico, and along the Colorado River
April 26, 2007	Page Community Forum	Bureau of Reclamation	Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations
April 26-27, 2007	The Colorado River: Conflicts, Concerns, and Challenges	The Colorado River Commission of Nevada	Colorado River current conditions and proposed operational guidelines
May 10-11, 2007	Law of the Colorado River	Water Law Institute, CLE International	Understanding key developments and issues
September 17-18, 2007	Western Water Law	Water Law Institute, CLE International	Overview of the major current issues in western water law

I.2 December 23, 2005 Letter to CAP Tribes

United States Department of the Interior

BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
BCOO-1000
ENV-6.00

DEC 23 2005

Honorable Raphael Bear
President, Ft. McDowell Yavapai Nation
P.O. Box 17779
Fountain Hills, AZ 85269

Subject: Request to Initiate Consultation on the Development of Lower Colorado River Basin (Lower Basin) Shortage Guidelines and Coordinated Management Strategies

Dear President Bear:

The Secretary of the Department of the Interior has recently directed the Bureau of Reclamation to develop Lower Basin shortage guidelines and coordinated management strategies for Lake Powell and Lake Mead under low reservoir conditions. Reclamation, in accordance with National Environmental Policy Act (NEPA) and Council on Environmental Quality regulations, has begun to prepare an Environmental Impact Statement (EIS) to address the proposed guidelines and strategies. A notice was published in the Federal Register on September 30, 2005, that announced the start of the scoping process and the intent to prepare an EIS (70 Federal Register 57322).

On behalf of the Department, we would like to initiate government-to-government consultation with the Ft. McDowell Yavapai Nation, in concert with the initiation of our NEPA process for this proposed action, to identify and consider potential impacts to any tribal trust resources as a result of the proposed action.

Mr. Rick Gold, Regional Director, Upper Colorado Region, and I respectfully request an opportunity to consult with you on these planned actions and discuss your interest and involvement in the NEPA process for this proposed action. To that end, we have arranged a meeting at Two Arizona Center, 400 North 5th Street, 12th Floor Conference Room A & B in Phoenix, Arizona, on January 27, 2006, from 10:00 a.m. to 12:00 noon.

Our staff will call your office during the next few weeks regarding this request. You may call Ms. Nan Yoder at 702-293-8495 or contact her by email at nyoder@lc.usbr.gov to discuss the consultation process or to confirm your availability for the meeting.

Sincerely,

Robert W. Johnson
Regional Director

Identical Letter Sent To:

Continued on next page.

Identical Letter Sent To:

Honorable Terry O. Enos
Chairperson, Ak-Chin Indian Community
42507 West Peters and Nall Road
Maricopa, AZ 85239-3940

Honorable Richard P. Narcia
Governor, Gila River Indian Community
P.O. Box 97
Sacaton, AZ 85247

Honorable Robert Valencia
Chairman, Pascua Yaqui Tribe
7474 South Camino de Oeste
Tucson, AZ 85746

Honorable Joni M. Ramos
President, Salt River Pima-Maricopa Indian Community
10005 E. Osborn Rd.
Scottsdale, AZ 85256

Honorable Kathleen Wesley-Kitcheyan
Chairwoman, San Carlos Apache Indian Tribe
P.O. Box "0"
San Carlos, AZ 85550

Honorable Vivian Juan-Saunders
Chairwoman, Tohono O'odham Nation
P.O. Box 837
Sells, AZ 85634-0837

Honorable Ivan Smith
Chairman, Tonto Apache Tribal Council
Tonto Apache Reservation No. 30
Payson, AZ 85541

Honorable Jamie Fullmer
Chairman, Yavapai-Apache Nation
2400 W. Datsi Street
Camp Verde, AZ 86322

bc: Mr. Bryan Bowker
Acting Regional Director
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

LC-1000, LC-1100, BCOO-1000, BCOO-1003, PXAO-1000, NAOO-1100, UC-100, UC-105, UC-402, UC-438, UC-700, UC-720

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I.3 December 23, 2005 Letter to Ten Tribes

United States Department of the Interior

BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

BCOO-1000
ENV-6.00

DEC 23 2005

Honorable Charles Wood
Chairman, Chemehuevi Indian Tribe
P.O. Box 1976
Havasu Lake, CA 92363-1976

Subject: Request to Initiate Consultation on the Development of Lower Colorado River Basin (Lower Basin) Shortage Guidelines and Coordinated Management Strategies

Dear Chairman:

The Secretary of the Department of the Interior has recently directed the Bureau of Reclamation to develop Lower Basin shortage guidelines and coordinated management strategies for Lake Powell and Lake Mead under low reservoir conditions. Reclamation, in accordance with National Environmental Policy Act (NEPA) and Council on Environmental Quality regulations, has begun to prepare an Environmental Impact Statement (EIS) to address the proposed guidelines and strategies. A notice was published in the Federal Register on September 30, 2005, that announced the start of the scoping process and the intent to prepare an EIS (70 Federal Register 57322).

On behalf of the Department, we would like to initiate government-to-government consultation with the Chemehuevi Indian Tribe, in concert with the initiation of our NEPA process for this proposed action, to identify and consider potential impacts to any tribal trust resources as a result of the proposed action.

Mr. Rick Gold, Regional Director, Upper Colorado Region, and I respectfully request an opportunity to consult with you on these planned actions and discuss your interest and involvement in the NEPA process for this proposed action. To that end, we have arranged a meeting at McCarran Airport, Las Vegas, Nevada, Rooms 4 and 5, on January 19, 2006, from 10:00 a.m. to 12:00 noon.

Our staff will call your office during the next few weeks regarding this request. You may call Ms. Nan Yoder at 702-293-8495 or contact her by email at nyoder@lc.usbr.gov to discuss the consultation process or to confirm your availability for the meeting.

Sincerely,

Robert W. Johnson
Regional Director

Identical Letter Sent To:

Continued on next page.

Identical Letter Sent To:

Honorable Sherry Cordova
Chairwoman, Cocopah Indian Tribe
West Founth 15th and Avenue G
Somerton, AZ 85350

Honorable Nora McDowell
Chairperson, Fort Mojave Indian Tribe
500 Merriman Avenue
Needles, CA 92363

Honorable Mike Jackson, Sr.
President, Quechan Indian Tribe
P.O. Box 1899
Yuma, AZ 85366

Honorable Clement Frost
Chairman, Southern Ute Indian Tribe
P.O. Box 737
Ignacio, CO 81137

Honorable Levi Pesata
President, Jicarilla Apache Nation
P.O. Box 507
Dulce, NM 87528

Honorable Daniel Eddy, Jr.
Chairman, Colorado River Indian Tribes
Route 1, Box 23-B
Parker, AZ 85344-9704

Honorable Joe Shirley, Jr.
President, Navajo Nation
P.O. Box 9000
Window Rock, AZ 86515

Honorable Maxine Natchees
Business Committee Chairwoman
Northern Ute Indian Tribe
P.O. Box 190
Fort Duchesne, UT 84026

Honorable Selwyn Whiteskunk
Chairman, Ute Mountain Ute Tribe
P.O. Box 248
Towaoc, CO 81334

bc: Mr. Bryan Bowker
Acting Regional Director
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

LC-1000, LC-1100, BCOO-1000, BCOO-1003, PXAO-1000, NAOO-1100, UC-100, UC-105, UC-402, UC-438, UC-700, UC-720

BCOO-1000-Chrono Daily WBR:NYoder:ms:12/21/05:8495
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I.4 March 16, 2006 Letter to CAP Tribes

United States Department of the Interior

BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
LC-2600
ENV-3.00

MAR 16 2006

CERTIFIED – RETURN RECEIPT REQUESTED

Honorable Delia Carlyle
Chairwoman, Ak-Chin Indian Community
42507 West Peters and Nall Road
Maricopa, AZ 85239-3940

Subject: Proposed Shortage Guidelines for the Lower Basin of the Colorado River and Coordinated Strategies for the Operation of Lake Powell and Lake Mead, Government-to-Government Consultation

Dear Chairwoman:

As you are aware, the Upper and Lower Colorado Regions of the Bureau of Reclamation are proposing to develop shortage guidelines for the Lower Basin of the Colorado River and coordinated strategies for the operation of Lake Powell and Lake Mead. A copy of the September 30, 2005 Federal Register notice initiating this process is enclosed. As part of this effort, Reclamation has already begun to engage your tribe in government-to-government consultations because of your participation in the Central Arizona Project water rights settlement.

In compliance with the National Historic Preservation Act (NHPA) and Executive Order 13007, regarding sacred sites, Reclamation is further seeking your assistance in identifying and evaluating historic properties, especially those of traditional religious or cultural importance, and what potential effects, if any, this proposed action might have on these properties.

A representative from Reclamation will be calling your office within two weeks to facilitate a government-to-government consultation regarding properties under NHPA and sacred site guidelines, or you may call Mr. John Jamrog, Environmental Compliance Group Manager for the Lower Colorado Region at 702-293-8675.

Sincerely,

William J. Liebhauser, Acting Director
Resources Management Office

Enclosure

cc: See next page.

cc: Mr. Allen J. Auspach
Acting Regional Director
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

Ms. Amy Heustein
Environmental Protection Officer
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

Ms. Cathy Wilson
Supervisory Water Rights Specialist
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

bc: Office of the Field Solicitor
U.S. Department of the Interior
Sandra Day O'Connor
U.S. Courthouse, Suite 404
Attention: Ms. Katherine Verburg
401 West Washington Street, SPC 44,
Phoenix, AZ 85003-2151

Office of the Field Solicitor
U.S. Department of the Interior
Sandra Day O'Connor
U.S. Courthouse, Suite 404
Attention: Mr. Bob Snow
401 West Washington Street, SPC 44,
Phoenix, AZ 85003-2151

BCOO-1000, BCOO-1003 (w/signed copy), LC-1000, LC-1100, LC-2000, LC-2010, LC- 2600, LC-2630, LC-2700, NAAO-1100, PXAO-1100, UC-100, UC-105, UC-402, UC-406, UC-438, UC-700, UC-720

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Identical Letter Sent To:

Ms. Nancy Nelson
Cultural Resources Manager
Ak-Chin Indian Community
47685 North Eco Museum Road
Maricopa, AZ 85239

Ms. Dezbah Hatathli
Acting Cultural Programs Supervisor
Salt River Pima-Maricopa Indian Community
Cultural & Environmental Services
10005 East Osborn Road
Scottsdale, AZ 85256

Honorable William R. Rhodes
Governor
Gila River Indian Community
P.O. Box 97
Sacaton, AZ 85746

Honorable Kathleen Wesley-Kitcheyan
Chairwoman, San Carlos Apache Indian Tribe
P.O. Box "0"
San Carlos, AZ 85550

Mr. Barnaby Lewis
Cultural Resources Program Specialist
Gila River Indian Community
P.O. Box 97
Sacaton, AZ 85746

Ms. Vernelda Grant
Tribal Archaeologist
San Carlos Apache Indian Tribe
P.O. Box "0"
San Carlos, AZ 85550

Honorable Herminia Frias
Chairwoman, Pascua Yaqui Tribe
7474 South Camino de Oeste
Tucson, AZ 85746

Honorable Vivian Juan-Saunders
Chairwoman, Tohono O'odham Nation
P.O. Box 837
Sells, AZ 85634-0837

Honorable Joni M. Ramos
President
Salt River Pima-Maricopa Indian Community
10005 East Osborn Road
Scottsdale, AZ 85256

Mr. Peter Steere
Project Manager
Cultural Resources Department
Tohono O'odham Nation
P. O. Box 837
Sells, AZ 85634-0834

Honorable Ivan Smith
Chairman, Tonto Apache Tribal Council
Tonto Apache Reservation No. 30
Payson, AZ 85541

Honorable Jamie Fullmer
Chairman, Yavapai-Apache Nation
2400 West Datsi Street
Camp Verde, AZ 86322

57322 Federal Register / Vol. 70, No. 189 / Friday, September 30, 2005 / Notices

or faxed comments should be submitted by October 17, 2005.

John W. Roberts,

Acting Chief, National Register/National Historic Landmarks Program.

ARKANSAS

Faulkner County

Lee, Carl and Esther, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 17493 US 65S, Damascus, 05001170

Tyler—Southerland House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 36 Southerland, Conway, 05001168

Ward, Earl and Mildred, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 1157 Mitchell St., Conway, 05001169

Webb, Joe and Nina, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 2945 Prince, Conway, 05001171

Washington County

Prairie Grove Battlefield (Boundary Increase II), N of US 62, E of Prairie Grove, Prairie Grove, 05001167

COLORADO

Montrose County

North Rim Road, Black Canyon of the Gunnison National Park, Black Canyon of the Gunnison National Park, Crawford, 05001181

GEORGIA

Bartow County

ATCO–Goodyear Mill and Mill Village Historic District, Roughly bounded by Sugar Valley Rd., Cassville rd. and Pettit Creek, Wingfoot Trail and Litchfield St., Cartersville, 05001172

MAINE

Androscoggin County

Keystone Mineral Springs, Keystone Rd., Poland, 05001175

Cumberland County

Battery Steele, Florida Ave., Peaks Island, Portland, 05001176

Lakeside Grange #63, Main St., jct. of Main St. and Lincoln St., Harrison, 05001173

Hancock County

Garland Farm, 1029 ME 3, Bar Harbor, 05001174

MINNESOTA

Cook County

Grand Portage National Monument, Off US 61 within the area of the Grand Portage Indian Reservation, Grand Portage, 05001180

MISSOURI

Madison County

St. Louis, Iron Mountain and Southern Railroad Depot, Allen St., 150 ft. No of Jct. of Allen and Kelly Sts., Fredericktown, 05001178

MONTANA

Park County

Hepburn, John, Place, 626 E. River Rd., Emigrant, 05001177

New Mexico

Santa Fe County

Kelly, Daniel T., House, (Buildings Designed by John Gaw Meem MPS) 531 E. Palace Ave., Santa Fe, 05001182

OREGON

Multnomah County

Harrison Court Apartments, 1834 SW. 5th Ave., Portland, 05001179

[FR Doc. 05–19526 Filed 9–29–05; 8:45 am]

BILLING CODE 4312–51–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of intent to prepare an environmental impact statement (EIS) and notice to solicit comments and hold public scoping meetings on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead under low reservoir conditions.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA), the Bureau of Reclamation (Reclamation) proposes to conduct public scoping meetings and prepare an EIS for the development of Lower Colorado River Basin Shortage Guidelines and Coordinated Management Strategies for Operation of Lake Powell and Lake Mead Under Low Reservoir Conditions. The Secretary of the Interior (Secretary) has directed Reclamation to develop additional Colorado River management strategies to address operations of Lake Powell and Lake Mead under low reservoir conditions.

The proposed action is to develop these guidelines and strategies. Through the NEPA process initiated by this **Federal Register** notice, Reclamation is considering development of: (1) Specific guidelines that will identify those circumstances under which the Department of the Interior (Department) would reduce annual water deliveries from Lake Mead to the Lower Basin States below the 7.5 million acre-feet (maf) Lower Basin apportionment and the manner in which those deliveries would be reduced, and (2) coordinated management strategies for the operation of Lake Powell and Lake Mead.

Alternatives to be analyzed in the EIS have not been developed at this time and will be developed through the NEPA process, including through the upcoming EIS scoping meetings.

DATES AND ADDRESSES: Four public meetings will be held to solicit comments on the scope of specific shortage guidelines and other coordinated management strategies and the issues and alternatives that should be analyzed. Oral and written comments will be accepted at the public meetings to be held at the following locations:

- Tuesday, November 1, 2005—6 p.m. to 8 p.m., Hilton Salt Lake City Center, Topaz Room, 255 South West Temple, Salt Lake City, Utah.
- Wednesday, November 2, 2005—6 p.m. to 8 p.m., Adam's Mark Hotel, Tower Court D, 1550 Court Place, Denver, Colorado.
- Thursday, November 3, 2005—6 p.m. to 8 p.m., Arizona Department of Water Resources, Third Floor, Conference Rooms A&B, 500 North Third Street, Phoenix, Arizona.
- Tuesday, November 8, 2005—6 p.m. to 8 p.m., Henderson Convention Center, Grand Ballroom, 200 South Water Street, Henderson, Nevada.

Written comments on the proposed development of these strategies may be sent by close of business on *Wednesday, November 30, 2005*, to: Regional Director, Bureau of Reclamation, Lower Colorado Region, Attention: BCOO–1000, PO Box 61470, Boulder City, Nevada 89006–1470, faxogram at (702) 293–8156, or e-mail at *strategies@lc.usbr.gov*; and/or Regional Director, Bureau of Reclamation, Upper Colorado Region, Attention: UC–402, 125 South State Street, Salt Lake City, Utah 84318–1147, faxogram at (801) 524–3858, or e-mail at *strategies@uc.usbr.gov.*

FOR FURTHER INFORMATION CONTACT: Terrance J. Fulp, PhD., at (702) 293–8500 or e-mail at *strategies@lc.usbr.gov*; and/or Randall Peterson at (801) 524–3633 or e-mail at *strategies@uc.usbr.gov*. If special assistance is required regarding accommodations for attendance at any of the public meetings, please call Nan Yoder at (702) 293–8495, faxogram at (702) 293–8156, or e-mail at *nyoder@lc.usbr.gov* no less than 5 working days prior to the applicable meeting(s).

SUPPLEMENTARY INFORMATION: In recent years the Colorado River Basin experienced the worst five-year drought

Federal Register / Vol. 70, No. 189 / Friday, September 30, 2005 / Notices 57323

in recorded history. Drought in the Basin has impacted system storage, while demands for Colorado River water supplies have continued to increase. In the future, low reservoir conditions may not be limited to drought periods as additional development of Colorado River water occurs. The Colorado River is of strategic importance in the southwestern United States for water supply, hydropower production, recreation, fish and wildlife habitat, and other benefits. In addition, the Republic of Mexico has an allocation to the waters of the Colorado River pursuant to a 1944 treaty with the United States.

In 2001, the Department adopted Interim Surplus Guidelines (66 FR 7772) that are used by the Secretary in making annual determinations regarding "Normal" and "Surplus" conditions for the operation of Lake Mead. Since adoption, these Guidelines have, among other operational and management benefits, allowed the Department and entities in Arizona, California, and Nevada that rely on the Colorado River greater predictability in identifying when Colorado River water in excess of 7.5 maf will be available for use within these three States. In contrast, at this time the Department does not have detailed guidelines in place for annual determinations of releases from Lake Mead of less than 7.5 maf to water users in the three Lower Division States of Arizona, California, and Nevada (often referred to as a "shortage" condition on the lower Colorado River). Therefore, water users who rely on the Colorado River in these States are not currently able to identify particular reservoir conditions under which the Secretary would release less than 7.5 maf for use on an annual basis. Nor are these water users able to identify the amount of any potential future annual reductions in water deliveries.

Over the past year, the seven Colorado River Basin States have been proactively discussing strategies to address the recent period of system-wide drought in the Colorado River Basin. In addition, Reclamation has conducted detailed briefings for stakeholders in the Colorado River Basin and other interested entities regarding future scenarios for Colorado River operations.

Currently, each year, the Secretary establishes an Annual Operating Plan (AOP) for the Colorado River Reservoirs. The AOP describes how Reclamation will manage the reservoirs over a 12-month period, consistent with the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Long-Range Operating Criteria), the Decree entered by the U.S. Supreme Court in the *Arizona* v. *California* litigation, and other provisions of applicable Federal law. Reclamation consults annually with the Colorado River Basin States, Indian tribes, and other interested parties in the development of the AOP. Further, as part of the AOP process, the Secretary makes annual determinations under the Long-Range Operating Criteria regarding the availability of Colorado River water for deliveries to the Lower Division States. To meet the consultation requirements of Federal law, Reclamation also consults with the Colorado River Basin States, Indian tribes, and other interested parties during the five-year periodic reviews of the Long-Range Operating Criteria.

During the mid-year review of the 2005 AOP conducted this past spring, the Department received conflicting recommendations from the Colorado River Basin States regarding operations of Glen Canyon Dam for the remainder of the 2005 water year. In a May 2, 2005, letter to the Governors of the Colorado River Basin States, issued to complete the 2005 AOP mid-year review, the Secretary directed Reclamation to develop additional strategies to improve coordinated management of the reservoirs in the Colorado River system. Pursuant to that direction, Reclamation conducted a public consultation workshop on May 26, 2005, in Henderson, Nevada; issued a **Federal Register** notice soliciting public comments on June 15, 2005; and conducted public meetings on July 26 and July 28, 2005, in Henderson, Nevada, and Salt Lake City, Utah, respectively. Reclamation received a broad range of public comments and suggestions from these discussions, not all of which can be addressed in this proposed process. In addition, some suggestions may be part of ongoing or future efforts.

In order to assure the continued productive management and use of the Colorado River into the future, Reclamation is now soliciting public comments on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead under low reservoir conditions. Reclamation will utilize a public process pursuant to NEPA. By this notice, Reclamation provides notice of its intent to prepare an EIS on this action, and provides notice of its upcoming EIS scoping meetings. Reclamation invites all interested members of the general public, including the seven Colorado River Basin States, Indian tribes, water and power contractors, environmental organizations, representatives of academic and scientific communities, representatives of the recreation industry, and other organizations and agencies to present oral and written comments concerning the format and scope of specific shortage guidelines and coordinated management strategies, and the issues and alternatives to be considered during the development of these proposed guidelines and strategies. Reclamation anticipates publishing a "scoping report" after completion of the public scoping meetings identified in this **Federal Register** notice.

All comments received will be considered as Reclamation develops formal alternatives under NEPA. Similar to the surplus guidelines referenced above, it is likely that these shortage guidelines will be interim in nature. It is the Department's intent that these guidelines and coordinated management strategies will provide guidance to the Secretary's AOP decisions, and provide more predictability to water users and the public throughout the Colorado River Basin, particularly those in the Lower Division States. The Department does not intend to evaluate the decommissioning of Glen Canyon Dam.

Public Disclosure

Written comments, including names and home addresses of respondents, will be made available for public review. Individual respondents may request that their home address be withheld from public disclosure, which will be honored to the extent allowable by law. There may be circumstances in which respondents' identity may also be withheld from public disclosure, as allowable by law. If you wish to have your name and/or address withheld, you must state this prominently at the beginning of your comment. All submissions from organizations, business, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public disclosure in their entirety.

Dated: September 22, 2005.

Rick L. Gold,

Regional Director—UC Region, Bureau of Reclamation.

Dated: September 22, 2005.

Jayne Harkins,

Deputy Regional Director—LC Region, Bureau of Reclamation.

[FR Doc. 05–19607 Filed 9–29–05; 8:45 am]

BILLING CODE 4310–MN–P

I.5 March 16, 2006 Letter to Ten Tribes

United States Department of the Interior

BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
LC-2600
ENV-3.00

MAR 16 2006

CERTIFIED – RETURN RECEIPT REQUESTED

The Honorable Charles Wood
Chairman, Chemehuevi Indian Tribe
P.O. Box 1976
Havasu Lake, CA 92363-1976

Subject: Proposed Shortage Guidelines for the Lower Basin of the Colorado River and Coordinated Strategies for the Operation of Lake Powell and Lake Mead, Government-to-Government Consultations

Dear Chairman:

As you are aware, the Upper and Lower Colorado Regions of the Bureau of Reclamation are proposing to develop shortage guidelines for the Lower Basin of the Colorado River and coordinated strategies for the operation of Lake Powell and Lake Mead. A copy of the September 30, 2005 Federal Register notice initiating this process is enclosed. As part of this effort, Reclamation has already begun to engage in government-to-government consultations with the Ten Tribes Partnership, of which your tribe is a member.

In compliance with the National Historic Preservation Act (NHPA) and Executive Order 13007, regarding sacred sites, Reclamation is further seeking your assistance in identifying and evaluating historic properties, especially those of traditional religious or cultural importance, and what potential effects, if any, this proposed action might have on these properties.

A representative from Reclamation will be calling your office within two weeks to facilitate a government-to-government consultation regarding properties under the NHPA and sacred site guidelines, or you may call Mr. John Jamrog, Environmental Compliance Group Manager for the Lower Colorado Region at 702-293-8675.

Sincerely,

William J. Liebhauser, Acting Director
Resources Management Office

Enclosure

cc: See next page.

cc: Mr. Allen J. Auspach
Acting Regional Director
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

Ms. Amy Heustein
Supervisory Water Rights Specialist
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

Ms. Cathy Wilson
Environmental Protection Officer
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

bc: Office of the Field Solicitor
U.S. Department of the Interior
Sandra Day O'Connor
U.S. Courthouse, Suite 404
Attention: Ms. Katherine Verburg
401 West Washington Street, SPC 44
Phoenix, AZ 85003-2151

Office of the Field Solicitor
U.S. Department of the Interior
Sandra Day O'Connor
U.S. Courthouse, Suite 404
Attention: Mr. Bob Snow
401 West Washington Street, SPC 44
Phoenix, AZ 85003-2151

BCOO-1000, BCOO-1003 (w/signed cpy), BCOO-4600, LC-1000, LC-1100, LC-2000, LC-2010, LC- 2600, LC-2630, LC-2700, NAAO-1100, PXAO-1100, UC-100, UC-105, UC-402, UC-406, UC-438, UC-700, UC-720

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Identical Letter Sent To:

Honorable Sherry Cordova
Chairwoman, Cocopah Indian Tribe
County 15th and Avenue G
Somerton, AZ 85350

Ms. Lisa Wanstall
Museum Director, Cocopah Indian Tribe
County 15th and Avenue G
Somerton, AZ 85350

Honorable Daniel Eddy, Jr.
Chairman, Colorado River Indian Tribes
Route 1, Box 23-B
Parker, AZ 85344-9704

Mr. Michael Tsosie
Museum Director
Colorado River Indian Tribes
Route 1, Box 23-B
Parker, AZ 85344-9704

Honorable Nora McDowell
Chairwoman, Fort Mojave Indian Tribe
500 Merriman Avenue
Needles, CA 92363

Ms. Linda Otero
Director, Ahamakav Cultural Society
Fort Mojave Indian Tribe
P.O. Box 5990
Mohave Valley, CA 86440

Honorable Joe Shirley, Jr.
President, Navajo Nation
Box 9000
Window Rock, AZ 86515

Dr. Alan Downer
Navajo Nation Historic Preservation Department
P.O. Box 4950
Window Rock, AZ 86515

Mr. Stephen Begay
NAGPRA Representative
Navajo Nation Historic Preservation Department
P.O. Box 4950
Window Rock, AZ 86515

Mr. Ron Maldonado
Navajo Nation Historic Preservation Office
P.O. Box 4950
Window Rock, AZ 86515

Honorable Michael Jackson, Sr.
President, Quechan Indian Tribe
P.O. Box 1899
Yuma, AZ 85366

Honorable Pauline Jose
Chairwoman, Quechan Culture Community
Fort Yuma Quechan Indian Tribe
P.O. Box 1899
Yuma, AZ 85366

Honorable Maxine Natchees
Business Committee Chairwoman
Northern Ute Indian Tribe
P.O. Box 190
Fort Duchesne, UT 84026

Honorable Clement J. Frost
Chairman, Southern Ute Indian Tribe
P.O. Box 737
Ignacio, CO 81137

Mr. Neil Cloud
NAGPRA Representative
Southern Ute Indian Tribe
P.O. Box 737
Ignacio, CO 81137

Mr. Terry O. Knight
NAGPRA Representative
Ute Mountain Ute Tribe
Box 53
Towaoc, CO 81334-0248

Honorable Levi Pesata
President, Jicarilla Apache Nation
P.O. Box 507
Dulce, NM 87528

Ms. Adelaide Paiz
Cultural Preservation Officer
Jicarilla Apache Nation
P.O. Box 507
Dulce, NM 87528

Honorable Manual Health
Chairman, Ute Mountain Ute Tribe
P.O. Box 248
Towaoc, CO 81334-0248

or faxed comments should be submitted by October 17, 2005.

John W. Roberts,

Acting Chief, National Register/National Historic Landmarks Program.

ARKANSAS

Faulkner County

Lee, Carl and Esther, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 17493 US 65S, Damascus, 05001170

Tyler—Southerland House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 36 Southerland, Conway, 05001168

Ward, Earl and Mildred, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 1157 Mitchell St., Conway, 05001169

Webb, Joe and Nina, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 2945 Prince, Conway, 05001171

Washington County

Prairie Grove Battlefield (Boundary Increase II), N of US 62, E of Prairie Grove, Prairie Grove, 05001167

COLORADO

Montrose County

North Rim Road, Black Canyon of the Gunnison National Park, Black Canyon of the Gunnison National Park, Crawford, 05001181

GEORGIA

Bartow County

ATCO–Goodyear Mill and Mill Village Historic District, Roughly bounded by Sugar Valley Rd., Cassville rd. and Pettit Creek, Wingfoot Trail and Litchfield St., Cartersville, 05001172

MAINE

Androscoggin County

Keystone Mineral Springs, Keystone Rd., Poland, 05001175

Cumberland County

Battery Steele, Florida Ave., Peaks Island, Portland, 05001176

Lakeside Grange #63, Main St., jct. of Main St. and Lincoln St., Harrison, 05001173

Hancock County

Garland Farm, 1029 ME 3, Bar Harbor, 05001174

MINNESOTA

Cook County

Grand Portage National Monument, Off US 61 within the area of the Grand Portage Indian Reservation, Grand Portage, 05001180

MISSOURI

Madison County

St. Louis, Iron Mountain and Southern Railroad Depot, Allen St., 150 ft. No of Jct. of Allen and Kelly Sts., Fredericktown, 05001178

MONTANA

Park County

Hepburn, John, Place, 626 E. River Rd., Emigrant, 05001177

New Mexico

Santa Fe County

Kelly, Daniel T., House, (Buildings Designed by John Gaw Meem MPS) 531 E. Palace Ave., Santa Fe, 05001182

OREGON

Multnomah County

Harrison Court Apartments, 1834 SW. 5th Ave., Portland, 05001179

[FR Doc. 05–19526 Filed 9–29–05; 8:45 am]

BILLING CODE 4312–51–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of intent to prepare an environmental impact statement (EIS) and notice to solicit comments and hold public scoping meetings on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead under low reservoir conditions.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA), the Bureau of Reclamation (Reclamation) proposes to conduct public scoping meetings and prepare an EIS for the development of Lower Colorado River Basin Shortage Guidelines and Coordinated Management Strategies for Operation of Lake Powell and Lake Mead Under Low Reservoir Conditions. The Secretary of the Interior (Secretary) has directed Reclamation to develop additional Colorado River management strategies to address operations of Lake Powell and Lake Mead under low reservoir conditions.

The proposed action is to develop these guidelines and strategies. Through the NEPA process initiated by this **Federal Register** notice, Reclamation is considering development of: (1) Specific guidelines that will identify those circumstances under which the Department of the Interior (Department) would reduce annual water deliveries from Lake Mead to the Lower Basin States below the 7.5 million acre-feet (maf) Lower Basin apportionment and the manner in which those deliveries would be reduced, and (2) coordinated management strategies for the operation of Lake Powell and Lake Mead.

Alternatives to be analyzed in the EIS have not been developed at this time and will be developed through the NEPA process, including through the upcoming EIS scoping meetings.

DATES AND ADDRESSES: Four public meetings will be held to solicit comments on the scope of specific shortage guidelines and other coordinated management strategies and the issues and alternatives that should be analyzed. Oral and written comments will be accepted at the public meetings to be held at the following locations:

- Tuesday, November 1, 2005—6 p.m. to 8 p.m., Hilton Salt Lake City Center, Topaz Room, 255 South West Temple, Salt Lake City, Utah.
- Wednesday, November 2, 2005—6 p.m. to 8 p.m., Adam's Mark Hotel, Tower Court D, 1550 Court Place, Denver, Colorado.
- Thursday, November 3, 2005—6 p.m. to 8 p.m., Arizona Department of Water Resources, Third Floor, Conference Rooms A&B, 500 North Third Street, Phoenix, Arizona.
- Tuesday, November 8, 2005—6 p.m. to 8 p.m., Henderson Convention Center, Grand Ballroom, 200 South Water Street, Henderson, Nevada.

Written comments on the proposed development of these strategies may be sent by close of business on *Wednesday, November 30, 2005*, to: Regional Director, Bureau of Reclamation, Lower Colorado Region, Attention: BCOO–1000, PO Box 61470, Boulder City, Nevada 89006–1470, faxogram at (702) 293–8156, or e-mail at *strategies@lc.usbr.gov*; and/or Regional Director, Bureau of Reclamation, Upper Colorado Region, Attention: UC–402, 125 South State Street, Salt Lake City, Utah 84318–1147, faxogram at (801) 524–3858, or e-mail at *strategies@uc.usbr.gov*.

FOR FURTHER INFORMATION CONTACT: Terrance J. Fulp, PhD., at (702) 293–8500 or e-mail at *strategies@lc.usbr.gov*; and/or Randall Peterson at (801) 524–3633 or e-mail at *strategies@uc.usbr.gov*. If special assistance is required regarding accommodations for attendance at any of the public meetings, please call Nan Yoder at (702) 293–8495, faxogram at (702) 293–8156, or e-mail at *nyoder@lc.usbr.gov* no less than 5 working days prior to the applicable meeting(s).

SUPPLEMENTARY INFORMATION: In recent years the Colorado River Basin experienced the worst five-year drought

in recorded history. Drought in the Basin has impacted system storage, while demands for Colorado River water supplies have continued to increase. In the future, low reservoir conditions may not be limited to drought periods as additional development of Colorado River water occurs. The Colorado River is of strategic importance in the southwestern United States for water supply, hydropower production, recreation, fish and wildlife habitat, and other benefits. In addition, the Republic of Mexico has an allocation to the waters of the Colorado River pursuant to a 1944 treaty with the United States.

In 2001, the Department adopted Interim Surplus Guidelines (66 FR 7772) that are used by the Secretary in making annual determinations regarding "Normal" and "Surplus" conditions for the operation of Lake Mead. Since adoption, these Guidelines have, among other operational and management benefits, allowed the Department and entities in Arizona, California, and Nevada that rely on the Colorado River greater predictability in identifying when Colorado River water in excess of 7.5 maf will be available for use within these three States. In contrast, at this time the Department does not have detailed guidelines in place for annual determinations of releases from Lake Mead of less than 7.5 maf to water users in the three Lower Division States of Arizona, California, and Nevada (often referred to as a "shortage" condition on the lower Colorado River). Therefore, water users who rely on the Colorado River in these States are not currently able to identify particular reservoir conditions under which the Secretary would release less than 7.5 maf for use on an annual basis. Nor are these water users able to identify the amount of any potential future annual reductions in water deliveries.

Over the past year, the seven Colorado River Basin States have been proactively discussing strategies to address the recent period of system-wide drought in the Colorado River Basin. In addition, Reclamation has conducted detailed briefings for stakeholders in the Colorado River Basin and other interested entities regarding future scenarios for Colorado River operations.

Currently, each year, the Secretary establishes an Annual Operating Plan (AOP) for the Colorado River Reservoirs. The AOP describes how Reclamation will manage the reservoirs over a 12-month period, consistent with the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Long-Range Operating Criteria), the Decree entered by the U.S. Supreme Court in the *Arizona* v. *California* litigation, and other provisions of applicable Federal law. Reclamation consults annually with the Colorado River Basin States, Indian tribes, and other interested parties in the development of the AOP. Further, as part of the AOP process, the Secretary makes annual determinations under the Long-Range Operating Criteria regarding the availability of Colorado River water for deliveries to the Lower Division States. To meet the consultation requirements of Federal law, Reclamation also consults with the Colorado River Basin States, Indian tribes, and other interested parties during the five-year periodic reviews of the Long-Range Operating Criteria.

During the mid-year review of the 2005 AOP conducted this past spring, the Department received conflicting recommendations from the Colorado River Basin States regarding operations of Glen Canyon Dam for the remainder of the 2005 water year. In a May 2, 2005, letter to the Governors of the Colorado River Basin States, issued to complete the 2005 AOP mid-year review, the Secretary directed Reclamation to develop additional strategies to improve coordinated management of the reservoirs in the Colorado River system. Pursuant to that direction, Reclamation conducted a public consultation workshop on May 26, 2005, in Henderson, Nevada; issued a **Federal Register** notice soliciting public comments on June 15, 2005; and conducted public meetings on July 26 and July 28, 2005, in Henderson, Nevada, and Salt Lake City, Utah, respectively. Reclamation received a broad range of public comments and suggestions from these discussions, not all of which can be addressed in this proposed process. In addition, some suggestions may be part of ongoing or future efforts.

In order to assure the continued productive management and use of the Colorado River into the future, Reclamation is now soliciting public comments on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead under low reservoir conditions. Reclamation will utilize a public process pursuant to NEPA. By this notice, Reclamation provides notice of its intent to prepare an EIS on this action, and provides notice of its upcoming EIS scoping meetings. Reclamation invites all interested members of the general public, including the seven Colorado River Basin States, Indian tribes, water and power contractors, environmental organizations, representatives of academic and scientific communities, representatives of the recreation industry, and other organizations and agencies to present oral and written comments concerning the format and scope of specific shortage guidelines and coordinated management strategies, and the issues and alternatives to be considered during the development of these proposed guidelines and strategies. Reclamation anticipates publishing a "scoping report" after completion of the public scoping meetings identified in this **Federal Register** notice.

All comments received will be considered as Reclamation develops formal alternatives under NEPA. Similar to the surplus guidelines referenced above, it is likely that these shortage guidelines will be interim in nature. It is the Department's intent that these guidelines and coordinated management strategies will provide guidance to the Secretary's AOP decisions, and provide more predictability to water users and the public throughout the Colorado River Basin, particularly those in the Lower Division States. The Department does not intend to evaluate the decommissioning of Glen Canyon Dam.

Public Disclosure

Written comments, including names and home addresses of respondents, will be made available for public review. Individual respondents may request that their home address be withheld from public disclosure, which will be honored to the extent allowable by law. There may be circumstances in which respondents' identity may also be withheld from public disclosure, as allowable by law. If you wish to have your name and/or address withheld, you must state this prominently at the beginning of your comment. All submissions from organizations, business, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public disclosure in their entirety.

Dated: September 22, 2005.

Rick L. Gold,

Regional Director—UC Region, Bureau of Reclamation.

Dated: September 22, 2005.

Jayne Harkins,

Deputy Regional Director—LC Region, Bureau of Reclamation.

[FR Doc. 05–19607 Filed 9–29–05; 8:45 am]

BILLING CODE 4310–MN–P

I.6 March 16, 2006 Letter to Other Tribes

United States Department of the Interior

BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
LC-2600
ENV-3.00

MAR 16 2006

CERTIFIED – RETURN RECEIPT REQESTED

Mr. Leigh Kuwanwisiwma
Director, Cultural Preservation Office
Hopi Tribe of Arizona
P.O. Box 123
Kykotsmovi, AZ 86039

Subject: Proposed Shortage Guidelines for the Lower Basin of the Colorado River and Coordinated Strategies for the Operation of Lake Powell and Lake Mead, Government-to-Government Consultations

Dear Mr. Kuwanwisiwma:

The Upper and Lower Colorado Regions of the Bureau of Reclamation are proposing to develop Lower Basin shortage guidelines and coordinated reservoir operations strategies for Lake Powell and Lake Mead. A copy of the September 30, 2005 Federal Register notice initiating this process is enclosed.

Reclamation would like to enter into a government-to-government consultation regarding any concerns your tribe might have with our proposed action. In addition, in compliance with the National Historic Preservation Act and Executive Order 13007, regarding sacred sites, Reclamation is seeking your assistance in identifying and evaluating historic properties, especially those of traditional religious or cultural importance, and what potential effects, if any, this proposed action might have on these properties.

A representative from Reclamation will be calling your office within two weeks to facilitate a government-to-government consultation regarding this action, or you may call Mr. John Jamrog, Environmental Compliance Group Manager for the Lower Colorado Region at 702-293-8675.

Sincerely,

William J. Liebhauser, Acting Director
Resources Management Office

Enclosure

2

bc: BCOO-1000, BCOO-1003 (w/cpy signed letter), LC-1000, LC-1100, LC-2000, LC-2010, LC-2600, LC-2630, LC-2700, NAAO-1100, PXAO-1100, UC-100, UC-105, UC-402, UC-406, UC-438, UC-700, UC-720

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Daily
WBR:JJamrog:nr:03/13/06:293-8675
(Usr\COMM2000\COM2600\John Jamrog:&Final Shortage EISmaillist3.othertribesculturalpropletter.doc)

Identical Letter Sent To:

Honorable Raphael Bear
President, Fort McDowell Yavapai Nation
P.O. Box 17770
Fountain Hills, AZ 85269

Ms. Karen Ray
Cultural Resource Representative
Fort McDowell Yavapai Nation
P.O. Box 17770
Fountain Hills, AZ 85269

Honorable Thomas Siyuja, Sr.
Chairman, Havasupai Tribe
P.O. Box 10
Supai, AZ 86435

Mr. Roland Manakaja
Cultural Representative
Havasupai Tribe
P.O. Box 10
Supai, AZ 86435

Honorable Wayne Taylor, Jr.
Chairman, Hopi Tribe
P.O. Box 123
Kykotsmovi, AZ 86029

Ms. Loretta Jackson
Tribal Historic Preservation Officer
Hualapai Tribe
215 Diamond Creek Road
Box 310
Peach Springs, AZ 86434

Honorable Charles Vaughn
Chairman, Hualapai Tribe
Box 179
Peach Springs, AZ 86434

Honorable Carmen Bradley
Chairwoman, Kaibab Band of Paiute Indians
HC65 Box 2
Fredonia, AZ 86022

Ms. Brenda Drye
Cultural Resource Representative
Kaibab Band of Paiute Indians
HC65 Box 2
Fredonia, AZ 86022

Honorable Alfreda Mitre
Chairwoman, Las Vegas Paiute Tribe
One Paiute Drive
Las Vegas, NV 89106

Mr. Kenny Anderson
Cultural Representative
Las Vegas Paiute Tribe
One Paiute Drive
Las Vegas, NV 89106

Honorable Phil Swain
Chairman, Moapa Paiute Tribe
P.O. Box 340
Moapa, NV 89025-0340

Ms. Lalovi Miller
Cultural Representative
Moapa Paiute Tribe
P.O. Box 391

Honorable Laura Tom
Chairwoman, Paiute Indian Tribe of Utah
440 No. Paiute Drive
Cedar City, UT 84720

Ms. Doreena Martineau
Cultural Resource Representative
Paiute Indian Tribe of Utah
440 No. Paiute Drive
Cedar City, UT 84720

Honorable Fred Vallo, Sr.
Governor, Pueblo of Acoma
Box 309
Acoma, NM 87034

Mr. Steven Concho
NAGPRA Representative
Pueblo of Acoma
Box 309
Acoma, NM 87304

Honorable Simon Suipa
Governor, Pueblo of Cochiti
Box 70
Cochiti Pueblo, NM 87072

Mr. Tony Herrera
NAGPRA Representative
Pueblo of Cochiti
Box 157
Cochiti, NM 87072

Mr. Jacob Pecos
Coordinator
Pueblo of Cochiti
Box 70
Cochiti, NM 87072

Honorable Raymond Lucero
Governor, Pueblo of Jemez
Box 100
Jemez Pueblo, NM 87024

Mr. Matthew Liebman
Cultural Resource Representative
Pueblo of Jemez
Box 100
Jemez Pueblo, NM 87024

Honorable Roland Johnson
Governor, Pueblo of Laguna
Box 194
Laguna Pueblo, NM 87026

Mr. Victor Sarracino
NAGPRA Representative
Pueblo of Laguna
Box 153
Laguna, NM 87026

Honorable Tom F. Talache, Jr.
Governor, Pueblo of Nambe
Route 1 Box 117-BB
Santa Fe, NM 87506

Mr. Ernest Mirabal
NAGPRA Representative
Pueblo of Nambe
Route 1 Box 117-A
Santa Fe, NM 87506

Mr. Charlie Tapia
NAGPRA Representative
Pueblo of Pojoaque
Route 11 Box 71
Santa Fe, NM 87501

Honorable Jacob Viarrial
Governor, Pueblo of Pojoaque
Route 11 Box 71
Santa Fe, NM 87501

Mr. Luke Duran
NAGPRA Representative
Pueblo of Pojoaque
Route 11 Box 71
Santa Fe, NM 87501

4

Mr. Herman Agoyo
NAGPRA Representative
Pueblo of San Juan
Box 1099
San Juan, NM 87566

Honorable Wilfred Garcia
Governor, Pueblo of San Juan
Box 1099
San Juan Pueblo, NM 87566

Ms. Jenny Holmes
Pueblo of Sandia
Box 6008
Bernalillo, NM 87004

Honorable Stuwart Paisano
Governor, Pueblo of Sandia
481 Sandia Loop
Bernalillo, NM 87004

Mr. Ben Robbins
Pueblo of Santa Ana
2 Dove Road
Santa Ana Pueblo, NM 87004

Honorable Myron Armijo
Governor, Pueblo of Santa Ana
2 Dove Road
Bernalillo, NM 87004

Honorable Denny Gutierrez
Governor, Pueblo of Santa Clara
Box 580
Espanola, NM 87532

Mr. Paul Baca
Pueblo of Santa Clara
Box 580
Bernalillo, NM 87532

Honorable Marvin Herrera
Governor, Pueblo of Tesuque
Route 42 Box 360-T
Santa Fe, NM 87506

Mr. Celestino Gauchupin
NAGPRA Representative
Pueblo of Zia
135 Capitol Square Drive
Zia Pueblo, NM 87053-6013

Honorable Peter Pino
Governor, Pueblo of Zia
135 Capitol Square Drive
Zia Pueblo, NM 87053-6013

Dr. Jonathan Damp
Pueblo of Zuni
Box 1149
Zuni Pueblo, NM 87327-0339

Honorable Arlen Quetawki, Sr.
Governor, Pueblo of Zuni
Box 339
Pueblo of Zuni, NM 87327-0339

Ms. Lorraine Swanick
Natural Resource Coordinator
Pueblo of San Felipe
Box 4339
San Felipe Pueblo, NM 87001

Honorable Lawrence Troncosa
Governor, Pueblo of San Felipe
Box 4339
San Felipe Pueblo, NM 87001

Honorable Ernest Jones Sr.
President, Yavapai-Prescott Indian Tribe
530 East Merritt Street
Prescott, AZ 86301-2038

Ms. Nancy Hayden
Director of Research
Yavapai-Prescott Indian Tribe
530 East Merritt Street
Prescott, AZ 86301-2038

5

Honorable Dallas Massey, Sr.
Chairman, White Mountain Apache
P.O. Box 700
White River, AZ 85941

or faxed comments should be submitted by October 17, 2005.

John W. Roberts,

Acting Chief, National Register/National Historic Landmarks Program.

ARKANSAS

Faulkner County

Lee, Carl and Esther, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 17493 US 65S, Damascus, 05001170

Tyler—Southerland House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 36 Southerland, Conway, 05001168

Ward, Earl and Mildred, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 1157 Mitchell St., Conway, 05001169

Webb, Joe and Nina, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 2945 Prince, Conway, 05001171

Washington County

Prairie Grove Battlefield (Boundary Increase II), N of US 62, E of Prairie Grove, Prairie Grove, 05001167

COLORADO

Montrose County

North Rim Road, Black Canyon of the Gunnison National Park, Black Canyon of the Gunnison National Park, Crawford, 05001181

GEORGIA

Bartow County

ATCO–Goodyear Mill and Mill Village Historic District, Roughly bounded by Sugar Valley Rd., Cassville rd. and Pettit Creek, Wingfoot Trail and Litchfield St., Cartersville, 05001172

MAINE

Androscoggin County

Keystone Mineral Springs, Keystone Rd., Poland, 05001175

Cumberland County

Battery Steele, Florida Ave., Peaks Island, Portland, 05001176

Lakeside Grange #63, Main St., jct. of Main St. and Lincoln St., Harrison, 05001173

Hancock County

Garland Farm, 1029 ME 3, Bar Harbor, 05001174

MINNESOTA

Cook County

Grand Portage National Monument, Off US 61 within the area of the Grand Portage Indian Reservation, Grand Portage, 05001180

MISSOURI

Madison County

St. Louis, Iron Mountain and Southern Railroad Depot, Allen St., 150 ft. No of Jct. of Allen and Kelly Sts., Fredericktown, 05001178

MONTANA

Park County

Hepburn, John, Place, 626 E. River Rd., Emigrant, 05001177

New Mexico

Santa Fe County

Kelly, Daniel T., House, (Buildings Designed by John Gaw Meem MPS) 531 E. Palace Ave., Santa Fe, 05001182

OREGON

Multnomah County

Harrison Court Apartments, 1834 SW. 5th Ave., Portland, 05001179

[FR Doc. 05–19526 Filed 9–29–05; 8:45 am]

BILLING CODE 4312–51–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of intent to prepare an environmental impact statement (EIS) and notice to solicit comments and hold public scoping meetings on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead under low reservoir conditions.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA), the Bureau of Reclamation (Reclamation) proposes to conduct public scoping meetings and prepare an EIS for the development of Lower Colorado River Basin Shortage Guidelines and Coordinated Management Strategies for Operation of Lake Powell and Lake Mead Under Low Reservoir Conditions. The Secretary of the Interior (Secretary) has directed Reclamation to develop additional Colorado River management strategies to address operations of Lake Powell and Lake Mead under low reservoir conditions.

The proposed action is to develop these guidelines and strategies. Through the NEPA process initiated by this **Federal Register** notice, Reclamation is considering development of: (1) Specific guidelines that will identify those circumstances under which the Department of the Interior (Department) would reduce annual water deliveries from Lake Mead to the Lower Basin States below the 7.5 million acre-feet (maf) Lower Basin apportionment and the manner in which those deliveries would be reduced, and (2) coordinated management strategies for the operation of Lake Powell and Lake Mead.

Alternatives to be analyzed in the EIS have not been developed at this time and will be developed through the NEPA process, including through the upcoming EIS scoping meetings.

DATES AND ADDRESSES: Four public meetings will be held to solicit comments on the scope of specific shortage guidelines and other coordinated management strategies and the issues and alternatives that should be analyzed. Oral and written comments will be accepted at the public meetings to be held at the following locations:

- Tuesday, November 1, 2005—6 p.m. to 8 p.m., Hilton Salt Lake City Center, Topaz Room, 255 South West Temple, Salt Lake City, Utah.
- Wednesday, November 2, 2005—6 p.m. to 8 p.m., Adam's Mark Hotel, Tower Court D, 1550 Court Place, Denver, Colorado.
- Thursday, November 3, 2005—6 p.m. to 8 p.m., Arizona Department of Water Resources, Third Floor, Conference Rooms A&B, 500 North Third Street, Phoenix, Arizona.
- Tuesday, November 8, 2005—6 p.m. to 8 p.m., Henderson Convention Center, Grand Ballroom, 200 South Water Street, Henderson, Nevada.

Written comments on the proposed development of these strategies may be sent by close of business on *Wednesday, November 30, 2005*, to: Regional Director, Bureau of Reclamation, Lower Colorado Region, Attention: BCOO–1000, PO Box 61470, Boulder City, Nevada 89006–1470, faxogram at (702) 293–8156, or e-mail at *strategies@lc.usbr.gov*; and/or Regional Director, Bureau of Reclamation, Upper Colorado Region, Attention: UC–402, 125 South State Street, Salt Lake City, Utah 84318–1147, faxogram at (801) 524–3858, or e-mail at *strategies@uc.usbr.gov.*

FOR FURTHER INFORMATION CONTACT: Terrance J. Fulp, PhD., at (702) 293–8500 or e-mail at *strategies@lc.usbr.gov*; and/or Randall Peterson at (801) 524–3633 or e-mail at *strategies@uc.usbr.gov.* If special assistance is required regarding accommodations for attendance at any of the public meetings, please call Nan Yoder at (702) 293–8495, faxogram at (702) 293–8156, or e-mail at *nyoder@lc.usbr.gov* no less than 5 working days prior to the applicable meeting(s).

SUPPLEMENTARY INFORMATION: In recent years the Colorado River Basin experienced the worst five-year drought

Federal Register / Vol. 70, No. 189 / Friday, September 30, 2005 / Notices 57323

in recorded history. Drought in the Basin has impacted system storage, while demands for Colorado River water supplies have continued to increase. In the future, low reservoir conditions may not be limited to drought periods as additional development of Colorado River water occurs. The Colorado River is of strategic importance in the southwestern United States for water supply, hydropower production, recreation, fish and wildlife habitat, and other benefits. In addition, the Republic of Mexico has an allocation to the waters of the Colorado River pursuant to a 1944 treaty with the United States.

In 2001, the Department adopted Interim Surplus Guidelines (66 FR 7772) that are used by the Secretary in making annual determinations regarding "Normal" and "Surplus" conditions for the operation of Lake Mead. Since adoption, these Guidelines have, among other operational and management benefits, allowed the Department and entities in Arizona, California, and Nevada that rely on the Colorado River greater predictability in identifying when Colorado River water in excess of 7.5 maf will be available for use within these three States. In contrast, at this time the Department does not have detailed guidelines in place for annual determinations of releases from Lake Mead of less than 7.5 maf to water users in the three Lower Division States of Arizona, California, and Nevada (often referred to as a "shortage" condition on the lower Colorado River). Therefore, water users who rely on the Colorado River in these States are not currently able to identify particular reservoir conditions under which the Secretary would release less than 7.5 maf for use on an annual basis. Nor are these water users able to identify the amount of any potential future annual reductions in water deliveries.

Over the past year, the seven Colorado River Basin States have been proactively discussing strategies to address the recent period of system-wide drought in the Colorado River Basin. In addition, Reclamation has conducted detailed briefings for stakeholders in the Colorado River Basin and other interested entities regarding future scenarios for Colorado River operations.

Currently, each year, the Secretary establishes an Annual Operating Plan (AOP) for the Colorado River Reservoirs. The AOP describes how Reclamation will manage the reservoirs over a 12-month period, consistent with the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Long-Range Operating Criteria), the Decree entered by the U.S. Supreme Court in the *Arizona* v. *California* litigation, and other provisions of applicable Federal law. Reclamation consults annually with the Colorado River Basin States, Indian tribes, and other interested parties in the development of the AOP. Further, as part of the AOP process, the Secretary makes annual determinations under the Long-Range Operating Criteria regarding the availability of Colorado River water for deliveries to the Lower Division States. To meet the consultation requirements of Federal law, Reclamation also consults with the Colorado River Basin States, Indian tribes, and other interested parties during the five-year periodic reviews of the Long-Range Operating Criteria.

During the mid-year review of the 2005 AOP conducted this past spring, the Department received conflicting recommendations from the Colorado River Basin States regarding operations of Glen Canyon Dam for the remainder of the 2005 water year. In a May 2, 2005, letter to the Governors of the Colorado River Basin States, issued to complete the 2005 AOP mid-year review, the Secretary directed Reclamation to develop additional strategies to improve coordinated management of the reservoirs in the Colorado River system. Pursuant to that direction, Reclamation conducted a public consultation workshop on May 26, 2005, in Henderson, Nevada; issued a **Federal Register** notice soliciting public comments on June 15, 2005; and conducted public meetings on July 26 and July 28, 2005, in Henderson, Nevada, and Salt Lake City, Utah, respectively. Reclamation received a broad range of public comments and suggestions from these discussions, not all of which can be addressed in this proposed process. In addition, some suggestions may be part of ongoing or future efforts.

In order to assure the continued productive management and use of the Colorado River into the future, Reclamation is now soliciting public comments on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead under low reservoir conditions. Reclamation will utilize a public process pursuant to NEPA. By this notice, Reclamation provides notice of its intent to prepare an EIS on this action, and provides notice of its upcoming EIS scoping meetings. Reclamation invites all interested members of the general public, including the seven Colorado River Basin States, Indian tribes, water and power contractors, environmental organizations, representatives of academic and scientific communities, representatives of the recreation industry, and other organizations and agencies to present oral and written comments concerning the format and scope of specific shortage guidelines and coordinated management strategies, and the issues and alternatives to be considered during the development of these proposed guidelines and strategies. Reclamation anticipates publishing a "scoping report" after completion of the public scoping meetings identified in this **Federal Register** notice.

All comments received will be considered as Reclamation develops formal alternatives under NEPA. Similar to the surplus guidelines referenced above, it is likely that these shortage guidelines will be interim in nature. It is the Department's intent that these guidelines and coordinated management strategies will provide guidance to the Secretary's AOP decisions, and provide more predictability to water users and the public throughout the Colorado River Basin, particularly those in the Lower Division States. The Department does not intend to evaluate the decommissioning of Glen Canyon Dam.

Public Disclosure

Written comments, including names and home addresses of respondents, will be made available for public review. Individual respondents may request that their home address be withheld from public disclosure, which will be honored to the extent allowable by law. There may be circumstances in which respondents' identity may also be withheld from public disclosure, as allowable by law. If you wish to have your name and/or address withheld, you must state this prominently at the beginning of your comment. All submissions from organizations, business, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public disclosure in their entirety.

Dated: September 22, 2005.

Rick L. Gold,

Regional Director—UC Region, Bureau of Reclamation.

Dated: September 22, 2005.

Jayne Harkins,

Deputy Regional Director—LC Region, Bureau of Reclamation.

[FR Doc. 05–19607 Filed 9–29–05; 8:45 am]

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I.7 May 3, 2006 Letter to Tribes

United States Department of the Interior

BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
LC-2600
ENV-3.00

MAY 3 2006

CERTIFIED – RETURN RECEIPT REQUESTED

Honorable Charles Wood
Chairman, Chemehuevi Indian Tribe
P.O. Box 1976
Havasu City, CA 92363-1976

Subject: Presentation of Draft Alternatives Being Considered for the Proposed Shortage Guidelines for the Lower Basin of the Colorado River and Coordinated Strategies for the Operation of Lake Powell and Lake Mead, Under Low Reservoir Conditions, Government-to-Government Consultations

Dear Chairman:

As part of continuing government-to-government consultations for the development of Lower Basin shortage guidelines and coordinated reservoir operations strategies for Lake Powell and Lake Mead, under low reservoir conditions, the Upper and Lower Colorado Regions of the Bureau of Reclamation request to meet with consulting tribes to present the draft alternatives currently being considered for analysis under the planned EIS.

During the meeting we will provide the tribal representatives with an update of progress on the project, a brief discussion of the recently published Scoping Summary Report, and a detailed presentation of the draft alternatives being considered for analysis, including preliminary results of modeling predictions of reservoir conditions as a result of each alternative being considered. A court reporter will be on hand to record the discussions at the meeting, including any input or suggestions you may have regarding the draft alternatives. The Definitions for Draft Alternatives and Elements/Options Matrix, and Draft Alternatives and Elements/Options Considered in Each Alternative, are enclosed for your review leading up to the meeting.

Although several tribal representatives have expressed interest in the potential impacts these alternatives may have on their reserved water rights, contracts, or operations, the analysis of those impacts has not yet been initiated. Therefore we will not be able to fully articulate these impacts with any certainty at this time. Our intention is to inform and engage tribal governments about the assumptions and proposals being considered for analysis at important stages of the EIS process. These impacts will be addressed through the EIS process in the future.

To accommodate the traveling distances of the majority of the consulting tribes, we are recommending a meeting in Phoenix, Arizona on one of the following days: May 22; May 23; or May 30, 2006. Please contact Mr. John Jamrog, Environmental Compliance Group Manager for the Lower Colorado Region, by phone at 702-293-8675, or via e-mail at jjamrog@lc.usbr.gov, to confirm which dates are best for you. A representative from Reclamation will also be calling your office within the week to confirm your availability and participation and to inform you of the exact location of the meeting facility in Phoenix.

Sincerely,

AMELIA C. PORTER

For

William J. Liebhauser, Director
Resources Management Office

Enclosures – 2

Identical Letter Sent To:

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cc: Mr. Allen J. Auspach
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Phoenix, AZ 85001

Ms. Cathy Wilson
Supervisory Water Rights Specialist
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(w/encls to each)

Ms. Amy Heustein
Environmental Protection Officer
Bureau of Indian Affairs
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Phoenix, AZ 85001

Mr. Sam Spiller
U.S. Fish and Wildlife Service
2321 West Royal Palm Road
Phoenix, AZ 85021

bc: Office of the Field Solicitor
U.S. Department of the Interior
Sandra Day O'Connor
U.S. Courthouse, Suite 404
Attention: Ms. Katherine Verburg
401 West Washington Street, SPC 44,
Phoenix, AZ 85003-2151

Office of the Field Solicitor
U.S. Department of the Interior
Sandra Day O'Connor
U.S. Courthouse, Suite 404
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Phoenix, AZ 85003-2151

LC-1000, LC-1100, LC-2000, LC-2001-Chrono, LC-2010, LC-2600, LC-2630, LC-2700, BCOO-1000, BCOO-1003, PXAO-1100, NAAO-1100, UC-100, UC-105, UC-402, UC-406, UC-438, UC-700, UC-720,
(w/encls to each)

Daily
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Definitions for Draft Alternatives and Elements/Options Matrix

(Working Draft: April 13, 2006 version)

- **Absolute protection of a specified reservoir elevation**
  - The reservoir release is reduced by the amount needed to keep the reservoir above the specified elevation (i.e., inflow = outflow)
  - Example: Absolute protection of elevation 3490' at Powell would reduce Powell's release below 8.23 MAF as Powell nears elevation 3490' and would result in additional water stored in Powell and less water in Mead
  - Example: Absolute protection of elevation 1000' in Mead would reduce Mead's release as Mead nears elevation 1000' and would result in shortages at whatever magnitude necessary

- **No protection of reservoir elevations**
  - The reservoir continues to make specified releases until there is no water above the dead pool; then inflow = outflow

- **Reservoir balancing**
  - Lake Powell's release is computed to keep it and Lake Mead at equal storage (or at the same percent full)

- **Modification of Lake Powell's annual release based on elevation**
  - The annual release changes each year depending upon where Lake Powell's elevation is at the beginning of the year (or can also be based on where the elevation is forecasted to be at the end of the year)

- **Proactive Shortage**
  - Shortages are applied at higher levels in the reservoir in order to reduce the chance of going below a lower, specified elevation
  - Results in more frequent shortages of smaller magnitudes than an absolute protection strategy
  - **Probabilistic protection -** shortages are taken at higher levels to approximate a specified chance

1

Draft Alternatives and Elements/Options Considered in Each Alternative

Working Draft: April 13, 2006 version

Alternatives		A Shortage Guidelines to reduce deliveries/releases from Lake Mead	B Coordinated Reservoir Operations (Lake Mead & Lake Powell)	C Lake Mead Storage and Delivery of Conserved and Non-system Water	D Interim Surplus Guidelines for deliveries/releases from Lake Mead
Alt. 1	No Action Alternative	• Two level shortage strategy - probabilistic protection of elevation 1050' at Lake Mead (80P1050) and absolute protection of elevation 1000' at Lake Mead.	• Minimum objective release of 8.23 MAF unless storage equalization releases are required. • Absolute protection of elevation 3490' at Lake Powell.	• No water management/accounting mechanism for storage and delivery of water conserved through extraordinary water conservation and/or water augmentation programs.	• No modification or extension of the Interim Surplus Guidelines which end in 2016. • Beginning in 2017, surplus declarations revert to the 70R strategy.
Alt. 2	Basin States Preliminary Alternative	• Stepped shortages up to 600 KAF. • Initiate efforts to develop additional guidelines for shortages if Lake Mead falls below elevation 1025' (Note: includes reconsultation with Basin States).	• Under low reservoir storage conditions, either reduce Lake Powell release or balance contents depending on projected Lake Mead and Lake Powell elevations. • No absolute protection of 3490' at Lake Powell.	• Storage/delivery water management/accounting program at Lake Mead for water conserved through extraordinary water conservation and/or water augmentation. • Maximum created storage credit of 625 KAF per year. • Maximum total additional Lake Mead storage through extraordinary conservation and/or augmentation of 2.1 MAF. • Maximum delivery from Lake Mead of water developed by extraordinary conservation and/or augmentation of 1.0 MAF per year.	• Modification of Interim Surplus Guidelines to eliminate Partial Domestic Surplus condition. • The modified guidelines are implemented from 2008 through 2025. • Beginning in 2026, surplus declarations revert to the 70R strategy.
Alt. 3	Conservation Before Shortage Alternative	• Absolute protection of SNWA intake (elevation 1000') at Lake Mead.	• Minimum objective release of 8.23 MAF unless storage equalization releases are required. • Absolute protection of elevation 3490' at Lake Powell.	• Conservation of different volumes of water tied to varying Lake Mead water levels prior to shortage.	• No modification or extension of the Interim Surplus Guidelines which end in 2016. • Beginning in 2017, surplus declarations revert to the 70R strategy.
Alt. 4	No Protections Alternative	• No protection of critical elevations. • Release full annual entitlement amounts until drawn down to top of dead pool: then outflow = inflow.	• Minimum objective release of 8.23 MAF unless storage equalization releases are required. • 8.23 MAF until drawn down to top of dead pool: then outflow = inflow	• No water management/accounting mechanism for storage and delivery of water conserved through extraordinary water conservation and/or water augmentation programs.	• No modification or extension of the Interim Surplus Guidelines which end in 2016. • Beginning in 2017, surplus declarations revert to the 70R strategy.
Alt. 5	Power Protection Alternative	• Absolute protection of minimum power pool elevation (1050') at Lake Mead.	• Minimum objective release of 8.23 MAF unless storage equalization releases are required. • Absolute protection of minimum power pool elevation (3490') at Lake Powell.	• No water management/accounting mechanism for storage and delivery of water conserved through extraordinary water conservation and/or water augmentation programs.	• No modification or extension of the Interim Surplus Guidelines which end in 2016. • Beginning in 2017, surplus declarations revert to the 70R strategy.

Common assumptions to ALL Alternatives:
1. First year of modeling under above-identified alternatives is 2008 and extends to 2060 (53 years) (Note: water elevation for January 1, 2008 will be projected using the May 2006 24-Month Study).
2. Future hydrologic sequences will be based on the 99-year natural flow record (1906-2004).
3. All alternatives revert to No Action modeling assumptions beginning in 2026.
4. Analysis of all alternatives will assume implementation of shortages to Mexico pursuant to Article 10 of 1944 Water Treaty with Mexico when Lower Basin shortage is declared.

- 1 -

5/2/2006, Pre-decisional

I.8 May 12, 2006 Letter to Tribes

copy

United States Department of the Interior

BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

LC-2600
ENV-3.00

MAY 12 2006

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Honorable Charles Vaughn
Chairman, Hualapai Tribe
P.O. Box 179
Peach Springs, AZ 86434

Subject: Response to Request for Consultation Meeting Regarding Shortage Guidelines EIS

Dear Chairman:

On April 6, 2006, Ms. Nancy Coulam, of the Bureau of Reclamation's Upper Colorado Region, spoke with you on the phone regarding government-to-government consultation between Reclamation and the Hualapai Tribe. This discussion was concerning Reclamation's proposal to develop Lower Basin shortage guidelines and coordinated reservoir operations strategies for Lake Powell and Lake Mead, under low reservoir conditions. An Environmental Impact Statement (EIS) is currently being prepared by Reclamation to analyze this proposal.

During that conversation, you expressed that the Hualapai Tribe had concerns about Lakes Powell and Mead, preserving a specific in-stream flow in the Colorado River, and protection of cultural resources if changes in the river level result in exposure or inundation of sites. You also stated an interest in having a face-to-face meeting to discuss the proposed action, as well as the concerns of the tribe. You should have already received a letter inviting you to a tribal consultation meeting scheduled for the end of this month regarding the alternatives being considered for analysis in the EIS. The meeting is planned to be in Phoenix, Arizona and will be hosted by Reclamation for all consulting tribes. In addition to that invitation, we would welcome the opportunity to meet with you personally, along with any staff or tribal members you wish to include, at our mutual convenience.

Please contact Mr. John Jamrog, Environmental Compliance Group Manager for the Lower Colorado Region at (702) 293-8675 or me to arrange a meeting with appropriate Reclamation management.

Sincerely,

William J. Liebhauser, Director
Resources Management Office

cc: See next page.

cc: Continued from previous page.

Mr. Allen J. Auspach
Acting Regional Director
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Phoenix, AZ 85001

Ms. Amy Heustein
Environmental Protection Officer
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

Ms. Cathy Wilson
Supervisory Water Rights Specialist
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

Mr. Sam Spiller
U.S. Fish and Wildlife Service
2321 West Royal Palm Road
Phoenix, AZ 85021

Ms. Loretta Jackson
Tribal Historic Preservation Officer
Hualapai Tribe
215 Diamond Creek Road
Box 310
Peach Springs, AZ 86434

bc: Office of the Field Solicitor
U.S. Department of the Interior
Sandra Day O'Connor U.S. Courthouse
Attention: Ms. Katherine Verburg
401 W. Washington St., Suite 404, SPC 44
Phoenix, AZ 85003-2151

Office of the Field Solicitor
U.S. Department of the Interior
Sandra Day O'Connor U.S. Courthouse
Attention: Mr. Bob Snow
401 W. Washington St., Suite 404, SPC 44
Phoenix, AZ 85003-2151

BCOO-1000, BCOO-1003 (w/cpy signed letter)
LC-1000, LC-1100, LC-2000, LC-2010, LC-2600, LC-2630, LC-2700
UC-100, UC-105, UC-402, UC-406, UC-438, UC-700, UC-720
NAAO-1100
PXAO-1100

2008
Daily
WBR:JJamrog:llm:05/11/06:293-8675
(Usr\COMM2000\COM2600\John Jamrog:&Shortage Hualapaiconsultinviteletter.doc)

I.9 September 28, 2006 Letter to Hualapai Tribe

United States Department of the Interior

BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
LC-2600
ENV-3.00

SEP 28 2006

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Honorable Charles Vaughn
Chairman, Hualapai Tribal Council
P.O. Box 179
Peach Springs, AZ 86434

Subject: Request for Meeting Regarding for the Lower Colorado Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead

Dear Chairman:

Thank you for your letter dated August 28, 2006, regarding the Environmental Impact Statement (EIS) for the Lower Colorado Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead.

Since receipt of your letter, we have also been contacted by Mr. H. Scott Althouse, of Williams and Works P.A., who is representing the Hualapai Tribe. We have been working with him to establish a mutually acceptable date for a government-to-government consultation meeting. We will continue to work with you and Mr. Althouse to accomplish this goal. Given the current schedule for the EIS, we suggest scheduling our meeting as soon as possible.

We appreciate your assistance and willingness to consult with us regarding this important undertaking. Although we will continue to work with Mr. Althouse by phone, please feel free to contact Mr. John Jamrog, Environmental Compliance Group Manager for the Lower Colorado Region in Boulder City, NV, at (702) 293-8675, directly, at any time.

Sincerely,

William J. Liebhauser, Director
Resources Management Office

cc: See next page.

2

cc: Continued from previous page.

cc: Mr. Allen J. Auspach
Acting Regional Director
Bureau of Indian Affairs
P.O. Box 10
Phoenix, AZ 85001

Ms. Cathy Wilson
Supervisory Water Rights Specialist
Bureau of Indian Affairs
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Ms. Loretta Jackson
Tribal Historic Preservation Officer
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H. Scott Althouse, Esq.
Williams & Works, P.A.
1801 Hildebrand Lane NE, Suite 200
Bainbridge Island, WA 98110

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bc: Ms. Katherine Verburg
Boulder City Solicitor
Department of the Interior
Native American Affairs Office
400 North 5th Street, Suite 1470
Phoenix, AZ 85004-3909

Department of the Interior
Office of the Solicitor
Attention: Mr. Bob Snow
1849 C Street, NW, MS-6412
Washington , DC 20240

BCOO-1000, BCOO-1003, LC-1000, LC-1100, LC-2000, LC-2600, LC-2630, LC-2700, NAAO-1100, PXAO-1100, UC-100, UC-105, UC-402,UC-406, UC-438, UC-700, UC-720

RMO
Daily
WBR:JJamrog:llm:09/27/06:293-8675
(Usr\COMM2000\COM2600\John Jamrog:&Sept09 letter to Vaughn ver2.doc)

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I.10 January 22, 2007 Letter to Tribal Representatives

United States Department of the Interior
BUREAU OF RECLAMATION
Boulder Canyon Operations Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
BCOO-4452
ENV-3.00

JAN 22 2007

Interested Parties (See Enclosed List)

Subject: Government-to-Government Consultation on the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Dear Tribal Representatives:

As part of continuing government-to-government consultations on the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, the Upper and Lower Colorado Regions of the Bureau of Reclamation request to meet with tribal representatives to discuss key aspects of the Draft Environmental Impact Statement (Draft EIS).

We invite you to meet from 12:00 p.m. to 3:00 p.m. Pacific Standard Time on February 22, 2007, in Mezzanine Room #3, McCarran International Airport, Las Vegas, Nevada. During the meeting, we will provide tribal representatives with an update of progress on the project and present information on key aspects of the Draft EIS that will be published on February 28, 2007. A court reporter will be present to record the discussions during the meeting. An agenda and power point presentation will be provided for you at the meeting.

If you are unable to attend, the following conference line is provided for your convenience: 1-866-830-3963 (code: 5142989).

Please contact Amber Cunningham at 702-293-8472 if you have any questions.

Sincerely,

Terrance J. Fulp, Ph.D.
Area Manager
Boulder Canyon Operations Office

Enclosure

2

cc: Mr. Allen J. Auspach
Acting Regional Director
Bureau of Indian Affairs
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Phoenix, AZ 85001

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Supervisory Water Rights Specialist
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Ms. Amy Heuslein
Environmental Protection Officer
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U.S. Fish and Wildlife Service
2321 West Royal Palm Road
Phoenix, AZ 85021

bc: Boulder City Field Unit of Field Solicitor
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Native American Affairs Office
Attention: Ms. Katherine Verburg
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U.S. Department of the Interior
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Tonto Apache Reservation No. 30
Payson, AZ 85541

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Mrs. Jackie Gutierrez
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Governor, Pueblo of Zuni
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Cultural Resource Representative
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Honorable Lawrence Troncosa
Governor, Pueblo of San Felipe
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San Felipe Pueblo, NM 87001

Honorable Ernest Jones, Sr.
President, Yavapai-Prescott Indian Tribe
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Ms. Nancy Hayden
Director of Research
Yavapai-Prescott Indian Tribe
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Prescott, AZ 86301-2038

Mr. Greg Glassco
Cultural Resource Representative
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Honorable Dallas Massey, Sr.
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Mr. Gary L. Parker
Gila River Indian Irrigation & Drainage
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Ms. Gloria Thomas
Tohono O'odham Nation
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Robyn Interpreter
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Honorable Charles Wood
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Dr. Carole Klopatek
Fort McDowell Yavapai Nation
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Mr. H. Scott Althouse
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1801 Hildebrand Lane NE, Suite 200
Bainbridge Island, WA 98110

Ms. Cyndy Cole
Arizona Daily Sun
1751 South Thompson
Flagstaff, AZ 86001

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I.11 March 16, 2007 Letter to CAP Tribes

United States Department of the Interior
BUREAU OF RECLAMATION
Boulder Canyon Operations Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
BCOO-1003
ENV-3.00

MAR 1 6 2007

Interested Parties (See Enclosed List)

Subject: Government-to-Government Consultation on the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Dear Tribal Representative:

As part of our continuing government-to-government consultations on the Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead, the Upper and Lower Colorado Regions of the Bureau of Reclamation request to meet with tribal representatives to discuss key aspects of the Draft Environmental Impact Statement (Draft EIS).

We invite you to meet from 10:00 a.m. to 1:00 p.m. on April 4, 2007, in the 12th Floor Conference Room at Two Arizona Center, 400 North 5th Street, Phoenix, Arizona. During the meeting we will provide tribal representatives with an update of progress on the project and information on key aspects of the Draft EIS that is currently available for public comment. A court reporter will be present to record the discussions during the meeting. An agenda, handouts, and presentation will be provided for you at the meeting.

A fact sheet about the project is enclosed for your consideration. It provides information on (1) obtaining copies of the Draft EIS, (2) submitting comments on the Draft EIS during the public comment period (March 1, through April 30, 2007), and (3) the announcement of three April 2007 public hearing dates on the Draft EIS.

Please contact Ms. Amber Cunningham at 702-293-8472 if you have any questions.

Sincerely,

Terrance J. Fulp, Ph.D.
Area Manager
Boulder Canyon Operations Office

Enclosure

Identical Letter Sent To:

Continued on next page.

2

Identical Letter Sent To:

Honorable Delia Carlyle
Chairwoman
Ak Chin Indian Community
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Ms Nancy Nelson
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Honorable William R Rhodes
Governor
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Mr Barnaby Lewis
Cultural Resources Program
Gila River Indian Community
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Honorable Herminia Frias
Chairwoman
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Mrs Marian Reyes
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Dezbah Hatathli
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Mr Greg Glassco
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Mr Sam Spiller
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Attention Ms Katherine Verburg
Us Department Of The Interior
Native American Affairs Office
400 N Fifth Street Ste 1470
Phoenix AZ 85004

Attention Mr Bob Snow
Office Of The Field Solicitor
Us Department Of The Interior
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Washington Dc 20240

Dr Carole Klopatek
Fort Mcdowell Yavapai Nation
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RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

FACT SHEET #4 FEBRUARY 2007

Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Draft EIS Available for Review and Comment

The Bureau of Reclamation (Reclamation) acting on behalf of the Secretary of Interior is announcing availability of the Draft environmental impact statement (Draft EIS) on the proposed adoption of specific Colorado River interim guidelines for Lower Basin shortages and operations for Lake Powell and Lake Mead, particularly under drought and low reservoir conditions. The Draft EIS presents four possible action alternatives for implementation, plus a "No Action Alternative." The action alternatives reflect input received from Reclamation staff, the cooperating agencies, stakeholders, and other interested parties.

The Draft EIS is available for viewing and copying at Reclamation's project website at: http://www.usbr.gov/lc/region/programs/strategies.html. Printed versions are available at various public facilities (see list on reverse). Parties interested in receiving a compact disc or hard copy can send a written request to the address below. Please use the same address to submit any comments on the Draft EIS. Comments must be submitted no later than April 30, 2007.

Direct Draft EIS comments or inquiries to:

Regional Director, Lower Colorado Region, Bureau of Reclamation, Attention: BCOO-1000, P.O. Box 61470, Boulder City, Nevada 89006-1470; faxogram at (702) 293-8156; or e-mail at strategies@lc.usbr.gov.

Public Hearing Dates and Locations

Reclamation has scheduled three hearings to receive public comments on the Draft EIS. Comments will be considered in the selection of the preferred alternative and will be addressed in the Final EIS.

Meetings are from 6:00 p.m. to 9:00 p.m.

Tuesday, April 3, 2007
Henderson Convention Center
Sierra Room
200 South Water Street
Henderson, Nevada

Wednesday, April 4, 2007
Phoenix Airport Marriott
Buckhorn Room
1101 North 44th Street
Phoenix, Arizona

Thursday, April 5, 2007
Hilton Salt Lake City Center
Canyon Room A & B
255 South West Temple
Salt Lake City, Utah

To request special assistance, please contact Nan Yoder at (702) 293-8495 or e-mail at strategies@lc.usbr.gov.

The public review period for the Draft EIS commenced on February 28, 2007 and will extend until April 30, 2007.

Project Need and Purpose

During the period from 2000-2006, the Colorado River has experienced the worst drought in approximately one hundred years of record keeping. During this period, storage in Colorado River reservoirs has dropped from nearly full to less than 60 percent of capacity at the end of 2006. Currently, the Department of the Interior (Department) does not have specific operational guidelines in place to address the operation of Lake Mead and Lake Powell during drought and low reservoir conditions. Accordingly, the Department proposes the adoption of specific interim guidelines for Lower Basin shortages and coordinated operations of Lake Powell and Lake Mead.

The purpose of the proposed federal action is to: 1) improve Reclamation's management of the Colorado River by considering the tradeoffs between the frequency and magnitude of reductions of water deliveries, and considering the effects on water storage in Lake Powell and Lake Mead, water supply, power production, recreation, and other environmental resources; 2) provide mainstream U.S. users of Colorado River water, particularly those in the Lower Division states, a greater degree of predictability with respect to the amount of annual water deliveries in future years, particularly under drought and low reservoir conditions; and, 3) provide additional mechanisms for the storage and delivery of water supplies in Lake Mead.

For Further Project Information

Please contact Terrance J. Fulp, Ph.D., at (702) 293-8500 or e-mail at strategies@lc.usbr.gov; and/or Randall Peterson at (801) 524-3633. You can also visit the project web site at: www.usbr.gov/lc/region/programs/strategies.html.

Hard copies of the Draft EIS are available at the following locations:

Department of the Interior
Natural Resources Library
1849 C St NW, Washington, D.C.

Yuma County Library
185 South Main St, Yuma, AZ

Palo Verde Valley Library
125 West Chanslor Wy, Blythe, CA

Mohave County Library
1170 Hancock Rd, Bullhead City, AZ

Laughlin Library
2840 So Needles Highway, Laughlin, NV

Las Vegas Clark County Library
833 Las Vegas Blvd N, Las Vegas, NV

James I. Gibson Library
280 Water St, Henderson, NV

Bureau of Reclamation offices:

Lower Colorado Regional Office
400 Railroad Ave, Boulder City, NV

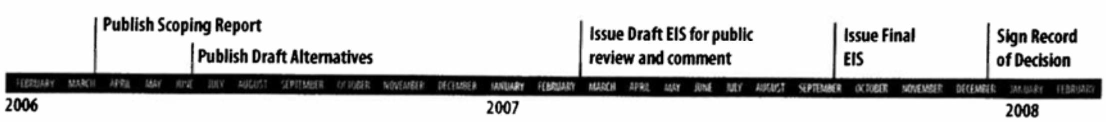
Upper Colorado Regional Office
125 South State St, Rm 7220
Salt Lake City, UT

Phoenix Area Office
6150 West Thunderbird Rd, Glendale, AZ

Yuma Area Office
7301 Calle Agua Salada, Yuma, AZ

Denver Federal Center Library
6th Avenue and Kipling, Building 67,
Rm 167, Denver, CO

Project Schedule



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I.12 August 21, 2007 Letter to CAP Tribes

United States Department of the Interior

BUREAU OF RECLAMATION
Boulder Canyon Operations Office
P.O. Box 61470
Boulder City, NV 89006-1470

AUG 21 2007

IN REPLY REFER TO:
BCOO-4452
ENV-3.00

Interested Parties (See Enclosed List)

Subject: Government-to-Government Consultation on the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead Environmental Impact Statement (EIS)

Dear Tribal Representative:

As part of our continuing government-to-government consultations, the Bureau of Reclamation's Upper and Lower Colorado Regions request to meet with tribal representatives on Friday, September 14, 2007, from 10:00 a.m. to 12:00 p.m., in the 1st Floor Roosevelt Conference Room at the Bureau of Reclamation, 6150 West Thunderbird Road, Glendale, Arizona 85306-4001.

During the meeting Reclamation will provide tribal representatives with an update on the progress of the project, including the identification of the preferred alternative and changes made in the Shortage Allocation Model for the final EIS. A court reporter will be present to record the discussions during the meeting. An agenda, handouts, and presentation will be provided for you at the meeting.

Additional project information is available on Reclamation's website at: http://www.usbr.gov/lc/region/programs/strategies.html.

Please contact Ms. Amber Cunningham at 702-293-8500 if you have questions.

Sincerely,

Steven C. Hvinden

ACTING FOR

Terrance J. Fulp, Ph.D.
Area Manager
Boulder Canyon Operations Office

2

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Maricopa AZ 85239 3940

Ms Nancy Nelson
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Honorable William R Rhodes
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Mr. Barnaby Lewis
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Ms. Amy Heuslein
Environmental Protection Officer
Bureau of Indian Affairs
400 N 5th St, 12th Floor
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Ms. Cathy Wilson
Supervisory Water Rights Specialist
Bureau of Indian Affairs
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Mr. Sam Spiller
US Fish and Wildlife Service
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Ms. Katherine Verburg
Department of the Interior
Native American Affairs Office
400 N Fifth Street Ste 1470
Phoenix AZ 85004

Mr. Bob Snow
Office of The Field Solicitor
Department of The Interior
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Po Box 17779
Fountain Hills AZ 85269 7779

BCOO-1000, BCOO-1003, LC-1000, LC-1100, LC-2000, LC-2600, LC-2624, LC-2630, LC-2700, NAAO-1100, PXAO-1100, PXAO-1500, UC-100, UC-413, UC-438, UC-700, UC-720

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Appendix J

Seven Basin States' Proposals Regarding Colorado River Interim Operations

The seven Colorado River Basin States developed and submitted a Preliminary Proposal Regarding Colorado River Interim Operations to the Secretary of the Department of the Interior (Secretary) in a letter dated February 3, 2006. As a comment on the Draft EIS, the seven Colorado River Basin States revised their preliminary proposal and submitted it to the Secretary in a letter dated April 30, 2007. The full text of the seven Colorado River Basin States' revised and preliminary proposals regarding the Final EIS are provided in this appendix.

J.1 Revised Basin States' Proposal – Letter to Secretary of the Interior

The States of Arizona, California, Colorado, Nevada,
New Mexico, Utah and Wyoming
Governors' Representatives on Colorado River Operations

April 30, 2007

Honorable Dirk Kempthorne, Secretary
Department of the Interior
1849 C. Street, NW
Washington, D.C. 20240

Re: Basin States' Comments on *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

Dear Secretary Kempthorne:

Thank you for the opportunity to comment on the *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* (72 Fed. Reg. 9,026) (Feb. 28, 2007) (hereinafter "DEIS"). The Basin States emphasize that the Basin States' Alternative best meets critical elements of the purpose and need statement articulated in the DEIS. It does so by giving water managers the certainty to engage in meaningful long-range planning while also promulgating programs to increase operational and resource management flexibility on the River. This is particularly important given the impacts of the drought on the Colorado River system over the last seven years and the uncertain hydrology going forward. Thus, the Basin States strongly encourage you to select the Basin States' Alternative analyzed in the DEIS, together with the modifications outlined in this letter and the included attachments ("Basin States' Proposal"), as the preferred alternative in the Final Environmental Impact Statement ("FEIS") and the selected action in the Record of Decision ("ROD").

<u>Basin States' Proposal</u>

The Basin States have made tremendous progress over the last two years in setting aside contentious issues and reaching agreements regarding operation of the Colorado River system reservoirs. Since the Basin States originally forwarded a Preliminary Proposal and draft Seven States' Agreement to your predecessor on February 3, 2006 ("Preliminary Proposal"), the Basin States have finalized a number of agreements and proposals. These documents, which are described in detail below, incorporate and give further definition to each of the elements of the Preliminary Proposal and the Basin States' Alternative in the DEIS. The Basin States believe that if all material terms of the Basin States' Proposal are included in the ROD, it will establish the first comprehensive set of detailed operating guidelines in the history of the Colorado River.

The Basin States' Proposal consists of the following documents:

1. Agreement Concerning Colorado River Management and Operations (Attachment "A"). This agreement among major Colorado River water interests in all seven states that share the River system is the foundation document in the Basin States' Proposal. This agreement memorializes the consensus recommendation to the Secretary for Colorado River management and operations during an interim period, sets forth agreements regarding pursuit of system augmentation and efficiency projects, and establishes a rigorous process for the resolution of claims and controversies between the parties in an effort to set aside long standing disputes on the River.

2. Proposed Interim Guidelines for Colorado River Operations (Attachment "B"). Building upon the Preliminary Proposal, the Basin States have drafted a comprehensive set of guidelines to govern Colorado River operations during the interim period. If adopted, these proposed guidelines would: (1) replace the Interim Surplus Guidelines; (2) establish guidelines for coordinated operations for Lakes Powell and Mead; (3) establish shortage guidelines for use within the United States; and (4) establish parameters for the creation and release of Intentionally Created Surplus ("ICS") and Developed Shortage Supplies ("DSS").

3. Forbearance Agreement (Attachment "C"). This draft agreement among the Lower Division States and major water users within those states recognizes that, in the absence of forbearance by the parties, surplus water is apportioned for use according to the percentages provided in Article II(B)(2) of the Consolidated Decree in *Arizona v. California*. The execution of this agreement will facilitate implementation of the ICS program.

4. Shortage Sharing Agreement between Arizona and Nevada (Attachment "D"). As anticipated by the Basin States' February 3, 2006 Preliminary Proposal, Arizona and Nevada have executed a Shortage Sharing Agreement premised upon the Secretary's reductions in deliveries within the United States of 333,000, 417,000 and 500,000 acre-feet per year based upon specific Lake Mead elevations.

5. Delivery Agreement. It will be necessary for the Secretary to enter into one or more agreements that enable and obligate the United States to deliver ICS and DSS to entities that create ICS or DSS in conformance with relevant provisions of the Guidelines and the Forbearance Agreement. At this time, the Basin States are developing a draft delivery agreement for the Department of the Interior's ("Interior") consideration and look forward to working with Interior on drafting one or more agreements that can be executed concurrently with the issuance of the ROD. The Basin States request that the U.S. Bureau of Reclamation ("Reclamation") include appropriate analysis of the

anticipated execution of one or more agreements to deliver ICS or DSS within the preferred alternative in the FEIS and the selected action in the ROD.

Implementation of any alternative that does not include all material terms of the Basin States' Proposal will carry with it a significant degree of uncertainty given that the Basin States' Agreement, Forbearance Agreement and Arizona-Nevada Shortage Sharing Agreement are each contingent upon the issuance of a ROD that is consistent with the material terms of those agreements. These agreements make it possible for components of the proposed action, such as coordinated management of Lakes Mead and Powell and the creation and release of ICS, to be implemented without adversarial actions involving the Basin States and major water users on the Colorado River.

Reduced Deliveries to Mexico

Recent negotiations among the Basin States and major water users in those states have involved multiple issues of critical importance to the Basin States. However, in the course of these negotiations no issue has surpassed the importance of how the United States exercises its authority to reduce the quantity of water allotted to Mexico under Article 10(a) of the Mexican Water Treaty of 1944.

In the Preliminary Proposal the Basin States recommended that the Secretary reduce deliveries from Lake Mead by 400,000, 500,000 and 600,000 acre-feet per year within the United States and Mexico at certain Lake Mead elevations. In accordance with the Preliminary Proposal, Arizona and Nevada have executed a Shortage Sharing Agreement premised upon the imposition by the Secretary of shortages within the United States of 333,000, 417,000 and 500,000 acre-feet per year at the same Lake Mead elevations contained in the Preliminary Proposal. For the first 600,000 acre-feet per year of any reductions in deliveries in any year due to a declared shortage, the Basin States have agreed that Arizona and Nevada will not take more than 500,000 acre-feet per year in aggregate and California will not take any reductions. The DEIS substantially incorporates the assumptions contained in the Preliminary Proposal, the Basin States' Agreement and the Shortage Sharing Agreement into its consideration and analysis of the Basin States' Alternative.

Due to the critical nature of this issue, the Basin States believe that the Secretary should include these assumptions as part of the preferred alternative in the FEIS and the selected action in the ROD. The Basin States strongly urge the United States to exercise its authority to reduce the quantity of water allotted to Mexico in years in which the Secretary imposes shortages in deliveries of water from Lake Mead in the United States in a quantity consistent with the assumptions in the DEIS, and in other appropriate circumstances.

Mexican Participation in ICS Program

The Basin States support the concept of Mexico participating in the ICS program at some time in the future, provided that its participation is addressed in the context of other river operation matters and is part of a comprehensive arrangement between the two nations that incorporates, at a minimum, the material terms of the Basin States' Proposal. The Basin States stand ready to discuss this comprehensive arrangement.

Colorado River Augmentation Projects

Implementation of projects to augment the long-term supply of the Colorado River is of utmost importance not only to the Basin States and the millions of people who live here, but to the nation as a whole. While no specific augmentation projects are included in the current Basin States' Proposal, the need to develop a process to implement augmentation projects must remain at the forefront of the Basin States' and Interior's agendas. Changes to existing or new federal regulations may be necessary to effectuate augmentation projects.

The Preliminary Proposal outlined a concept for water users in Arizona, California, or Nevada to secure additional water supplies by funding the development of a non-Colorado River System water supply in one Lower Division State for use in another Lower Division State by exchange. Through the cooperation of the International Boundary and Water Commission, United States and Mexico, similar arrangements could be established by which non-Colorado River System water supplies in Mexico could be developed for use in the United States by exchange.

The Basin States view the inclusion in the DEIS of a quantitative analysis of the impacts to the Colorado River resulting from the implementation of future augmentation projects as a positive step and encourage you to include the same analysis in the FEIS in order to begin to establish the environmental compliance framework for future augmentation projects.

Conclusion

In closing, the Basin States thank you for your leadership and urge Interior to adopt a ROD that includes all of the material terms of the Basin States' Proposal.

Herbert R. Guenther
Director
Arizona Department of Water Resources

Patricia Mulroy
General Manager
Southern Nevada Water Authority

Dana B. Fisher, Jr.
Chairman
Colorado River Board of California

John R. D'Antonio, Jr.
Secretary
New Mexico Interstate Stream Commission

Scott Balcomb
Governor's Representative
State of Colorado

Dennis J. Strong
Director
Utah Division of Water Resources
Utah Interstate Stream Commissioner

Rod Kuharich
Director
Colorado Water Conservation Board

Patrick T. Tyrrell
State Engineer
State of Wyoming

Richard W. Bunker
Chairman
Colorado River Commission of Nevada

Attachments

c: Robert W. Johnson, Commissioner, U. S. Bureau of Reclamation
Rick Gold, Regional Director, U. S. Bureau of Reclamation, Upper Colorado Regional Office
Jayne Harkins, Acting Regional Director, U. S. Bureau of Reclamation, Lower Colorado Regional Office
Larry Walkoviak, Deputy Regional Director, U. S. Bureau of Reclamation, Lower Colorado Regional Office

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Attachment A

Agreement Concerning Colorado River Management and Operations

This attachment to Appendix J contains the text of Attachment A to the Revised Basin States' Proposal.

ATTACHMENT A

AGREEMENT CONCERNING COLORADO RIVER MANAGEMENT AND OPERATIONS

This Agreement is entered into effective as of April 23, 2007, by and among the Arizona Department of Water Resources; Colorado River Board of California; Colorado Water Conservation Board; Governor's Representative for the State of Colorado; Colorado River Commission of the State of Nevada; Southern Nevada Water Authority; New Mexico Interstate Stream Commission; Utah Division of Water Resources; Utah Interstate Stream Commissioner; and Wyoming State Engineer.

RECITALS

A. Parties.

1. Arizona.

   a. The Arizona Department of Water Resources, through its Director, is the successor to the signatory agency of the State for the 1922 Colorado River Compact, and the 1944 Contract for Delivery of Water with the United States, both authorized and ratified by the Arizona Legislature, A.R.S. §§ 45-1301 and 1311. Pursuant to A.R.S. §§ 45-107, the Director is authorized and directed, subject to the limitations in A.R.S. §§ 45-106, for and on behalf of the State of Arizona, to consult, advise and cooperate with the Secretary of the Interior of the United States with respect to the exercise by the Secretary of Congressionally authorized authority relative to the waters of the Colorado River (including but not limited to the Boulder Canyon Project Act, 43 U.S.C. § 617, and the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1501) and with respect to the development, negotiation and execution of interstate agreements. Additionally, under A.R.S. § 45-105(A)(9), the Director is authorized to "prosecute and defend all rights, claims and privileges of this state respecting interstate streams."

   b. Under A.R.S. § 11-951 et. seq., the Director is authorized to enter into Intergovernmental Agreements with other public agencies, which includes another state; departments, agencies, boards and commissions of another state; and political subdivisions of another state.

2. California. The Chairman of the Colorado River Board of California, acting as the Colorado River Commissioner pursuant to California Water Code section 12525, has the authority to exercise on behalf of California every right and power granted to California by the Boulder Canyon Project Act, and to do and perform all other things necessary or expedient to carry out the purposes of the Colorado River Board.

1

3. Colorado.

   a. Section 24-1-109, Colorado Revised Statutes (2005) provides that "Interstate compacts authorized by law shall be administered under the direction of the office of the governor." This includes the Colorado River Compact and the Upper Colorado River Basin Compact. Section 37-60-109 provides that "the governor from time to time, with approval of the board, shall appoint a commissioner, who shall represent the state of Colorado upon joint commissions to be composed of commissioners representing the state of Colorado and another state or other states for the purpose of negotiating and entering into compacts or agreements between said states…" By letter dated April 12, 2006, the Governor appointed Upper Colorado River Commissioner Scott Balcomb to represent the State of Colorado.

   b. Section 37-60-106, subsections (e) and (i), C.R.S. (2005), authorize the Colorado Water Conservation Board to "cooperate with the United States and the agencies thereof, and with other states for the purpose of bringing about the greater utilization of the water of the state of Colorado and the prevention of flood damages," and "to confer with and appear before the officers, representatives, boards, bureaus, committees, commissions, or other agencies of other states, or of the federal government, for the purpose of protecting and asserting the authority, interests, and rights of the state of Colorado and its citizens with respect to the waters of the interstate streams in this state." Therefore, by statute the Director of the Colorado Water Conservation Board is authorized to negotiate with and enter into agreements with other state entities within the Colorado River Basin.

4. Nevada.

   a. The Colorado River Commission of Nevada (CRCN) is an agency of the State of Nevada, authorized generally by N.R.S. §§ 538.041 and 538.251. CRCN is authorized by N.R.S. § 538.161 (6), (7) to enter into this Agreement. The CRCN, in furtherance of the State of Nevada's responsibility to promote the health and welfare of its people in Colorado River matters, makes this Agreement to supplement the supply of water in the Colorado River which is available for use in Nevada, augment the waters of the Colorado River, and facilitate the more flexible operation of dams and facilities by the Secretary of the Interior of the United States. The Chairman of the Commission, signatory hereto, serves as one of the Governor's representatives as contemplated by Section 602(b) of the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1552(b) and the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act.

b. The Southern Nevada Water Authority (SNWA) is a Nevada joint powers agency and political subdivision of the State of Nevada, created by agreement dated July 25, 1991, as amended November 17, 1994 and January 1, 1996, pursuant to N.R.S. §§ 277.074 and 277.120. SNWA is authorized by N.R.S. § 538.186 to enter into this Agreement and, pursuant to its contract issued under section 5 of the Boulder Canyon Project Act of 1928, SNWA has the right to divert "supplemental water" as defined by NRS § 538.041 (6). The General Manager of the SNWA, signatory hereto, serves as one of the Governor's Representatives as contemplated by Section 602(b) of the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1552(b) and the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act.

5. New Mexico. Pursuant to NMSA 1978, 72-14-3, the New Mexico Interstate Stream Commission is authorized to investigate water supply, to develop, to conserve, to protect and to do any and all other things necessary to protect, conserve and develop the waters and stream systems of the State of New Mexico, interstate or otherwise. The Interstate Stream Commission also is authorized to institute or cause to be instituted in the name of the State of New Mexico any and all negotiations and/or legal proceedings as in its judgment are necessary. By Resolution dated January 24, 2007, the Interstate Stream Commission authorizes the execution of this Agreement.

6. Utah. The Division of Water Resources (DWR) is the water resource authority for the State of Utah. Utah Code Ann. § 73-10-18. The Utah Department of Natural Resources Executive Director (Department), with the concurrence of the Utah Board of Water Resources (Board), appoints the DWR Director (Director). § 63-34-6(1). The Board makes DWR policy. § 73-10-1.5. The Board develops, conserves, protects, and controls Utah waters, § 73-10-4(4), (5), and, in cooperation with the Department and Governor, supervises administration of interstate compacts, § 73-10-4, such as the Colorado River Compact, §§ 73-12a-1 through 3, and the Upper Colorado River Basin Compact, § 73-13-10. The Board, with Department and Gubernatorial approval, appoints a Utah Interstate Stream Commissioner, § 73-10-3, currently the DWR Director, to represent Utah in interstate conferences to administer interstate compacts. §§ 73-10-3 and 73-10-4. These delegations of authority authorize the Utah Interstate Stream Commissioner/DWR Director to sign this document. He acts pursuant to a Board resolution, acknowledged by the Department, dated March 7, 2007.

7. Wyoming. Water in Wyoming belongs to the state. Wyo. Const. Art. 8 § 1. The Wyoming State Engineer is a constitutionally created office and is Wyoming's chief water official with general supervisory authority over the waters of the state. Wyo. Const. Art. 8 § 5. The Wyoming legislature conferred upon Wyoming officers the authority to cooperate with and assist

like authorities and entities of other states in the performance of any lawful power, duty, or authority. Wyo. Stat. Ann. § 16-1-101 (2005). Wyoming and its State Engineer represent the rights and interests of all Wyoming appropriators with respect to other states. *Wyoming v. Colorado*, 286 U.S. 494 (1922). See *Hinderlider v. La Plata River & Cherry Creek Ditch Co.*, 304 U.S. 92 (1938). In signing this Agreement, the State Engineer intends that this Agreement be mutually and equally binding between the Parties.

B. Background.

1. Federal law and practice (including Section 16 of the Boulder Canyon Project Act, 43 U.S.C § 617o and Section 602(b) of the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1552(b), and the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act), contemplate that in the operation of Lakes Powell and Mead, the Secretary of the Interior consults with the States through Governors' Representatives, who represent the Governors and their respective state agencies. Through this law and practice, the Governors' Representatives and state agencies have in the past reached agreements among themselves and with the Secretary on various aspects of Colorado River reservoir operation. This Agreement is entered into in furtherance of this law and practice.

2. On January 16, 2001, the Secretary adopted Colorado River Interim Surplus Guidelines (ISG) based on an alternative prepared by the Colorado River Basin States, for the purposes of determining annually the conditions under which the Secretary would declare the availability of surplus water for use within the states of Arizona, California and Nevada in accordance with and under the authority of the Boulder Canyon Project Act of 1928 (45 Stat. 1057) and the Decree of the United States Supreme Court in *Arizona v. California*, 376 U.S. 340 (1964), as amended and supplemented. The ISG are effective through calendar year 2015 (through preparation of the 2016 Annual Operating Plan).

3. In the years following the adoption of the ISG, drought conditions in the Colorado River Basin caused a significant reduction in storage levels in Lakes Powell and Mead, and precipitated discussions by and among the Parties, and between the Parties and the United States through the Department of the Interior and the Bureau of Reclamation. The Parties recognize that the Upper Division States have not yet developed their full apportionment under the Colorado River Compact. Although the Secretary has not imposed any shortage in the Lower Basin, the Parties also recognize that with additional Upper Basin development and in drought conditions, the Lower Division States may be required to suffer shortages in deliveries of water from Lake Mead. Therefore, these discussions focused on ways to improve the management of water in Lakes Powell and Mead so as to enhance the

4

protection afforded to the Upper Basin by Lake Powell, and to delay the onset and minimize the extent and duration of shortages in the Lower Basin.

4. On May 2, 2005, the Secretary announced her intent to undertake a process to develop Lower Basin shortage guidelines and explore management options for the coordinated operation of Lakes Powell and Mead. On June 15, 2005, the Bureau of Reclamation published a notice in the Federal Register, announcing its intent to implement the Secretary's direction. The Bureau of Reclamation has proceeded to undertake scoping and develop alternatives pursuant to the National Environmental Policy Act (the NEPA Process), which the Parties anticipate will form the basis for a ROD to be issued by the Secretary by December 2007.

5. On August 25, 2005, the Parties wrote a letter to the Secretary expressing conceptual agreement in the development and implementation of three broad strategies for improved management and operation of the Colorado River: Coordinated Reservoir Management and Lower Basin Shortage Guidelines; System Efficiency and Management; and Augmentation of Supply.

6. On February 3, 2006, the Parties transmitted to the Secretary their recommendation for the scope of the NEPA Process (Preliminary Proposal), which refined many of the elements outlined in the August 25, 2005 letter.

7. In February 2007, the Secretary issued a Draft Environmental Impact Statement (DEIS) pursuant to the NEPA Process. The DEIS includes an alternative, called the Basin States' Alternative, that is based on the recommendations of the Parties.

8. At the request of the Secretary, the Parties have continued their discussions relative to the areas of agreement outlined in the letters of August 25, 2005 and February 3, 2006, and the DEIS, and have agreed on: a) additional actions for their mutual benefit designed to augment the supply of water available for use in the Colorado River System and improve the management of water in the Colorado River; b) recommendations to the Secretary for adoption as the preferred alternative in the Final Environmental Impact Statement and in the ROD; and c) consultation processes among themselves, and consultation recommendations to the Secretary for incorporation into the ROD.

C. Purpose. The Parties intend that the actions by them contemplated in this Agreement will: improve cooperation and communication among them; provide additional security and certainty in the water supply of the Colorado River System for the benefit of the people served by water from the Colorado River System; and avoid circumstances which could otherwise form the basis for claims or controversies over interpretation or implementation of the Colorado River Compact and other applicable provisions of the law of the river.

AGREEMENT

In consideration of the above recitals and the mutual covenants contained herein, and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the Parties agree as follows:

1. Recitals. The Recitals set forth above are material facts that are relevant to and form the basis for the agreements set forth herein.

2. Definitions. As used in this Agreement, the following terms have the following meanings:

A. Colorado River System. This term shall have the meaning as defined in the Colorado River Compact.

B. ISG. The Colorado River Interim Surplus Guidelines adopted by the Secretary on January 16, 2001, as modified by the ROD.

C. NEPA Process. The decision-making process pursuant to the National Environmental Policy Act, 42 U.S.C. §§ 4321 through 4347, beginning with the Bureau of Reclamation's Notice to Solicit Comments and Hold Public Meetings, 70 Fed. Reg. 34794 (June 15, 2005) and culminating in a Record of Decision.

D. Party or Parties. Any party or parties to this Agreement.

E. Parties' Recommendation. The Seven Basin States' comments on the DEIS transmitted to the Secretary of the Interior on or before April 30, 2007.

F. ROD. The Record of Decision anticipated to be issued by the Secretary after completion of the NEPA Process including but not limited to any interim guidelines promulgated pursuant thereto.

G. Secretary. The Secretary of the Interior or the Bureau of Reclamation, as applicable.

H. State or States. Any of the states of Arizona, California, Colorado, Nevada, New Mexico, Utah or Wyoming, as context requires.

3. Support for Parties' Recommendation.

A. After considering a number of alternatives, each Party has determined that the Parties' Recommendation is in the best interests of that Party, and promotes the health and welfare of that Party and of the Colorado River Basin States. The Parties support the Secretary's incorporation of the Parties'

Recommendation and this Agreement into the ROD, as appropriate to effectuate the material terms of the Parties' Recommendation. If during the course of the NEPA Process any new information becomes available which causes any Party, in its sole and absolute discretion, to reassess any provision of the Parties' Recommendation and this Agreement, that Party shall immediately notify all other Parties in writing. The Parties shall jointly consult and, if they agree to any modification of the Parties' Recommendation or this Agreement, shall consult with the Secretary to advise him/her of such modification and request the adoption thereof in the ROD.

B. If after such consultations it is apparent there is an irreconcilable conflict between the Parties as to such modification, then any Party may upon written notice to the other Parties withdraw from this Agreement, and in such event this Agreement shall no longer be effective or binding upon such withdrawing Party. All withdrawing Parties hereby reserve all rights upon withdrawal from this Agreement to take such actions, including support of or challenges to the ROD, as they in their sole and absolute discretion deem necessary or appropriate. In the event of the withdrawal of any one or more Parties from this Agreement, this Agreement shall continue in full force and effect as to the remaining Parties. The remaining Parties may consult to determine whether to continue this Agreement in effect, to amend this Agreement, or to terminate this Agreement. In the event of termination, all Parties shall be relieved from the terms hereof, except as provided in Paragraph 10, and this Agreement shall be of no further force or effect.

4. ROD Consistent with the Parties' Recommendation and this Agreement. In the event the Secretary adopts a ROD in substantial conformance with the Parties' Recommendation and this Agreement, the Parties shall take all necessary actions to implement the terms of the ROD, including the approval and execution of agreements necessary for such implementation.

5. ROD Inconsistent with the Parties' Recommendation and this Agreement. In the event the Secretary adopts a ROD that any Party, in its sole and absolute discretion, determines is not in substantial conformance with the Parties' Recommendation and this Agreement, such Party shall immediately notify all other Parties of such determination in writing. The Parties shall jointly consult, and consult with the Secretary as necessary, in order to determine whether the ROD is in substantial conformance with the Parties' Recommendation and this Agreement, or whether any action, including the amendment of this Agreement, may resolve such concern. If after such consultation it is apparent there is an irreconcilable conflict between the ROD and the concerns of such Party, then such Party may upon written notice to the other Parties withdraw from this Agreement, and in such event this Agreement shall no longer be effective or binding upon such withdrawing Party. All withdrawing Parties hereby reserve all rights upon withdrawal from this Agreement to take such actions, including support of or challenges to the ROD, as they in their sole and absolute discretion deem necessary or appropriate. In the event of the withdrawal of any one or more Parties from this Agreement, this Agreement shall

continue in full force and effect as to the remaining Parties. The remaining Parties may consult to determine whether to continue this Agreement in effect, to amend this Agreement, or to terminate this Agreement. In the event of termination, all Parties shall be relieved from the terms hereof, except as provided in Paragraph 10, and this Agreement shall be of no further force or effect.

6. Additions to the ROD. The Parties hereby request that the Secretary recognize the specific provisions of this Agreement as part of the NEPA Process and include in the ROD specific provisions that reference this Agreement as a basis for the ROD. The Parties also hereby request that the Secretary include in the ROD the following specific provisions:

A. The Secretary will first consult with all the States before making any substantive modification to these guidelines.

B. Upon a request by a State for modification of these guidelines, or upon a request by a State to resolve any claim or controversy arising under: i) the Agreement Concerning Colorado River Management and Operations; ii) these Guidelines; iii) the operations of Lakes Powell and Mead pursuant to these guidelines; or, iv) any other applicable provision of federal law, regulation, criteria, policy, rule or guideline, or the Mexican Water Treaty of 1944, the Secretary shall invite the Governors of all the Basin States, or their designated representatives, to consult with the Secretary in an attempt to resolve such claim or controversy by mutual agreement.

C. In the event projections included in any Bureau of Reclamation monthly 24 Month Study indicates Lake Mead elevations may approach an elevation that would trigger shortages in deliveries of water from Lake Mead in the United States, the Secretary shall consult with all the States on how the United States shall reduce the quantity of water allotted to Mexico.

7. Consultation on Operations. After the Secretary commences operating Lakes Powell and Mead pursuant to the ROD, the Parties shall consult among themselves as necessary, but at least annually, to assess such operations. Any Party may request consultation with the other Parties on a proposed adjustment or modification of such operations, based on changed circumstances, unanticipated conditions, or other factors. Upon such request, the Parties shall consult in good faith with each other to resolve any such issues, and based thereon may request consultation by the States with the Secretary on adjustments to or modifications of operations under the ROD. In any event, the Parties shall initiate consultations before December 31, 2020, to determine whether to extend this Agreement and recommend that the Secretary continue operations under the ROD for an additional period, or modify this Agreement and recommend that the Secretary modify operations under the ROD, or terminate this Agreement and recommend that the Secretary not continue operations under the ROD after the expiration thereof. Any extension of this Agreement and any recommendation by the Parties to the Secretary to extend or modify operations under the ROD shall be made by unanimous

consent of the Parties. If such extension and recommendation are not made, this Agreement shall terminate in accordance with Paragraph 16.

8. Development of Interim Water Supplies, System Augmentation, System Efficiency and Water Enhancement Projects. The Parties agree to diligently pursue interim water supplies, system augmentation, system efficiency and water enhancement projects within the Colorado River System. The term "system augmentation" includes the quantifiable addition of new sources of supply to the Colorado River Basin, including importation from outside the Basin or desalination of ocean water or brackish water. The term "system efficiency" includes efficiency projects in the Lower Basin that will result in the more efficient use of existing supplies, such as in-system storage and enhanced management. The term "water enhancement" includes projects that may increase available system water, including cloud seeding and non-native vegetation management. Due to the critical importance of implementing these projects in reducing the potential for shortages, the Parties shall continue to jointly pursue the study and implementation of such projects, and to regularly consult on the progress of such projects.

Specifically, the Parties agree to cooperatively pursue an interim water supply of at least a cumulative amount of 280,000 acre-feet for use in Nevada while long-term augmentation projects are being pursued. It is anticipated that this interim water supply will be made available in return for Nevada's funding of the Drop 2 Reservoir mandated for construction by the Bureau of Reclamation by P.L. 109-432 § 396. Annual recovery of this interim water supply by Nevada will not exceed 40,000 acre-feet.

In consideration of the Parties' diligent pursuit of long-term augmentation and the availability of the interim water supply, the Southern Nevada Water Authority (SNWA) agrees that it will withdraw right-of-way Application No. N-79203 filed with the Bureau of Land Management on October 1, 2004 for the purpose of developing Permit No. 58591 issued by the Nevada State Engineer in Ruling No. 4151.

The SNWA will not re-file such right-of-way application or otherwise seek to divert the water rights available under Permit No. 58591 from the Virgin River prior to 2014 so long as Nevada is allowed to utilize its pre-Boulder Canyon Project Act Virgin and Muddy River rights in accordance with the Parties' Recommendation, and the interim water supply made available to Nevada is reasonably certain to remain available. The SNWA will not re-file such right-of-way application or otherwise seek to divert the water rights available under Permit No. 58591 from the Virgin River after 2014 so long as diligent pursuit of system augmentation is proceeding to provide or has provided Nevada an annual supply of 75,000 acre-feet by the year 2020. Prior to re-filing any applications with the Bureau of Land Management, SNWA and Nevada will consult with the other Basin States.

This agreement is without prejudice to any Party's claims, rights or interests in the Virgin or Muddy River systems.

9. Consistency with Existing Law. The Parties' Recommendation has been developed with the intent to be consistent with existing law. The Parties expressly agree, for purposes of this Agreement, that the storage of water in and release of water from Lakes Powell and Mead pursuant to a ROD issued by the Secretary in substantial conformance with the Parties' Recommendation and this Agreement, and any agreements, rules and regulations adopted by the Secretary or the parties to implement such ROD, shall not constitute a violation of Article III(a)-(e) inclusive of the Colorado River Compact, or Sections 601 and 602(a) of the Colorado River Basin Project Act of 1968 (43 U.S.C. §§ 1551 and 1552(a)), and all applicable rules and regulations promulgated thereunder.

10. Resolution of Claims or Controversies Not Related to Reductions in Deliveries to Mexico under the Mexican Water Treaty of 1944. The Parties recognize that judicial or administrative proceedings are not preferred alternatives to the resolution of claims or controversies concerning the law of the river. In furtherance of this Agreement, the Parties desire to avoid judicial or administrative proceedings, and agree to pursue a consultative approach to the resolution of any claim or controversy. In the event that any Party becomes concerned that there may be a claim or controversy under this Agreement, the ROD, Article III(a)-(e) inclusive of the Colorado River Compact, or Sections 601 and 602(a) of the Colorado River Basin Project Act of 1968 (43 U.S.C. §§ 1551 and 1552(a)), and all applicable rules and regulations promulgated thereunder, such Party shall notify all other Parties in writing, and the Parties shall in good faith meet in order to resolve such claim or controversy by mutual agreement prior to initiating any judicial or administrative proceeding. No Party shall initiate any judicial or administrative proceeding against any other Party or against the Secretary under Article III (a)-(e) inclusive of the Colorado River Compact, or Sections 601 and 602(a) of the Colorado River Basin Project Act of 1968 (43 U.S.C. §§ 1551 and 1552(a)), or any other applicable provision of federal law, regulation, criteria, policy, rule or guideline, and no claim thereunder shall be ripe, until such consultation has been completed. All States shall comply with any request by the Secretary for consultation in order to resolve any claim or controversy. In addition, any State may invoke the provisions of Article VI of the Colorado River Compact. Notwithstanding anything in this Agreement to the contrary, the terms of this Paragraph shall survive for a period of five years following the termination or expiration of this Agreement, and shall apply to any withdrawing Party after withdrawal for such period.

11. Resolution of Claims and Controversies Related to Reductions in Deliveries to Mexico under the Mexican Water Treaty of 1944 and Limitations on Reductions to Lower Division States.

A. The United States has the authority to reduce the quantity of water allotted to Mexico under Article 10(a) of the Mexican Water Treaty of 1944. The timing and quantity of such reductions will directly affect the quantity of water stored in Lakes Powell and Mead, and the timing and quantity of both present and future shortages in deliveries of water from Lake Mead in the United States imposed by the Secretary. A material consideration in the

10

development of the Parties' Recommendation is the assumption that the United States will reduce the quantity of water allotted to Mexico in years in which the Secretary imposes shortages in deliveries of water from Lake Mead in the United States. The Basin States' Preliminary Proposal of February 3, 2006, proposed that total shortages of 400,000, 500,000 and 600,000 acre-feet per year should be imposed within the United States and Mexico at certain Lake Mead elevations. In accordance with the Preliminary Proposal, Arizona and Nevada have executed a Shortage Sharing Agreement premised upon the imposition by the Secretary of shortages within the United States of 333,000, 417,000 and 500,000 acre-feet per year at the same Lake Mead elevations contained in the Preliminary Proposal. The DEIS substantially incorporates these assumptions into its consideration and analysis of the Basin States' alternative. For the first 600,000 acre-feet per year of any reductions in deliveries in any year due to a declared shortage, the Basin States have agreed that Arizona and Nevada will not take more than 500,000 acre-feet per year in aggregate and California will not take any reductions. The Parties recognize that there may be other circumstances in which the United States may reduce the amount of water allotted to Mexico under the 1944 Treaty.

B. Each of the Parties to this Agreement takes the affirmative position that in years in which the Secretary imposes shortages in deliveries of water from Lake Mead in the United States, the United States must reduce the quantity of water allotted to Mexico under Article 10(a) of the Mexican Water Treaty of 1944. In the event that any Party becomes concerned that there may be a claim or controversy regarding the United States' delivery of water allotted to Mexico under Article 10(a) of the Mexican Water Treaty of 1944, such Party shall notify all other Parties in writing. Pursuant to such notification, the Parties shall in good faith meet to consult and formulate a uniform position regarding such claim or controversy. If the Parties are successful in formulating a uniform position regarding such claim or controversy, then the Parties shall cooperate in taking any and all actions appropriate to the resolution of such claim or controversy.

C. Once consultation and any subsequent actions agreed by each Party to be taken following completion of such consultation are completed, any Party may initiate litigation or other appropriate challenge against the United States relative to any action or inaction of the United States pursuant to the Mexican Water Treaty of 1944 or the modification of the ROD. Any adverse position taken by any Party to any position taken by any other Party under this Paragraph 11. C. shall not constitute a breach of this Agreement, and all of the other terms and conditions contained in this Agreement shall remain in full force and effect.

12. <u>Reservation of Rights</u>. Notwithstanding the terms of this Agreement and the Parties' Recommendation, in the event that for any reason this Agreement is terminated,

or that the term of this Agreement is not extended, or upon the withdrawal of any Party from this Agreement, the Parties reserve, and shall not be deemed to have waived, any and all rights, including any claims or defenses, they may have as of the date hereof or as may accrue during the term hereof, under any existing federal or state law or administrative rule, regulation or guideline, including without limitation the Colorado River Compact, the Upper Colorado River Basin Compact, the Consolidated Decree in *Arizona v. California*, the Colorado River Basin Project Act of 1968, the Mexican Water Treaty of 1944, and any other applicable provision of federal law, rule, regulation, or guideline. Nothing in this Agreement shall be utilized against any other Party in any administrative, judicial or other proceeding, except for the sole purpose of enforcing the terms of this Agreement. Notwithstanding anything in this Agreement to the contrary, the terms of this Paragraph shall survive the termination or expiration of this Agreement, and shall apply to any withdrawing Party after withdrawal.

13. <u>No Third-Party Beneficiaries</u>. This Agreement is made for the benefit of the Parties. No Party to this Agreement intends for this Agreement to confer any benefit upon any person or entity not a signatory upon a theory of third-party beneficiary or otherwise.

14. <u>Joint Defense Against Third Party Claims</u>. In the event the Secretary adopts a ROD in substantial conformance with the Parties' Recommendation as set forth herein, the Parties will have certain common, closely parallel, or identical interests in supporting, preserving and defending the ROD and this Agreement. The nature of this interest and the relationship among the Parties present common legal and factual issues and a mutuality of interests. Because of these common interests, the Parties will mutually benefit from an exchange of information relating to the support, preservation and defense of the ROD and this Agreement, as well as from a coordinated investigation and preparation for discussion of such interests. In furtherance thereof, in the event of any challenge by a third party as to the ROD or this Agreement (including claims by any withdrawing Party), the Parties will cooperate to proceed with reasonable diligence and to use reasonable best efforts in the support, preservation and defense thereof, including any lawsuit or administrative proceeding challenging the legality, validity or enforceability of any term of the ROD or this Agreement, and will to the extent appropriate enter into such agreements, including joint defense or common interest agreements, as are necessary therefor. Each Party shall bear its own costs of participation and representation in any such defense.

15. <u>Reaffirmation of Existing Law</u>. Nothing in this Agreement or the Parties' Recommendation is intended to, nor shall this Agreement be construed so as to, diminish or modify the right of any Party under existing law, including without limitation the Colorado River Compact, the Upper Colorado River Basin Compact, the Consolidated Decree in *Arizona v. California*, or the Mexican Water Treaty of 1944. The Parties hereby affirm the entitlement and right of each State under such existing law to use and develop the water of the Colorado River System.

16. Term. This Agreement shall be effective as of the date of the first two signatories hereto, and shall be effective as to any additional Party as of the date of execution by such Party. Unless earlier terminated, this Agreement shall be effective for so long as the ROD and the ISG are in effect, and shall terminate on December 31, 2025 or upon the termination of the ROD and the ISG, whichever is earlier.

17. Authority. The persons and entities executing this Agreement on behalf of the Parties are recognized by the Parties as representing the respective States in matters concerning the operation of Lakes Powell and Mead, and as those persons and entities authorized to bind the respective Parties to the terms hereof. Each person executing this Agreement has the full power and authority to bind the respective Party to the terms of this Agreement. No Party shall challenge the authority of any person or Party to execute this Agreement and bind such Party to the terms hereof, and the Parties waive the right to challenge such authority.

[Signatures begin on following page.]

Herbert R. Guenther
Director
Arizona Department of Water Resources

Dana B. Fisher, Jr.
Chairman
Colorado River Board of California

Scott Balcomb
Governor's Representative
State of Colorado

Rod Kuharich
Director
Colorado Water Conservation Board

Richard W. Bunker
Chairman
Colorado River Commission of Nevada

Patricia Mulroy
General Manager
Southern Nevada Water Authority

John R. D'Antonio, Jr.
Secretary
New Mexico Interstate Stream Commission

Dennis J. Strong
Director
Utah Division of Water Resources
Utah Interstate Stream Commissioner

Patrick T. Tyrrell
State Engineer
State of Wyoming

Attachment B

Proposed Interim Guidelines for Colorado River Operations

This attachment to Appendix J contains the text of Attachment B to the Revised Basin States' Proposal.

ATTACHMENT B

Proposed Interim Guidelines for Colorado River Operations

The Basin States propose the following Guidelines to be implemented and used for determinations made pursuant to the *Criteria for Coordinated Long-Range Operation of the Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (LROC)* during the period identified in Section 9[1]:

Section 1. Definitions

A. Each of the following terms shall have the meaning provided herein. All defined terms are identified by initial letter capitalization.

1. "Basin States" shall mean the Colorado River Basin States of Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming.

2. "Certification Report" shall mean the written documentation provided by a Contractor pursuant to Section 5.D.5 that provides the Secretary with sufficient information to verify the quantity of ICS created and that the creation was consistent with the approved project.

3. "Colorado River System" shall have the same meaning as defined in the 1922 Colorado River Compact.

4. "Consolidated Decree" shall mean the Consolidated Decree entered by the United States Supreme Court in *Arizona v. California*, 126 S. Ct. 1543, 547 U.S. 150 (2006).

5. "Contractor" shall mean a Boulder Canyon Project Act Section 5 Contractor or an entity receiving Mainstream water pursuant to other applicable federal statutes or the Consolidated Decree.

6. "Delivery Agreement" shall mean an agreement consistent with these guidelines entered into between the Parties to the Forbearance Agreement, one or more Contractors creating ICS, and the Secretary of the Interior.

7. "Developed Shortage Supply ("DSS")" shall mean water available for use by a Contractor under the terms and conditions of a Delivery Agreement and Section 6.

8. "Direct Delivery Domestic Use" shall mean direct delivery of water to domestic end users or other municipal and industrial water providers within the contractor's area of normal service, including incidental regulation of Colorado River water supplies within the Year of operation but not including Off-stream Banking. For the Metropolitan Water District of Southern California (MWD), Direct Delivery Domestic Use shall include delivery of water to end users within its area of normal service, incidental regulation of Colorado River water

[1] Unless otherwise specified, references to "Section" or "Sections" in these Guidelines are in reference to sections of these Guidelines.

1

supplies within the Year of operation and Off-stream Banking only with water delivered through the Colorado River Aqueduct.

9. "Domestic Use" shall have the same meaning as defined in the 1922 Colorado River Compact.

10. "Forbearance Agreement" shall mean the Lower Colorado River Intentionally Created Surplus Forbearance Agreement, to be entered into among the Lower Division States, and certain Contractors in the Lower Division States.

11. "Intentionally Created Surplus ("ICS")" shall mean intentionally created surplus available for use under the terms and conditions of the Forbearance Agreement and a Delivery Agreement.

    a. ICS created through extraordinary conservation, as provided for in Section 5.D.1, shall be referred to as "Extraordinary Conservation ICS."

    b. ICS created through tributary conservation, as provided for in Section 5.D.2, shall be referred to as "Tributary Conservation ICS."

    c. ICS created through system efficiency projects, as provided for in Section 5.D.3, shall be referred to as "System Efficiency ICS."

    d. ICS created through the importation of non-Colorado River System Water, as provided for in Section 5.D.4, shall be referred to as "Imported ICS."

12. "ICS Account" shall mean records established by the Secretary.

13. "ICS Declaration" shall mean a declaration by the Secretary that ICS is available for release.

14. "Interim Period" refers to the effective period as described in Section 9.

15. "Lower Division States" shall mean the Colorado River Basin States of Arizona, California, and Nevada.

16. "Mainstream" shall have the same meaning as defined in the Consolidated Decree.

17. "Off-stream Banking" shall mean the diversion of Colorado River water to underground storage facilities for use in subsequent Years from the facility used by a Contractor diverting such water.

18. "Parties" shall mean all of the signatories to the Forbearance Agreement.

19. "ROD" shall mean the Record of Decision issued by the Secretary for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.

20. "Upper Division States" shall mean the Colorado River Basin States of Colorado, New Mexico, Utah, and Wyoming.

21. "Water Year" shall mean October 1 through September 30 of the following calendar year.

22. "Year" shall mean calendar year.

Section 2. Allocation of Unused Basic Apportionment Water under Article II(B)(6)

A. Introduction

Article II(B)(6) of the Consolidated Decree allows the Secretary to allocate water that is apportioned to one Lower Division State, but is for any reason unused in that State, to another Lower Division State. This determination is made for one Year only, and no rights to recurrent use of the water accrue to the state that receives the allocated water.

B. Application to Unused Basic Apportionment

Before making a determination of a surplus condition under these Guidelines, the Secretary will determine the quantity of apportioned but unused water from the basic apportionments under Article II(B)(6), and will allocate such water in the following order of priority:

1. Meet the Direct Delivery Domestic Use requirements of MWD and Southern Nevada Water Authority (SNWA), allocated as agreed by said agencies;

2. Meet the needs for Off-stream Banking activities in California by MWD and in Nevada by SNWA, allocated as agreed by said agencies; and

3. Meet the other needs for water in California in accordance with the California Seven-Party Agreement as supplemented by the Quantification Settlement Agreement.

Section 3. Coordinated Operation of Lakes Powell and Mead During the Interim Period

A. During the Interim Period, the Secretary shall coordinate the operations of Lake Powell and Lake Mead according to the strategy set forth in this Section 3.

B. The objective of the operation of Lakes Powell and Mead as described herein is to avoid curtailment of uses in the Upper Basin, minimize shortages in the Lower Basin and not adversely affect the yield for development available in the Upper Basin.

C. The August 24-month study projections for the January 1 system storage and reservoir water surface elevations, for the following Water Year, would be used to determine the applicability of the coordinated operation of Lakes Powell and

Mead. Equalization or balancing of storage in Lakes Powell and Mead shall be achieved by the end of each Water Year.

Powell Elevation (feet)	Powell Operation	Powell Live Storage (maf)
3700	Equalize, avoid spills or 8.23 maf	**24.32**
3636 - 3666 (see table below)	8.23 maf; if Mead < 1075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	**15.54 - 19.29** (2008 - 2026)
3575	7.48 maf 8.23 maf if Mead < 1025 feet	**9.52**
3525	Balance contents with a min/max release of 7.0 and 9.5 maf	**5.93**
3370		**0**

4

Lake Powell Equalization Elevation Table

In each of the following Water Years, the Lake Powell Equalization Elevation will be as follows:

Water Year	Elevation (feet)
2008	3636
2009	3639
2010	3642
2011	3643
2012	3645
2013	3646
2014	3648
2015	3649
2016	3651
2017	3652
2018	3654
2019	3655
2020	3657
2021	3659
2022	3660
2023	3662
2024	3663
2025	3664
2026	3666

1. Equalization: In Water Years when Lake Powell content is projected on January 1 to be at or above the elevation stated in the Lake Powell Equalization Elevation Table, an amount of water will be released from Lake Powell to Lake Mead at a rate greater than 8,230,000 acre-feet per Water Year to the extent necessary to avoid spills, or equalize storage in

the two reservoirs, or otherwise to release 8,230,000 acre-feet from Lake Powell.

2. Upper Elevation Balancing: In Water Years when Lake Powell content is projected on January 1 to be below the elevation stated in the Lake Powell Equalization Elevation Table and at or above 3575 feet, the Secretary shall release 8,230,000 acre-feet from Lake Powell if the projected elevation of Lake Mead is at or above 1075 feet. If the projected elevation of Lake Mead is below 1075 feet, the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release no more than 9,000,000 acre-feet and no less than 7,000,000 acre-feet from Lake Powell.

3. Mid-Elevation Releases: In Water Years when Lake Powell content is projected on January 1 to be below 3575 feet and at or above 3525 feet, the Secretary shall release 7,480,000 acre-feet from Lake Powell if the projected elevation of Lake Mead is at or above 1025 feet. If the projected elevation of Lake Mead is below 1025 feet, the Secretary shall release 8,230,000 acre-feet from Lake Powell.

4. Lower Elevation Balancing: In Water Years when Lake Powell content is projected on January 1 to be below 3525 feet, the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release no more than 9,500,000 acre-feet and no less than 7,000,000 acre-feet from Lake Powell.

5. When determining lake elevations and contents under this Section 3, no adjustment shall be made for ICS.

Coordinated Operation of Lakes Powell and Mead as described herein will be presumed to be consistent with the Section 602(a) storage requirement contained in the Colorado River Basin Project Act.

Section 4. Determination of Lake Mead Operation during the Interim Period

A. Normal Conditions

In Years when Lake Mead elevation is projected on January 1 to be at or above elevation 1075 feet and below 1145 feet, the Secretary shall determine a normal operating condition, unless there is an ICS Surplus under Section 4.B.5.

B. Surplus Conditions

1. Domestic Surplus (Lake Mead above Elevation 1145 feet and below 70R Strategy) in Effect through December 31, 2015 (through preparation of 2016 Annual Operating Plan for the Colorado River System Reservoirs ("AOP"))

In Years when Lake Mead content is projected to be above elevation 1145 feet, but less than the amount which would initiate a Surplus under Section B.3 70R Strategy or Section B.4 Flood Control Surplus on January 1, the

6

Secretary shall determine a Domestic Surplus. The amount of such Surplus shall equal:

a. For Direct Delivery Domestic Use by MWD, 1.250 million acre-feet (maf) reduced by the amount of basic apportionment available to MWD.

b. For use by SNWA, the Direct Delivery Domestic Use within the SNWA service area in excess of the State of Nevada's basic apportionment.

c. For use in Arizona, the Direct Delivery Domestic Use in excess of Arizona's basic apportionment.

2. Domestic Surplus (Lake Mead above Elevation 1145 feet and below 70R Strategy) in Effect from January 1, 2016 through December 31, 2025 (through preparation of 2026 AOP)

In Years when Lake Mead content is projected to be above elevation 1145 feet, but less than the amount which would initiate a Surplus under Section B.3 70R Strategy or Section B.4 Flood Control Surplus on January 1, the Secretary shall determine a Domestic Surplus. The amount of such Surplus shall equal:

a. For use by MWD, 250,000 acre-feet per Year in addition to the amount of California's basic apportionment available to MWD;

b. For use by SNWA, 100,000 acre-feet per Year in addition to the amount of Nevada's basic apportionment available to SNWA;

c. For use by Arizona, 100,000 acre-feet per Year in addition to the amount of Arizona's basic apportionment available to Arizona contractors.

3. Quantified Surplus (70R Strategy)

In Years when the Secretary determines that water should be released for beneficial consumptive use to reduce the risk of potential reservoir spills based on the 70R Strategy, the Secretary shall determine and allocate a Quantified Surplus sequentially as follows:

a. Establish the volume of the Quantified Surplus. For the purpose of determining the existence, and establishing the volume, of Quantified Surplus, the Secretary shall not consider any volume of ICS as defined in these Guidelines.

b. Allocate and distribute the Quantified Surplus 50% to California, 46% to Arizona and 4% to Nevada, subject to c. through e. that follow.

c. Distribute California's share first to meet basic apportionment demands and MWD's demands, and then to California Priorities 6 and 7 and other surplus contracts. Distribute Nevada's share first to meet basic apportionment demands and SNWA demands. Distribute Arizona's share to surplus demands in Arizona including Off-stream Banking and interstate banking demands. Arizona, California and Nevada agree that Nevada would get first priority for interstate banking in Arizona.

d. Distribute any unused share of the Quantified Surplus in accordance with Section 2, Allocation of Unused Basic Apportionment Water Under Article II(B)(6).

e. Determine whether MWD, SNWA and Arizona have received the amount of water they would have received under Sections 4.B.1 or 4.B.2 if a Quantified Surplus had not been determined. If they have not, then determine and meet all demands provided for in Sections 4.B.1 or 4.B.2.

4. Flood Control Surplus

In Years in which the Secretary makes space-building or flood control releases pursuant to the February 8, 1984 Field Working Agreement between Reclamation and the Army Corps of Engineers, the Secretary shall determine a Flood Control Surplus for the remainder of that Year or the subsequent Year as specified in Section 12. In such Years, releases will be made to satisfy all beneficial uses within the United States, including unlimited Off-Stream Banking. Under current practice, surplus declarations under the Treaty for Mexico are declared when flood control releases are made. Modeling assumptions used in the FEIS are based on this practice. These Guidelines are not intended to identify, or change in any manner, conditions when Mexico may schedule up to an additional 0.2 maf.

5. ICS Surplus

a. In Years in which Lake Mead's elevation is projected on January 1 to be above elevation 1075 feet and ICS has been requested for release, the Secretary shall determine an ICS Surplus.

b. In Years in which a Quantified Surplus or a Domestic Surplus is available to a Contractor, the Secretary shall first deliver the Quantified Surplus or Domestic Surplus before delivering any requested ICS to that Contractor. If Quantified Surplus or Domestic Surplus is insufficient or unavailable to meet a Contractor's demands, the Secretary may release ICS available in that Contractor's ICS Account at the request of the Contractor.

c. The Secretary shall release ICS as described in Section 5.

C. Allocation of Colorado River Water and Forbearance Arrangements

Under these Guidelines, Colorado River water will continue to be allocated for use among the Lower Division States in a manner consistent with the provisions of the Consolidated Decree. It is expected that Lower Division States and individual Contractors for Colorado River water have or will adopt arrangements that will affect utilization of Colorado River water during the Interim Period. It is expected that water orders from Colorado River Contractors will be submitted to reflect forbearance arrangements by Lower Division States and individual Contractors. The Secretary will deliver Colorado River water to Contractors in a manner consistent with these arrangements. Surplus water will be delivered only to entities with contracts that are eligible to receive surplus water. ICS will be delivered pursuant to Section 5.D.6.

D. Shortage Conditions

1. Reductions in deliveries to the Lower Division States during declared shortages shall be implemented in the following manner:

   a. Step One reduction: In Years when Lake Mead content is projected on January 1 to be at or below elevation 1075 feet and at or above 1050 feet, a quantity of 333,000 acre-feet shall not be released or delivered in the Lower Division States.

   b. Step Two reduction: In Years when Lake Mead content is projected on January 1 to be below elevation 1050 feet and at or above 1025 feet, a quantity of 417,000 acre-feet shall not be released or delivered in the Lower Division States.

   c. Step Three reduction: In Years when Lake Mead content is projected on January 1 to be below 1025 feet, a quantity of 500,000 acre-feet shall not be released or delivered in the Lower Division States.

2. In the event projections included in any Bureau of Reclamation monthly 24-Month Study indicate Lake Mead elevations may approach an elevation that would trigger shortages in deliveries of water from Lake Mead in the United States, the Secretary shall consult with the Basin States on how the United States shall reduce the quantity of water allotted to Mexico.

3. Whenever Lake Mead is below elevation 1025 feet, the Secretary shall consult with the Basin States annually to determine whether Colorado River hydrologic conditions, together with the anticipated delivery of water to the Lower Division States and Mexico, will cause the elevation of Lake

9

Mead to fall below 1000 feet. Upon such a determination, the Secretary shall consult with the Basin States to discuss further measures that may be undertaken. If increased reductions are required, the Secretary shall implement the reductions consistent with the law of the river.

4. Subject to the provisions of Section 4.D.3, the Lower Division States shall not take shortages in excess of those provided in Section 4.D.1 Arizona and Nevada have agreed to share all reductions, described in Section 4.D.1 based on the Arizona-Nevada Shortage Sharing Agreement dated February 9, 2007. California shall not be required to share in any reductions described in Section 4.D.1.

5. The Secretary shall consult with the Basin States to evaluate actions at critical elevations that may avoid shortage determinations as reservoir elevations approach critical thresholds.

6. During declared Shortages described in Section 4.D.1, the Secretary may release Developed Shortage Supply, subject to the provisions in Sections 5 and 6.

Section 5. System Efficiency, Extraordinary Conservation, Tributary Conservation and Importation of Non-Colorado River System Water for the Purpose of Developing Intentionally Created Surplus

A. Findings

ICS may be created through projects that create water system efficiency, extraordinary conservation, tributary conservation, and the importation of non-Colorado River System water into the Colorado River Mainstream. ICS is consistent with the concept that the States will take actions to augment storage of water in the Lower Colorado River Basin. The ICS shall be released to the Contractor that created it pursuant to both Article II(B)(2) of the Consolidated Decree and agreements among various Contractors to forbear from taking water that they otherwise would be able to request. Implementation under these Guidelines shall be predicated upon the execution of a Forbearance Agreement and a Delivery Agreement, as further provided for below.

B. Purposes

The purposes of ICS are to:

1. Encourage the efficient use and management of Colorado River water, and to increase the water supply in Colorado River system reservoirs, through the creation, release, and use of ICS;

2. Help avoid shortages to the Lower Basin;

3. Benefit both Lake Mead and Lake Powell;

4. Increase the surface elevations of both Lakes Powell and Mead to higher levels than would have otherwise occurred; and

5. Assure any Contractor that invests in conservation or augmentation to create ICS that no Contractor within another state will claim the ICS created by the Contractor.

C. Statement of Consistency with the Law of the River and Consequential Limitations on ICS Guidelines

In Years in which the Secretary determines that sufficient Mainstream water is available for release to satisfy annual consumptive use in the Lower Division States in excess of 7,500,000 acre-feet, Article II(B)(2) of the Consolidated Decree authorizes the Secretary to apportion surplus Mainstream water 50% for use in California, 46% for use in Arizona, and 4% for use in Nevada. The Boulder Canyon Project Act and Articles II(B)(2) and II(B)(6) of the Consolidated Decree, taken together, authorize the Secretary to apportion surplus water and to release one Lower Division State's unused apportionment for use in another Lower Division State. Pursuant to such authority and for the purpose of increasing the efficiency, flexibility, and certainty of Colorado River management and thereby helping satisfy the regional water demands that exist, the Secretary has the authority to promulgate guidelines to establish a procedural framework for facilitating the creation and release of ICS.

In the absence of forbearance, surplus water is apportioned for use according to the percentages provided in Article II(B)(2) of the Consolidated Decree. The Forbearance Agreement, as approved by the Parties, will provide the basis for such forbearance. The Parties will forbear only with respect to ICS created by projects described in exhibits attached to the Forbearance Agreement or added thereto by written consent of all Parties. It is hereby recognized that the creation, release and use of ICS pursuant to these Guidelines shall not be administered in such a way as to violate the Consolidated Decree, including Articles II(B)(2) and II(B)(6) therein. These Guidelines regarding ICS shall have no force or effect absent the existence and effectiveness of the Forbearance Agreement.

D. Creation and Release of ICS

1. Extraordinary Conservation ICS

A Contractor may create Extraordinary Conservation ICS through the following activities:

a. Fallowing of land that currently is, historically was, and otherwise would have been irrigated in the next Year.

b. Canal lining programs.

c. Desalination programs in which the desalinated water is used in lieu of Mainstream water.

d. Extraordinary conservation programs that existed on January 1, 2006.

e. Extraordinary Conservation ICS demonstration programs pursuant to a letter agreement entered into between the United States Bureau of

Reclamation and the Contractor prior to the effective date of these Guidelines.

f. Tributary Conservation ICS created under Section 5.D.2 and not released in the Year created.

g. Imported ICS created under Section 5.D.4 and not released in the Year created.

h. Other extraordinary conservation measures, including development and acquisition of a non-Colorado River System water supply used in lieu of Colorado River Mainstream water within the same state, in consultation with the Basin States, and as agreed upon by the Parties pursuant to the Forbearance Agreement.

2. Tributary Conservation ICS

A Contractor may create Tributary Conservation ICS by purchasing documented water rights on Colorado River System tributaries upstream of Hoover Dam within the Contractor's state if there is documentation that the water rights have been used for a significant period of Years and that the water rights were perfected prior to June 25, 1929 (the effective date of the Boulder Canyon Project Act). The quantity of Tributary Conservation ICS shall be limited to the quantity of water set forth in Exhibits incorporated in the Forbearance Agreement, and shall in no event be more than the quantity of such water the Secretary verifies actually flows into Lake Mead. Any Tributary Conservation ICS not released pursuant to Section 5.D.6 or deducted pursuant to Section 5.D.5.c in the Year it was created will, at the beginning of the following Year, be converted to Extraordinary Conservation ICS at the request of the Contractor and will thereafter be subject to all provisions applicable to Extraordinary Conservation ICS. Tributary Conservation ICS may be released for Domestic Use only.

3. System Efficiency ICS

A Contractor may make contributions of capital to the Secretary for use in Secretarial projects designed to realize system efficiencies that save water that would otherwise be lost from the Colorado River Mainstream in the United States. An amount of water equal to a portion of the water saved may be made available to contributing Contractor(s) by the Secretary as System Efficiency ICS. System efficiency projects are intended only to provide temporary water supplies. System Efficiency ICS will not be available for permanent use. System Efficiency ICS will be released to the contributing Contractor(s) on a predetermined schedule of annual deliveries for a period of Years as agreed by the Parties. The Secretary, in consultation with the Basin States, will identify potential system efficiency projects, terms for capital participation in such projects, and types and amounts of benefits the Secretary should provide in consideration of non-federal capital contributions to system efficiency projects, including identification of a portion of the water saved by such projects.

4. Imported ICS

A Contractor may create Imported ICS by introducing non-Colorado River System water in that Contractor's state into the Mainstream. Contractors proposing to create Imported ICS shall make arrangements with the Secretary, contractual or otherwise, to ensure no interference with the Secretary's management of Colorado River system reservoirs and regulatory structures. Any arrangement shall provide that the Contractor must obtain appropriate permits or other authorizations required by state law and that the actual amount of water introduced to the Mainstream shall be reported to the Secretary on an annual basis. Any Imported ICS not released pursuant to Section 5.D.6 or deducted pursuant to Section 5.D.5.c in the Year it was created will be converted, at the beginning of the following Year, to Extraordinary Conservation ICS at the request of the Contractor and thereafter will be subject to all provisions applicable to Extraordinary Conservation ICS.

5. Creation of ICS

A Contractor may create ICS subject to the following conditions:

a. A Contractor shall submit a plan for the creation of ICS to the Secretary and the Basin States demonstrating how all requirements of these Guidelines will be met in the Contractor's creation of ICS. Until such plan is reviewed and approved by the Secretary in consultation with the other Basin States, such plan, or any ICS purportedly created through it, shall not be a basis for an ICS Declaration. A Contractor may modify its plan for creation of ICS during any Year, subject to approval by the Secretary in consultation with the Basin States. System Efficiency ICS with an approved multi-Year plan shall not require annual approval by the Secretary or consultation with the Basin States.

b. A Contractor that creates ICS shall submit a Certification Report to the Secretary demonstrating the amount of ICS created and that its creation was consistent with the Forbearance Agreement, these Guidelines, and a Delivery Agreement executed by the Secretary. The Secretary shall verify the information in the Certification Report in consultation with the Basin States, and provide a final written decision to the Contractor, the Parties and the Basin States. The Contractor or any Party or Basin State may appeal the Secretary's verification of the Certification Report through administrative and judicial processes.

c. There shall be a one-time deduction of five percent (5%) from the amount of ICS in the Year of its creation. This deduction results in additional water in storage in Lake Mead for future use in accordance with the Consolidated Decree and these Guidelines. This provision shall not apply to:

(1) System Efficiency ICS created pursuant to Section 5.D.3 because a large portion of the water saved by this type of project will increase the quantity of water in storage.

(2) Extraordinary Conservation ICS created by conversion of Tributary Conservation ICS that was not released in the Year created, pursuant to Section 5.D.1.f because 5% of the ICS is deducted at the time the Tributary Conservation ICS is created.

(3) Extraordinary Conservation ICS created by conversion of Imported ICS that was not released in the Year created, pursuant to Section 5.D.1.g because 5% of the ICS is deducted at the time the Imported ICS is created.

d. The records of any Contractor relating to the creation of ICS shall be open to inspection by the Secretary or any Contractor, Party or Basin State.

e. In addition to the conditions described above, creation of Extraordinary Conservation ICS is subject to the following conditions:

(1) Except as provided in Sections 5.D.2 and 5.D.4, Extraordinary Conservation ICS can only be created if such water would have otherwise been beneficially used.

(2) The maximum total amount of Extraordinary Conservation ICS that can be created during any Year is limited to the following:

(a) 400,000 acre-feet for California Contractors;

(b) 125,000 acre-feet for Nevada Contractors; and

(c) 100,000 acre-feet for Arizona Contractors.

(3) The maximum quantity of Extraordinary Conservation ICS that may be accumulated in all ICS Accounts, at any time, is limited to the following:

(a) 1,500,000 acre-feet for California Contractors;

(b) 300,000 acre-feet for Nevada Contractors; and

(c) 300,000 acre-feet for Arizona Contractors.

(4) Except as provided in Sections 5.D.2 and 5.D.4, no category of surplus water can be used to create Extraordinary Conservation ICS.

(5) The quantity of Extraordinary Conservation ICS remaining in an ICS Account at the end of each Year shall be diminished by annual evaporation losses of 3%. Losses shall be applied

annually to the end-of-the-Year balance of Extraordinary Conservation ICS beginning in the Year after the ICS is created and continuing until no Extraordinary Conservation ICS remains in Lake Mead. No evaporation losses shall be assessed during a Year in which the Secretary has declared a shortage.

(6) Extraordinary Conservation ICS from a project within a state may be credited to the ICS Account of a Contractor within that state that has funded or implemented the project creating ICS, or to the ICS Account of a Contractor within the same state as the funding entity and project and with written agreement of the funding entity.

(7) A Contractor must notify Reclamation by September 15 of the amount of Extraordinary Conservation ICS it wishes to create for the subsequent Year. If conditions during the Year change due to weather or other unforeseen circumstances, a Contractor may request a mid-Year modification of its water order to reduce the amount of ICS created during that Year. A Contractor cannot increase the amount of ICS it had previously scheduled to create during the Year.

6. Release of ICS

The release of ICS shall be pursuant to the terms of a Delivery Agreement entered into among the Secretary, the Parties to the Forbearance Agreement and any Contractor creating ICS. The Secretary shall not release ICS to a Contractor unless that Contractor is a party to a Delivery Agreement. A Contractor that has created ICS may request release of its ICS as is provided within such Delivery Agreement and subject to the following conditions:

a. ICS shall be released pursuant to an ICS Declaration.

b. If a Contractor has an overrun payback obligation, as described in the October 10, 2003 Inadvertent Overrun and Payback Policy or Exhibit C to the October 10, 2003 Colorado River Water Delivery Agreement, the Contractor must pay the overrun payback obligation in full before requesting or receiving a release of any ICS. The Contractor's ICS account shall be reduced by the amount of the overrun payback obligation in order to pay the overrun payback obligation.

c. If more ICS is released to a Contractor than is actually available for release to the Contractor in that Year, then the excess ICS released shall be treated as an inadvertent overrun until it is fully repaid.

d. A Contractor may reduce its request for release of ICS during the Year for any reason, including reduction in water demands. A Contractor may increase its request for release of ICS during the Year only if extraordinary weather conditions or water emergencies occur.

e. In addition to the conditions described above, the release of Extraordinary Conservation ICS is subject to the following conditions:

(1) The total amount of Extraordinary Conservation ICS that may be released in any Year is limited to the following:

(a) 400,000 acre-feet for California Contractors;

(b) 300,000 acre-feet for Nevada Contractors; and

(c) 300,000 acre-feet for Arizona Contractors.

(2) If the May 24-month study for that Year indicates that a shortage condition would be declared in the succeeding Year if the requested amounts for the current Year under Section 5.D.6.e.(1) were released, the Secretary may release less than the amounts of ICS requested to be released.

(3) If the Secretary releases Flood Control Surplus water, Extraordinary Conservation ICS accumulated in ICS Accounts shall be reduced by the amount of the Flood Control Surplus on an acre-foot for acre-foot basis until no Extraordinary Conservation ICS remains. The reductions to the ICS Accounts shall be shared on a pro-rata basis among all Contractors that have accumulated Extraordinary Conservation ICS.

E. Accounting Procedure for ICS

In consultation with the Basin States, the Secretary shall develop a water accounting procedure to annually establish separate ICS Accounts to account for, at a minimum, the following:

1. For each Contractor that creates Extraordinary Conservation ICS:

a. The quantity of Extraordinary Conservation ICS created by the Contractor.

b. The releases of Extraordinary Conservation ICS to the Contractor.

c. The amount of Extraordinary Conservation ICS no longer available for release to the Contractor due to releases for flood control purposes.

d. The amount of Extraordinary Conservation ICS deducted pursuant to Section 5.D.5.c.

e. The amount of Extraordinary Conservation ICS no longer available for release to the Contractor due to annual evaporation losses pursuant to Section 5.D.5.e.(5).

f. The amount of Extraordinary Conservation ICS remaining available for release to the Contractor.

2. For each Contractor that creates Tributary Conservation ICS:

   a. The quantity of Tributary Conservation ICS created by the Contractor.

   b. The releases of Tributary Conservation ICS to the Contractor.

   c. The amount of Tributary Conservation ICS deducted pursuant to Section 5.D.5.c.

   d. The amount of Tributary Conservation ICS converted to Extraordinary Conservation ICS, if any.

3. For each Contractor that creates System Efficiency ICS:

   a. The quantity of System Efficiency ICS created by the Contractor.

   b. The releases of System Efficiency ICS to the Contractor.

   c. The amount of System Efficiency ICS no longer available for release to the Contractor for any reason.

   d. The amount of System Efficiency ICS remaining available for release to the Contractor.

4. For each Contractor that creates Imported ICS:

   a. The quantity of Imported ICS created by the Contractor.

   b. The releases of Imported ICS to the Contractor.

   c. The amount of Imported ICS deducted pursuant to Section 5.D.5.c.

   d. The amount of Imported ICS converted to Extraordinary Conservation ICS, if any.

F. Delivery Agreement

The Secretary shall release ICS to a Contractor only after entering into a Delivery Agreement with the Contractor and the Parties to the Forbearance Agreement. Any Delivery Agreement shall be consistent with these Guidelines and the Forbearance Agreement, and shall include the following:

1. A procedure for the annual schedule for the submission and approval of the plans for the creation of ICS, required by Section 5.D.5.a.

2. Procedures for demonstrating and verifying the creation of ICS, including a description of the contents of the Certification Report, required by Section 5.D.5.b.

3. A procedure for the release of ICS, in accordance with Section 5.D.6.

4. An accounting procedure, pursuant to Section 5.E.

Section 6. Creation and Release of Developed Shortage Supply

A. During any Year in which the Secretary declares a shortage within the United States, Developed Shortage Supply may be created by:

1. Purchasing documented water rights on Colorado River System tributaries upstream of Hoover Dam within the Contractor's state if there is documentation that the water rights have been used for a significant period of Years and that the water rights were perfected prior to June 25, 1929 (the effective date of the Boulder Canyon Project Act), provided that the quantity of such Developed Shortage Supply shall be limited to the quantity of water set forth in Exhibits incorporated in the Forbearance Agreement, and shall in no event be more than the quantity of such water the Secretary verifies actually flows into Lake Mead; and/or

2. Introducing non-Colorado River System water in that Contractor's state into the Colorado River Mainstream, making sufficient arrangements with the Secretary, contractual or otherwise, to ensure no interference with the Secretary's management of Colorado River system reservoirs and regulatory structures. Any arrangement shall provide that the Contractor must obtain appropriate permits or other authorizations required by state law and reporting the actual amount of water introduced to the Colorado River Mainstream to the Secretary on an annual basis.

B. Developed Shortage Supply may only be created by a project that is approved for creation of ICS prior to the declared Shortage.

C. Except as provided in Sections 6.D through 6.F, Developed Shortage Supply is subject to all conditions set forth in Section 5 relating to creation and release of ICS.

D. Any Developed Shortage Supply not released pursuant to Section 6.E in the Year it is created may not be converted to Extraordinary Conservation ICS.

E. The Secretary shall release Developed Shortage Supply during a declared shortage. The following conditions shall apply to the release of Developed Shortage Supply:

1. Developed Shortage Supply shall be released pursuant to a Shortage Declaration.

2. Release of Developed Shortage Supply shall not cause the total deliveries within the Lower Division States to reach or exceed 7.5 million acre-feet in any Year. If the volume of Developed Shortage Supply requested to be released in any Year would cause the total deliveries within the Lower Division States to reach or exceed 7.5 million acre-feet for that Year, the Secretary shall consult with all Contractors requesting the release of Developed Shortage Supply and release so much thereof as will not cause

total deliveries in the Lower Division States to reach or exceed 7.5 million acre-feet in that Year.

F. The Secretary shall account for the creation and release of Developed Shortage Supply through the AOP and the Article V Consolidated Decree accounting processes.

G. Delivery Agreement

For a Contractor seeking to create and use Developed Shortage Supply, the Delivery Agreement for ICS executed by the Secretary, the Contractor and the Parties to the Forbearance Agreement shall also include the following:

1. A procedure for the annual schedule for the submission and approval of the plans for the creation of Developed Shortage Supply, required by Sections 6.C and 5.D.5.a.

2. Procedures for demonstrating and verifying the creation of Developed Shortage Supply, including a description of the contents of the Certification Report, required by Sections 6.C and 5.D.5.b.

3. A procedure for the release of Developed Shortage Supply, in accordance with Sections 6.C, 6.E, and 5.D.6.

4. An accounting procedure, pursuant to Section 6.F.

Section 7. Implementation of Guidelines

During the effective period of these Guidelines the Secretary shall utilize the currently established process for development of the AOP and use these Guidelines to make determinations regarding Normal, Surplus and Shortage conditions for the operation of Lake Mead, allocation of apportioned but unused water, the coordinated operations of Lakes Mead and Powell, and the administration of Developed Shortage Supply and contractor accounts for ICS.

The operation of the other Colorado River System reservoirs and determinations associated with development of the AOP shall be in accordance with the Colorado River Basin Project Act of 1968, these Guidelines, and other applicable federal law.

In order to allow for better overall water management during the Interim Period, the Secretary shall undertake a "mid-Year review" pursuant to Section 1(2) of the LROC, allowing for the revision of the current AOP, as appropriate, if actual runoff conditions are greater than projected or demands are lower than projected. The Secretary shall revise the determination for the current Year only to allow for additional deliveries. Any revision in the AOP, including reductions in the amount of ICS released, may occur only after a re-initiation of the AOP consultation process as required by law.

As part of the AOP process during the effective period of these Guidelines, California shall report to the Secretary on its progress in implementing its California Colorado River Water Use Plan.

The Secretary will base annual determinations of surplus, normal and shortage conditions on these Guidelines, unless extraordinary circumstances arise. Such circumstances could include operations necessary for safety of dams or other emergency situations, or other unanticipated or unforeseen activities arising from actual operating experience.

Section 8. Consultation

In addition to the circumstances described in Section 4.D.2, the Secretary shall consult with the Basin States in the following circumstances:

A. The Secretary will first consult with all the Basin States before making any substantive modification to these Guidelines.

B. Upon a request by a State for modification of these Guidelines, or upon a request by a State to resolve any claim or controversy arising under these Guidelines or under the operations of Lakes Powell and Mead pursuant to these guidelines or any other applicable provision of federal law, regulation, criteria, policy, rule, or guideline, or the Mexican Water Treaty of 1944, the Secretary shall invite the Governors of all the Basin States, or their designated representatives, to consult with the Secretary in an attempt to resolve such claim or controversy by mutual agreement.

Section 9. Effective Period & Termination

A. Effective Period

These guidelines will be in effect 30 days from the publication of the ROD in the Federal Register and will, unless subsequently modified, remain in effect through December 31, 2025 (through preparation of the 2026 AOP), except that during the effective period of the Forbearance Agreement defined in Section 5.C:

1. Any ICS remaining in an ICS Account on December 31, 2025, may be released as provided herein until December 31, 2035.

2. Tributary Conservation ICS described in Section 5.D.2 and Imported ICS described in Section 5.D.4 shall continue in full force and effect until fifty years from the date of the execution of the Forbearance Agreement.

3. Developed Shortage Supply described in Section 6 shall continue in full force and effect until fifty years from the date of the execution of the Forbearance Agreement.

B. Termination of Guidelines

Except as provided in Section 9.A, these Guidelines shall terminate on December 31, 2025 (through preparation of the 2026 AOP). At the conclusion of the effective period of these Guidelines, the operating criteria for Lake Powell and Lake Mead are assumed to revert to the operating criteria used to model baseline conditions in the Final Environmental Impact Statement for the Interim Surplus Guidelines dated December 2000 (i.e., modeling assumptions are based upon a 70R strategy for the period commencing January 1, 2026 (for preparation of the 2027 AOP)).

C. Review of Guidelines

Beginning no later than December 31, 2020, the Secretary shall initiate a formal review for purposes of evaluating the effectiveness of these Guidelines. The Secretary shall consult with the Basin States in initiating this review.

Section 10. California's Colorado River Water Use Plan Implementation Progress

The California agricultural (Palo Verde Irrigation District (PVID), Yuma Project Reservation Division (YPRD), Imperial Irrigation District (IID), and Coachella Valley Water District (CVWD)) usage plus 14,500 acre-feet of Present Perfected Right (PPR) use would need to be at or below the following amounts at the end of the Year indicated in Years of Quantified Surplus (for Decree accounting purposes all reductions must be within 25,000 acre-feet of the amounts stated):

Benchmark Date (Year)	Benchmark Quantity (California Agricultural Usage & 14,500 af of PPR Use in maf)
2009	3.53
2012	3.47

In the event that California has not reduced its use in amounts to equal the above Benchmark Quantities, the surplus determinations under Sections 4.B.1 or 4.B.2 will be suspended and will instead be based upon the 70R Strategy, for up to the remainder of the term of these Guidelines. If however, California meets the missed Benchmark Quantity before the next Benchmark Date, or after 2012, the surplus determinations under Sections 4.B.1 or 4.B.2 shall be reinstated as the basis for the surplus determinations under the AOP for the next following Year(s).

Section 11. Authority

These Guidelines are issued pursuant to the authority vested in the Secretary by federal law, including the Boulder Canyon Project Act of 1928 (28 Stat. 1057) (the "BCPA"), and the Consolidated Decree and shall be used to implement Article III of the Criteria for the Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Pub. L. No. 90-537), amended March 21, 2005.

Section 12. Modeling and Data

The August 24-Month Study projections for the January 1 system storage and reservoir water surface elevations, for the following Year, will be used to determine the applicability of these Guidelines.

In preparation of the AOP, Reclamation will utilize the 24-Month Study and/or other modeling methodologies appropriate for the determinations and findings necessary in the AOP.

Reclamation will utilize the best available data and information, including National Weather Service forecasting to make these determinations.

Attachment C

Forbearance Agreement

This attachment to Appendix J contains the text of Attachment C to the Revised Basin States' Proposal.

ATTACHMENT C

Lower Colorado River Basin Intentionally Created Surplus Forbearance Agreement

The State of Arizona, acting through the Arizona Department of Water Resources ("ADWR"); the Palo Verde Irrigation District ("PVID"); the Imperial Irrigation District ("IID"); The City of Needles; the Coachella Valley Water District ("CVWD"); The Metropolitan Water District of Southern California ("MWD"); the Southern Nevada Water Authority ("SNWA"); and the Colorado River Commission of Nevada enter into this Lower Colorado River Basin Intentionally Created Surplus Forbearance Agreement ("Forbearance Agreement") as follows:

Recitals

A. The purposes of this Forbearance Agreement are to:

1. Encourage the efficient use and management of Colorado River water, and to increase the water supply in Colorado River system reservoirs, through the creation, release, and use of Intentionally Created Surplus ("ICS");

2. Help avoid shortages to the Lower Basin;

3. Benefit both Lake Mead and Lake Powell; and

4. Increase the surface elevations of both Lakes Powell and Mead to higher levels than would have otherwise occurred.

5. Assure any Contractor that invests in conservation or augmentation to create ICS under this Forbearance Agreement that no Contractor within another state will claim the ICS created by the Contractor.

B. The Parties to the Forbearance Agreement and their respective authority to forbear are as follows:

1. The Arizona Department of Water Resources, through its Director, is the successor to the signatory agency of the State for the 1922 Colorado River Compact, and the 1944 Contract for Delivery of Water with the United States, both authorized and ratified by the Arizona Legislature, A.R.S. §§ 45-1301 and 1311. Pursuant to A.R.S. § 45-107, the Director is authorized and directed, subject to the limitations in A.R.S. § 45-106, for and on behalf of the State of Arizona, to consult, advise and cooperate with the Secretary of the Interior of the United States ("Secretary") with respect to the exercise by the Secretary of Congressionally authorized authority relative to the waters of the Colorado River (including, but not limited to, the Boulder Canyon Project Act of 1928, 43 U.S.C. § 617, and the Colorado River Basin Project Act of 1968, 43 U.S.C. § 1501) and with respect to the development, negotiation and execution of interstate agreements. Additionally, under A.R.S. § 45-105(A)(9), the Director is authorized to "prosecute and defend all rights, claims and privileges of this state respecting interstate streams."

2. SNWA is a Nevada joint powers agency and political subdivision of the State of Nevada, created by agreement dated July 25, 1991, as amended November 17, 1994, and January 1, 1996, pursuant to N.R.S. §§ 277.074 and 277.120. SNWA is authorized by N.R.S. § 538.186 to enter into this Forbearance Agreement and, pursuant to its contract issued under Section 5 of the Boulder Canyon Project Act of 1928, SNWA has the right to divert ICS released by the Secretary for use within the State of Nevada pursuant to the Consolidated Decree.

3. The Colorado River Commission of the State of Nevada (CRCN) is an agency of the State of Nevada, authorized generally by N.R.S. §§ 538.041 and 538.251. CRCN is authorized by N.R.S. § 538.161 (6), (7) to enter into this

2

Agreement. The CRCN, in furtherance of the State of Nevada's responsibility to promote the health and welfare of its people in Colorado River matters, makes this Agreement to supplement the supply of water in the Colorado River which is available for use in Nevada, augment the waters of the Colorado River, and facilitate the more flexible operation of dams and facilities by the Secretary.

4. PVID is an irrigation district created under the Palo Verde Irrigation District Act, codified at Section 33-1 et seq. of the Appendix to the California Water Code, and delivers Colorado River water in Riverside and Imperial Counties, California, pursuant to its contract issued under Section 5 of the Boulder Canyon Project Act of 1928.

5. IID is an irrigation district created under the California Irrigation District Law, codified at Section 20500 *et seq.* of the California Water Code, and delivers Colorado River water in Imperial County, California, pursuant to its contract issued under Section 5 of the Boulder Canyon Project Act of 1928.

6. CVWD is a county water district created under the California County Water District Law, codified at Section 30000 *et seq.* of the California Water Code, and delivers Colorado River water to portions of its service area in Imperial, Riverside, and San Diego Counties, California, pursuant to its contract issued under Section 5 of the Boulder Canyon Project Act of 1928 and the California Quantification Settlement Agreement.

7. MWD is a metropolitan water district created under the California Metropolitan Water District Act, codified at Section 109-1 *et seq.* of the Appendix to the California Water Code; and delivers Colorado River water to portions of its service area in Los Angeles, Orange, Riverside, San Bernardino, San Diego and Ventura Counties, California, pursuant to its contracts issued under Section 5 of the Boulder Canyon Project Act of 1928.

8. The City of Needles is a charter city duly authorized and existing under and by virtue of the laws of the State of California and delivers Colorado River water, either directly or by exchange, to portions of Imperial, Riverside, and San Bernardino Counties, California, pursuant to its contracts issued under Section 5 of the Boulder Canyon Project Act of 1928,

NOW, THEREFORE, in consideration of the mutual covenants herein contained, the Parties hereby agree as follows:

Article 1
Definitions and Term

1.1 Definitions.

The definitions in the Interim Surplus Guidelines ("ISG") described in the Record of Decision dated January 16, 2001, and modified by the ROD are hereby incorporated in this Forbearance Agreement. In addition, each of the following terms shall have the meaning defined here. All defined terms shall be identified by initial letter capitalization.

A. "Certification Report" shall mean the written documentation provided by a Contractor pursuant to Article 2.5(B) that provides the Secretary with sufficient information to verify the quantity of ICS created and that the creation was consistent with the approved project exhibit, this Forbearance Agreement, the Delivery Agreement, and the ROD.

B. "Colorado River System" shall have the same meaning as defined in the 1922 Colorado River Compact.

C. "Consolidated Decree" shall mean the Consolidated Decree entered by the United States Supreme Court in *Arizona v. California*, 126 S.Ct. 1543, 547 U.S. ____ (2006).

D. "Contractor" shall mean a Boulder Canyon Project Act Section 5 Contractor or an entity receiving Mainstream water pursuant to other applicable federal statute or the Consolidated Decree.

E. "Delivery Agreement" shall mean the agreement entered into by the Parties to this Agreement and the Secretary of the Interior contemporaneously with this Forbearance Agreement.

F. "Forbearance Agreement" shall mean this Lower Colorado River Basin Intentionally Created Surplus Forbearance Agreement.

G. "ICS" shall mean intentionally created surplus available for use under the terms and conditions of this Forbearance Agreement and the Delivery Agreement.

1. ICS created through extraordinary conservation, as provided for in Article 2.1 herein, shall be referred to as "Extraordinary Conservation ICS."

2. ICS created through tributary conservation, as provided for in Article 2.2 herein, shall be referred to as "Tributary Conservation ICS."

3. ICS created through system efficiency projects, as provided for in Article 2.3 herein, shall be referred to as "System Efficiency ICS."

4. ICS created through the importation of non-Colorado River System Water, as provided for in Article 2.4 herein, shall be referred to as "Imported ICS."

H. "ICS Account" shall mean a record established by the Secretary under the terms of this Forbearance Agreement, the Delivery Agreement, and the ROD.

I. "ICS Declaration" shall mean a declaration of ICS made by the Secretary pursuant to the ROD, the Delivery Agreement and the provisions of this Forbearance Agreement.

J. "Lower Division States" shall mean the Colorado River Basin States of Arizona, California, and Nevada.

K. "Mainstream" shall have the same meaning as defined in the Consolidated Decree.

L. "Parties" shall mean all of the signatories to this Forbearance Agreement.

M. "ROD" shall mean the Record of Decision issued by the Secretary for the Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead, Particularly Under Low Reservoir Conditions, and including the policy for implementation of ICS.

N. "Year" shall mean calendar year.

1.2 <u>Term of the Forbearance Agreement</u>.

This Forbearance Agreement shall commence on the date of execution by all Parties and shall terminate December 31, 2025; provided, however, that any ICS remaining in an ICS

Account on December 31, 2025, may be released as provided herein until December 31, 2035.

1.3 Extended Term for Tributary Conservation ICS and Imported ICS.

Notwithstanding Article 1.2, the provisions of this Forbearance Agreement for creation, and release in the Year of creation, of Tributary Conservation ICS under Article 2.2 and Imported ICS under Article 2.4, shall continue in full force and effect after termination of this Forbearance Agreement until the earlier of (1) the termination of the period provided in the ROD for the creation, release, and use of Tributary Conservation ICS and Imported ICS, or (2) fifty years from the date of execution of this Forbearance Agreement. The amount of Tributary Conservation ICS and Imported ICS that may be created, released, and used through the end of the extended term provided by this Article 1.3 shall not exceed the amount shown in, and shall be consistent with, the attached Exhibits ___ and ___ for Tributary Conservation ICS and Imported ICS. Such ICS may be released during the extended term as provided herein. The obligations of the Parties under Articles 2.5, 2.6, 3, 4, and 5 shall continue with regard to such ICS.

1.4 Seven Colorado River Basin States' Agreement

Notwithstanding Articles 1.2 and 1.3 above, if one or more states withdraw from the agreement dated ____, executed by the seven Colorado River Basin states, the Parties to this Forbearance Agreement shall consult to determine whether to continue this Forbearance Agreement in effect or to amend or terminate this Forbearance Agreement. In such event, the terms of this Forbearance Agreement shall continue in effect until the Parties have consulted and agreed to continue, amend, or terminate this Forbearance Agreement. In the event of termination, all Parties shall be relieved from the terms hereof and this Forbearance Agreement shall be of no further force or effect.

Article 2

Creation and Release of ICS

2.1 Extraordinary Conservation ICS

Pursuant to procedures set forth in the ROD, the Delivery Agreement, and this Forbearance Agreement, Extraordinary Conservation ICS may be created only through the following activities:

A. Fallowing of land that currently is, historically was, and otherwise would have been irrigated in the next Year.

B. Canal lining programs.

C. Desalination programs in which the desalinated water is used in lieu of Mainstream water.

D. Extraordinary conservation programs that existed on January 1, 2006.

E. Demonstration Extraordinary Conservation ICS programs pursuant to a letter agreement entered into between the United States Bureau of Reclamation and the Contractor prior to the effective date of the ROD.

F. Tributary Conservation ICS created under Article 2.2 hereto and not released in the Year created.

G. Imported ICS created under Article 2.4 hereto and not released in the Year created.

H. Other extraordinary conservation measures, including development and acquisition of a non-Colorado River System water supply used in lieu of Mainstream water within the same state, as agreed upon by the Parties pursuant to this Forbearance Agreement.

2.2 Tributary Conservation ICS

Pursuant to procedures set forth in the ROD, a Contractor may create Tributary Conservation ICS by purchasing documented water rights on Colorado River System tributaries within the

8

Contractor's state if there is documentation that the water rights have been used for a significant period of years and that the water rights were perfected prior to June 25, 1929 (the effective date of the Boulder Canyon Project Act of 1928). The quantity of Tributary Conservation ICS that may be created shall be limited to the quantity of water set forth in Exhibits __ and __, and shall in no event be more than the quantity of such water the Secretary verifies actually flows into Lake Mead. Any Tributary Conservation ICS not released or deducted pursuant to Article 2.5(C) in the Year it was created will be converted to Extraordinary Conservation ICS at the request of the Contractor and will be subject to all provisions of this Forbearance Agreement applicable to Extraordinary Conservation ICS.

2.3 System Efficiency ICS

Pursuant to procedures set forth in the ROD, a Contractor may make contributions of capital to the Secretary for use in Secretarial projects designed to realize efficiencies that save water that would otherwise be lost from the Mainstream in the United States. An amount of water equal to a portion of the water saved may be made available to contributing Contractors by the Secretary as System Efficiency ICS. System efficiency projects are only intended to provide temporary water supplies and System Efficiency ICS will not be available for permanent use. The System Efficiency ICS will be released to the capital contributor on a predetermined schedule of annual deliveries for a period of years as agreed by the Parties.

2.4 Imported ICS

Pursuant to procedures set forth in the ROD, a Contractor may create Imported ICS by introducing non-Colorado River System water in that Contractor's state into the Mainstream. Contractors proposing to create Imported ICS shall make sufficient arrangements with the Secretary, contractual or otherwise, to guarantee that the creation of Imported ICS shall cause no harm to the Secretary's management of the Colorado River System. These arrangements shall provide that the Contractor must obtain appropriate permits or other authorizations required by state law and that the actual amount of water introduced to the Mainstream would be reported to the Secretary on an annual basis. Any Imported ICS not released or deducted pursuant to Article 2.5(C) in the Year it was created will be converted to Extraordinary Conservation ICS at the request of the Contractor and will be subject to all provisions of this Forbearance Agreement applicable to Extraordinary Conservation ICS.

2.5 Creation of ICS

A Contractor may create ICS subject to the following conditions:

A. Pursuant to procedures set forth in the ROD, a Contractor shall submit a plan for the creation of ICS to the Secretary and the Lower Division States demonstrating how all requirements of this Forbearance Agreement will be met in the Contractor's creation of ICS. System Efficiency ICS with an approved multi-year plan shall not require annual approval by the Secretary or consultation with the Lower Division States. Until such plan is reviewed and approved by the Secretary annually in consultation with the Lower Division States, such ICS plan, or any ICS purportedly created through it, cannot be a basis for an ICS Declaration. A Contractor may modify its plan for creation of ICS during any Year, subject to approval by the Secretary in consultation with the Lower Division States.

B. Pursuant to procedures set forth in the ROD, a Contractor that creates ICS shall submit a Certification Report to the Secretary demonstrating the amount of ICS created and that its creation was consistent with this Forbearance Agreement and the ROD. The Secretary shall verify the information in the Certification Report in consultation with the Lower Division States, and provide a final written decision to the Parties. Any Party may appeal the Secretary's verification of the Certification Report through administrative and judicial processes.

C. There shall be a one-time deduction of five percent (5%) from the amount of ICS in the Year of its creation. This deduction results in additional water in storage in Lake Mead for future use in accordance with the Consolidated Decree, the Interim Surplus Guidelines, and the ROD. This provision shall not apply to:

1. System Efficiency ICS created pursuant to Article 2.3 of this Forbearance Agreement because a large portion of the water saved by this type of project will increase the quantity of water in storage.
2. Extraordinary Conservation ICS created by conversion of Tributary Conservation ICS that was not released in the Year created, pursuant to Article 2.1(E) of this Forbearance Agreement, because 5% of the ICS is deducted at the time the Tributary Conservation ICS is created.
3. Extraordinary Conservation ICS created by conversion of Imported ICS that was not released in the Year created, pursuant to Article 2.1(F) of this Forbearance Agreement, because 5% of the ICS is deducted at the time the Imported ICS is created.

D. In addition to the conditions described above, creation of Extraordinary Conservation ICS is subject to the following conditions:

1 Except as provided in Articles 2.2 and 2.4, Extraordinary Conservation ICS can only be created if such water would have otherwise been beneficially used.

2. The maximum total amount of Extraordinary Conservation ICS that can be created during any Year is limited to the following:
   a. 400,000 acre-feet for California Contractors;
   b. 125,000 acre-feet for Nevada Contractors; and
   c. 100,000 acre-feet for Arizona Contractors.
3. The maximum quantity of Extraordinary Conservation ICS that may be accumulated in all ICS Accounts, at any time, is limited to the following:
   a. 1,500,000 acre-feet for California Contractors;
   b. 300,000 acre-feet for Nevada Contractors; and
   c. 300,000 acre-feet for Arizona Contractors.
4. Except as provided in Articles 2.2 and 2.4, no category of surplus water can be used to create Extraordinary Conservation ICS.
5. The quantity of Extraordinary Conservation ICS remaining in an ICS Account at the end of each Year shall be diminished by annual

evaporation losses, as determined by the Secretary in consultation with the Lower Division States, provided that such losses shall not exceed three percent (3%). Losses shall be applied annually to the end-of-the-Year balance of Extraordinary Conservation ICS beginning in the Year after the ICS is created and continuing until no Extraordinary Conservation ICS remains in Lake Mead. No evaporation losses shall be assessed during a Year in which the Secretary has declared a shortage.

6. Extraordinary Conservation ICS from a project within a state may only be credited to the ICS Account of a Contractor within that state that has funded or implemented the project creating the ICS, or to the ICS Account of a Contractor within the same state as the funding entity and project and with written agreement of the funding entity.

2.6 Request for Release of ICS

A Contractor that has created ICS may request that the Secretary release its ICS subject to the following conditions:

A. If a Contractor has an overrun payback obligation, as described in the October 10, 2003 Inadvertent Overrun and Payback Policy or Exhibit C to the October 10, 2003 Colorado River Water Delivery Agreement, the Contractor must pay the overrun payback obligation in full before requesting or receiving a release of any ICS. The Contractor may request that the amount of ICS in the Contractor's ICS Account be reduced by the amount of the overrun payback obligation in order to pay the overrun payback obligation.

B. ICS shall only be released pursuant to an ICS Declaration.

C. In addition to the conditions described above, a Contractor's request for release of Extraordinary Conservation ICS is subject to the following conditions:

1. The total amount of Extraordinary Conservation ICS that may be released in any Year is limited to the following:
   a. 400,000 acre-feet for California Contractors;
   b. 300,000 acre-feet for Nevada Contractors; and
   c. 300,000 acre-feet for Arizona Contractors;
2. If the May, 24-month study for that Year indicates that a shortage condition would be declared in the succeeding Year if the requested amounts for the current Year under Article 2.6 were released, the Secretary may release less than the amounts of ICS requested to be released.
3. If the Secretary releases Flood Control Surplus water, Extraordinary Conservation ICS accumulated in ICS Accounts shall be reduced by the amount of the Flood Control Surplus on an acre-foot for acre-foot basis until no Extraordinary Conservation ICS remains. The reductions to the ICS Accounts shall be shared on a pro-rata basis among all Contractors that have accumulated Extraordinary Conservation ICS unless otherwise agreed to by the Contractors.

2.7 Additional Terms Regarding Creation and Release of ICS

It is the specific intent of the Parties that the terms, conditions and procedures regarding the creation and release of ICS contained in this Article 2 will be applied in conformance with additional terms, conditions and procedures governing the creation and release of ICS contained in the Delivery Agreement.

Article 3

Forbearance

3.1 In the absence of forbearance, surplus water is apportioned for use according to the percentages provided in Article II(B)(2) of the Consolidated Decree. The Parties respectively agree as follows:

13

A. ADWR hereby forbears:

1. Any right the State of Arizona may have to delivery of any ICS released in accordance with the terms and conditions set forth in this Forbearance Agreement and the Delivery Agreement for use within the State of California or the State of Nevada.

2. Any right the State of Arizona may have to the release and delivery of water for direct delivery domestic use to entities in California or Nevada under a Domestic Surplus as described in the Delivery Agreement and the ROD.

B. PVID, IID, CVWD, the City of Needles and MWD hereby forbear:

1. Any right they may have to delivery of any ICS released in accordance with the terms and conditions set forth in this Forbearance Agreement and the Delivery Agreement for use within the State of Arizona or the State of Nevada.

2. Any right they may have to the release and delivery of water for direct delivery domestic use to entities in Arizona or Nevada under a Domestic Surplus as described in the Delivery Agreement and the ROD.

C. SNWA and CRCN hereby forbear:

1. Any right SNWA or the State of Nevada may have to delivery of any ICS released in accordance with the terms and conditions set forth in this Forbearance Agreement and the Delivery Agreement for use within the State of Arizona or the State of California.

2. Any right SNWA or the State of Nevada may have to the release and delivery of water for direct delivery domestic use to entities in Arizona or California under a Domestic Surplus as described in the Delivery Agreement and the ROD.

3.2 Notwithstanding the foregoing forbearance of ICS, the Parties only forbear with respect to ICS that is created pursuant to exhibits attached to and incorporated within this Forbearance Agreement. This Forbearance Agreement incorporates Exhibits A through ___as of the date of execution. Additional exhibits may be

14

added to this Forbearance Agreement after written approval of all of the Parties. Such approval shall not be unreasonably withheld.

3.3 The Parties do not forbear any right to the release or delivery of any water that is not described in Article 3.1.

3.4 Forbearance of all Parties is conditioned on the following:

A. The execution, by all of the Parties and the Secretary, of a Delivery Agreement that will be a companion to this Forbearance Agreement.

B. The adoption by the Secretary of a ROD implementing an ICS program in substantial conformance with the provisions of this Forbearance Agreement and its companion Delivery Agreement.

C. The continued implementation of an ICS program that is in substantial conformance with this Forbearance Agreement and its companion Delivery Agreement, including:

1. The availability of the verification and appeal process described in Article 2.5(B);
2. The establishment and use of an ICS accounting procedure by the Secretary consistent with this Forbearance Agreement and the Delivery Agreement;
3. The Secretary's annual declaration of Normal, Surplus (other than Quantified Surplus), or Shortage conditions based on conditions in Lake Mead with consideration of the amount of ICS accumulated by the Parties. The determination of the amount of Quantified Surplus shall not include the volume of accumulated Extraordinary Conservation ICS; and
4. The termination of Partial Domestic Surplus as defined in the Record of Decision dated January 16, 2001, upon issuance of the ROD.

Article 4

General Provisions

4.1 The records of any Party to this Forbearance Agreement that relate to the creation of ICS shall be open to inspection by any other Party.

4.2 The Parties to this Forbearance Agreement are hereby notified of A.R.S. § 38-511.

4.3 The Parties agree to comply with all applicable federal or state laws relating to equal opportunity and non-discrimination.

4.4 Except as provided in Article 3, including additional exhibits agreed upon by the Parties pursuant to Article 3.2, nothing in this Forbearance Agreement shall be deemed to diminish or waive the rights of any Party. The failure of any Party to enforce a provision of this Forbearance Agreement shall not be deemed to constitute a waiver of that provision. The execution of, and forbearance in compliance with, this Forbearance Agreement shall not be admissible against any Party in any action except for an action to enforce the terms of this Forbearance Agreement or the companion Delivery Agreement.

4.5 No Party to this Forbearance Agreement shall be considered to be in default in the performance of any obligations under this Forbearance Agreement when a failure of performance shall be due to uncontrollable forces. The term "uncontrollable force" shall mean any cause beyond the control of the party unable to perform such obligation, including but not limited to failure or threat of failure of facilities, flood, earthquake, storm, fire, lightning, and other natural catastrophes, epidemic, war, civil disturbance or disobedience, strike, labor dispute, labor or material shortage, sabotage, restraint by order of a court or regulatory agency of competent jurisdiction, and action or non-action by, or failure to obtain the necessary authorizations or approvals from, a federal governmental agency or authority, which by exercise of due diligence and foresight such party could not reasonably have been expected to overcome. Nothing contained herein shall be construed to require any party to settle any strike or labor dispute in which it is involved.

Article 5

Notices

5.1 Notices and Requests

A. All notices and requests required or allowed under the terms of this Forbearance Agreement shall be in writing and shall be mailed first class postage paid to the following entities at the following addresses:

CRCN:
Colorado River Commission of Nevada
555 E. Washington Ave., Suite 3100
Las Vegas, NV 89101
Attn: Executive Director, Colorado River Commission

SNWA:
Southern Nevada Water Authority
1001 S. Valley View Boulevard
Las Vegas, NV 89153
Attn: General Manager

PVID:
Palo Verde Irrigation District
180 West 14th Avenue
Blythe, CA 92225
Attn: General Manager

IID:

Imperial Irrigation District
333 E. Barioni Boulevard
Imperial, CA 92251
Attn: General Manager

CVWD:
Coachella Valley Water District
P. O. Box 1058
Coachella, CA 92236
Attn: General Manager/Chief Engineer

City of Needles:
City of Needles
817 Third Street
Needles, CA 92363-2933
Attention: City Manager

MWD:
The Metropolitan Water District of Southern California
700 North Alameda Street
Los Angeles, CA 90012
Attn: General Manager

State of California:
Colorado River Board of California
770 Fairmont Avenue, Suite 100
Glendale, CA 91203-1068
Attn: Executive Director

State of Arizona:
Arizona Department of Water Resources

3550 North Central Avenue
Phoenix, AZ 85012
Attn: Director

B. Any Party may, at any time, change its mailing address by notice to the other Parties.

5.2 Notices and Requests by Facsimile

A. Notices and requests may be given by facsimile among the Parties in lieu of first class mail as provided in Article 5.1. Such facsimiles shall be deemed complete upon a receipt from the sender's facsimile machine indicating that the transmission was satisfactorily completed and after phone communication with administrative offices of the recipient notifying the recipient that a facsimile has been sent.

B. The facsimile numbers of the entities listed in Article 5.1(A) are as follows:

State of Arizona:	(602) 771-8681 (Attn: Director)
SNWA	
CRCN	(702) 486-2670 (Attn: Executive Director, Colorado River Commission)
PVID	(760) 922-8294 (Attn: General Manager)
IID	(760) 339-9392 (Attn: General Manager)
CVWD	(760) 398-3711 (Attn: General Manager/Chief Engineer)
City of Needles	
MWD	(213) 217-5704 (Attn: General Manager)
CRB	(818) 543-4685 (Attn: Executive Director)

C. Any Party may, at any time, change its facsimile number by notice to the other Parties.

In Witness of this Forbearance Agreement, the Parties affix their official signatures below, acknowledging execution of this document on the ________ day of _________________, 2007.

Attest:

THE STATE OF ARIZONA acting through the ARIZONA DEPARTMENT OF WATER RESOURCES

By: ______________________________
Title

By: _________________________________
Director

Approved as to form:

By: ______________________________
Title

Attest:

PALO VERDE IRRIGATION DISTRICT

By: ______________________________
General Manager

By: _________________________________
Chair

Approved as to form:

By: ______________________________
Title

20

Attest:	IMPERIAL IRRIGATION DISTRICT
By: ______________________________ General Manager	By: ______________________________ Chair
Approved as to form:	
By: ______________________________ Title	
Attest:	THE CITY OF NEEDLES
By: ______________________________ Title	By: ______________________________ City Manager
Approved as to form:	
By: ______________________________ Title	
Attest:	COACHELLA VALLEY WATER DISTRICT
By: ______________________________ General Manager	By: ______________________________ Chair
Approved as to form:	
By: ______________________________	

Attest:	THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
By: ____________________ Title	By: ____________________ General Manager
Approved as to form:	
By: ____________________ Title	
Attest:	SOUTHERN NEVADA WATER AUTHORITY
By: ____________________ Executive Director	By: ____________________ Chair
Approved as to form:	
By: ____________________ Title	
Attest:	THE COLORADO RIVER COMMISSION OF NEVADA
By: ____________________ Title	By: ____________________ Chair

Approved as to form:

By: ______________________________
Title

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Attachment D

Shortage Sharing Agreement between Arizona and Nevada

This attachment to Appendix J contains the text of Attachment D to the Revised Basin States' Proposal.

ATTACHMENT D

Arizona-Nevada Shortage-Sharing Agreement

This Agreement is entered into among the Arizona Department of Water Resources ("Arizona"), the Arizona Water Banking Authority ("AWBA"), the Colorado River Commission of Nevada ("CRC") and the Southern Nevada Water Authority ("SNWA"). For convenience, Arizona, AWBA, CRC and SNWA are at times herein referred to individually as "Party" and collectively as "Parties" and CRC and SNWA are referred to as "Nevada".

Preamble

The 1944 Mexican Water Treaty, the 1964 U.S. Supreme Court Decree in *Arizona v. California*, and the 1968 Colorado River Basin Project Act authorize and guide the Secretary of the Interior ("Secretary") in the determination of water deliveries to the Republic of Mexico and from the mainstream of the Colorado River within the Lower Basin during shortage conditions. However, there remain significant differences of opinion between Arizona and Nevada regarding how much water would be delivered to each state within the Lower Colorado River Basin during a shortage declared by the Secretary. Arizona and Nevada have now, therefore, agreed on how Secretarial shortage declarations of up to 500,000 acre-feet within the United States would be shared between them during an Interim Period. This Agreement is conditioned upon the inclusion of all material terms from the *Seven Basin States' Preliminary Proposal Regarding Colorado River Interim Operations* (Seven States' Proposal) that was forwarded to the Secretary on February 3, 2006, as it may be modified, within the Record of Decision for *Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions* ("Record of Decision"). If shortage declarations within the United States exceed 500,000 acre-feet, the Secretary would consult with representatives from the seven Colorado River Basin states before allocating additional shortage reductions. That consultation would be initiated anytime that the water surface elevation of Lake Mead is at or below water surface elevation 1025 feet.

AGREEMENT

Now, therefore, based upon the mutual covenants and promises contained herein, the receipt and sufficiency of which are hereby acknowledged, the Parties hereto do agree as follows:

1. Definitions:

a. Interim Period. The period beginning on the date the Secretary issues a Record of Decision and ending on December 31, 2025 (through preparation of the 2026 Annual Operating Plan).

b. Shortage. Any shortage within the United States declared by the Secretary pursuant to Article II(B)(3) of the Decree during the Interim Period.

1

2. Reduction in Mexican Deliveries. The Parties have entered into this Agreement based on the presumption that the United States will reduce deliveries to Mexico as described in the Seven States' Proposal. In the event that the United States does not reduce deliveries to Mexico in accordance with paragraph (3)(F)(5) of the Seven States' Proposal, the Parties have agreed only to the shortage allocations described in Section 3 of this Agreement.

3. Shortage Sharing Between Arizona and Nevada. During the Interim Period the Parties agree that shortages shall be allocated between Arizona and Nevada in the following quantities:

A. In years when Lake Mead content is projected on January 1 to be at or below elevation 1075 ft. and at or above 1050 ft., then Nevada's share of the shortage within the United States shall equal 13,000 acre-feet and Arizona's share of the shortage within the United States shall equal 320,000 acre-feet.

B. In years when Lake Mead content is projected on January 1 to be below elevation 1050 ft. and at or above 1025 ft., then Nevada's share of the shortage within the United States shall equal 17,000 acre-feet and Arizona's share of the shortage within the United States shall equal 400,000 acre-feet.

C. In years when Lake Mead content is projected on January 1 to be below 1025 ft., then Nevada's share of the shortage within the United States shall equal 20,000 acre-feet and Arizona's share of the shortage within the United States shall equal 480,000 acre-feet.

4. Agreement Limited to Maximum Shortage Volume of 500,000 Acre-feet Within the United States. This Agreement and the Parties relative obligations hereunder are specifically limited to a maximum shortage volume of 500,000 acre-feet within the United States in any year during the Interim Period. Should Lower Basin total shortage volume exceed 500,000 acre-feet within the United States, then the Parties will consult with the Secretary concerning shortage sharing beyond 500,000 acre-feet within the United States.

5. Shortage Assistance. For the purpose of assisting Arizona in offsetting impacts from shortages that may occur during the Interim Period, SNWA agrees to provide to the Arizona Water Banking Authority the sum of $8,000,000.00 (Eight Million Dollars) ("the Funds"). The Arizona Water Banking Authority will use the Funds to purchase and/or store water supplies. This sum shall be paid to Arizona within 60 days of the date the Secretary issues a Record of Decision, unless otherwise agreed in writing by the SNWA and Arizona. Neither the payment nor the use of the Funds are conditioned on the occurrence of a shortage during the Interim Period, and the Funds shall be nonrefundable.

6. Condition Precedent to Effectiveness of Agreement. The Parties agree, as an express condition precedent to the effectiveness and enforceability of this Agreement,

that the Secretary must issue a Record of Decision that is consistent with all material terms included in the Seven States' Proposal, including this Agreement, by July 1, 2008, unless otherwise agreed to in writing by the Parties. If such condition precedent does not occur by the date set forth herein or as extended or modified by written agreement of the Parties, this Agreement shall be of no force or effect among the Parties.

7. Nevada's Use of Tributary Conservation Water and Nevada State Groundwater During Declared Shortage Condition. The Parties anticipate that following the issuance of the Record of Decision, Nevada will be able to create Intentionally Created Surplus ("ICS") by introducing into the Colorado River mainstream Nevada State Groundwater ("Imported ICS") and Virgin and Muddy River water pursuant to Nevada water rights that pre-date the Boulder Canyon Project Act ("Tributary Conservation ICS"). Pursuant to a mutually agreed upon forbearance agreement, the Secretary will deliver such ICS for municipal and industrial uses within Nevada. The Parties have agreed that the water that would be used to create Tributary Conservation ICS and Imported ICS during non-shortage years will be available during declared shortages. It is anticipated by the Parties that the Record of Decision will establish guidelines whereby the Secretary of Interior, through the Bureau of Reclamation, may enter into agreements to verify and deliver ICS to the party that created it.

Arizona agrees that if in any year, pursuant to Article II (B)(3) of the Decree, there is insufficient mainstream water available to satisfy the consumptive use of 7.5 maf in the lower division states, then Arizona will not object to the delivery by the Secretary to Nevada of water that would otherwise qualify for creation and release of Tributary Conservation ICS or Imported ICS during a non-shortage year nor otherwise claim a right to use such water in any form or fashion. Arizona's agreement not to object to any secretarial delivery of and Nevada's diversion of such water shall be binding on Arizona only to the extent that such delivery does not cause the total deliveries within the lower division states to exceed 7.5 maf in any year in which the Secretary has declared a shortage. Furthermore, Arizona's agreement is conditioned on application of the same provisions for verification that would apply to the creation of Tributary Conservation ICS or Imported ICS under the Seven States' Proposal.

8. Reservation of Rights. Notwithstanding the terms of this Agreement, in the event that for any reason this Agreement is terminated, or that the term of this Agreement is not extended, or upon the withdrawal of any Party from this Agreement, the Parties reserve, and shall not be deemed to have waived, any and all rights, including any claims or defenses, they may have as of the date hereof or as may accrue during the term hereof, including specifically the respective legal positions of Nevada and Arizona regarding how the delivery of water under a shortage declaration by the Secretary would be administered within the Lower Colorado River Basin and any other rights, claims or defenses under any existing federal or state law or administrative rule, regulation or guideline, including without limitation the Colorado River Compact, the Decree in *Arizona v. California* (the "Decree"), the Colorado River Basin Project Act of 1968, and any other applicable provision of federal law, rule, regulation, or guideline.

In Witness of this Agreement, the Parties affix their official signatures below, this 9th day of February, 2007.

Herbert R. Guenther
Director
Arizona Department of Water Resources

Herbert R. Guenther
Chairman
Arizona Water Banking Authority

Richard Bunker
Chairman
Colorado River Commission of Nevada

Patricia Mulroy
General Manager
Southern Nevada Water Authority

4

J.2 Preliminary Proposal - Letter to Secretary of the Interior

**The States of Arizona, California, Colorado, Nevada,
New Mexico, Utah and Wyoming
Governor's Representatives on Colorado River Operations**

February 3, 2006

Honorable Gale A. Norton, Secretary
Department of the Interior
1849 C. Street, NW
Washington, D.C. 20240

Re: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for the Operation of Lake Mead and Lake Powell Under Low Reservoir Conditions

Dear Secretary Norton:

The materials attached to this letter contain descriptions of the programs that the seven Colorado River Basin States suggest be included within the scope of the environmental impact statement (EIS) for the proposed *Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions* (70 Fed. Reg. 57322) (Sept. 30, 2005).

The Basin States, Bureau of Reclamation and others have consulted regularly since our previous correspondence on August 25, 2005 to further discuss and refine recommended management strategies for the Colorado River system. Subsequently, individual entities within the seven Basin States submitted oral and written comments to the Bureau of Reclamation on the above-referenced EIS process. Attachment A, "Seven Basin States' Preliminary Proposal Regarding Colorado River Interim Operations," is submitted as a consensus document on behalf of the seven Basin States. Please recognize that the States are still actively working on the matters addressed in this submission and anticipate further refinement.

Our recommendation is designed to provide input for the Department's consideration as it develops additional operational and water accounting procedures to: 1) delay the onset and minimize the extent and duration of shortages in the Lower Division States; 2) maximize the protection afforded the Upper Division States by storage in Lake Powell against possible curtailment of Upper Basin uses; 3) provide for more efficient, flexible, responsive and reliable operation of the system reservoirs for the benefit of both the Upper and Lower Basins by developing additional system water supplies through extraordinary conservation, system efficiency and augmentation projects; 4) allow the continued development and use of the Colorado River resource in both the Upper and Lower Basins; and 5) allow for development of dedicated water supplies through participation in improvements to system efficiency and clarification of how to proceed with development of non-system water reaching the Lower Basin

S-2006

The Honorable Gale A. Norton
February 3, 2006
Page 2 of 3

mainstream. It is our position that implementation of these operational and accounting procedures can be accomplished without modification of the Long Range Operating Criteria or other elements of the law of the river.

The States' attached proposal incorporates an approach to shortage management. Additionally, the proposal includes modification and extension of the Department's Interim Surplus Guidelines to incorporate operations for all reservoir conditions.

The attached proposal also addresses the States' recommended approach to implementation of shortages pursuant to the U.S.-Mexico Treaty of 1944. We request that the Department of the Interior initiate, at the earliest appropriate time, consultation with the U.S. Section of the International Boundary and Water Commission and the U.S. Department of State on implementation of Treaty shortages. We further request the opportunity to consult with Interior and State Department officials on this issue as the federal government formulates its approach to any bi-national consultation with Mexico.

An agreement between Basin State water managers and users will be necessary to put in place additional terms upon which they have reached common understanding. We intend that this agreement be finalized while Reclamation is preparing the draft EIS, and be executed as soon as practicable. We are including with this letter a draft version of the agreement (Attachment B), to memorialize our current understandings and to provide you the benefits of our thoughts at this time. As with Attachment A, please recognize that the parties are still actively working on the matters addressed in Attachment B, and contemplate additional development and refinement of the agreement. We recognize that timely execution of our agreement is necessary in order to allow funding of certain efficiency projects to go forward.

During the time Reclamation is preparing the draft EIS, the States will move forward with a package of other actions that include implementation of a demonstration program for extraordinary conservation in 2006, system efficiency projects, preparation of an action plan for system augmentation through weather modification, execution of a memorandum of understanding for preparing a Lower Division States interstate drought management plan, development of forbearance agreements among the Lower Division States and the initiation of a study for long-term augmentation of Colorado River system water supplies. The States have already begun the consultant procurement process to support the long-term augmentation study, and intend to complete a weather modification action plan and a memorandum of understanding for interstate drought planning as soon as practicable. The Basin States recognize that Reclamation is undertaking NEPA compliance separately to determine whether to construct a regulating reservoir near Drop 2 of the All-American Canal and urge swift completion of that process.

We appreciate the opportunity you have provided for the Colorado River Basin States to recommend to you a program of reservoir management that considers all their respective concerns and interests. The Basin States look forward to working with you and Reclamation in analyzing and addressing these matters.

S-2006

The Honorable Gale A. Norton
February 3, 2006
Page 3 of 3

Sincerely,

Herb Guenther
Director
Arizona Department of Water Resources

Gerald R. Zimmerman
~~Executive Director~~
Colorado River Board of California

Scott Balcomb
Governor's Representative
State of Colorado

Rod Kuharich
Director
Colorado Water Conservation Board

Richard Bunker
Chairman
Colorado River Commission of Nevada

Patricia Mulroy
General Manager
Southern Nevada Water Authority

John R. D'Antonio, Jr.
Governor's Representative
State of New Mexico

Patrick Tyrrell
State Engineer
State of Wyoming

D. Larry Anderson
Director
Utah Division of Water Resources

List of Attachments:

Attachment A: Seven Basin States' Preliminary Proposal Regarding Colorado River Interim Operations

Attachment B: Draft Agreement

S-2006

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Attachment A

Preliminary Proposal Regarding Colorado River Interim Operations

This attachment to Appendix J contains the text of Attachment A to the Preliminary Basin States' Proposal.

ATTACHMENT A
Seven Basin States' Preliminary Proposa Regarding Colorado River Interim Operations

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The Seven Basin States (States) have worked together to recommend interim operations to the Secretary that should minimize shortages in the Lower Basin and avoid the risk of curtailment in the Upper Basin through conservation, more efficient reservoir operations, and long-term alternatives to bring additional water into the Colorado River community.

The States' recommendation has three key elements. First, the States propose to manage the reservoirs to minimize shortages and avoid curtailments. Second, the States have identified actions in the Lower Basin to conserve water. Third, the States recommend a specific proposal for implementing shortages in the Lower Basin. Finally, the States recognize the need for additional water supplies to meet the current and future needs in the Basin.

Section 1. Allocation of Unused Basic Apportionment Water under Article II(B)(6)

A. Introduction

Article II(B)(6) of the 1964 Decree in *Arizona* v. *California* (Decree) allows the Secretary to allocate water that is apportioned to one Lower Division State, but is for any reason unused in that State, to another Lower Division State. This determination is made for one year only and no rights to recurrent use of the water accrue to the State that receives the allocated water.

B. Application of Unused Basic Apportionment

Before making a determination of a surplus condition under this proposal, the Secretary will determine the quantity of apportioned but unused water under Article II (B)(6), and will allocate such water in the following order of priority.

1. Meet the direct delivery domestic use requirements of the Metropolitan Water District of Southern California, (MWD) and the Southern Nevada Water Authority (SNWA), as allocated between them by agreement.

2. Meet the needs of off stream banking activities by MWD in California and SNWA in Nevada, as allocated between them by agreement.

3. Meet the other needs for water in California in accordance with the California Seven-Party Agreement as supplemented by the Quantification Settlement Agreement.

Section 2. Coordinated Operation of Lakes Powell and Mead

Figure 1 describes the operating strategy that has been agreed to by the Colorado River Basin States.

S-2006

ATTACHMENT A
Seven Basin States' Preliminary Proposa Regarding Colorado River Interim Operations

Powell Elevation (feet)	Powell Operation	Powell Live Storage (maf)
3700		24.32
	Equalize or 8.23 maf	
3636 - 3664 (see table below)		15.54- 19.02 (2008 - 2025)
	8.23 maf; if Mead < 1075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	
3575		9.52
	7.48 maf 8.23 maf if Mead < 1025 f	
3525		5.93
	Balance contents with a min/max release of 7.0 and 9.5 maf	
3370		0

Lake Powell Equalization Elevation Table

In each of the following years, the Lake Powell Equalization Elevation will be as follows:

Year	Elevation (feet)
2008	3636
2009	3639
2010	3642
2011	3643
2012	3645
2013	3646
2014	3648
2015	3649
2016	3651
2017	3652
2018	3654
2019	3655
2020	3657
2021	3659
2022	3660
2023	3662
2024	3663
2025	3664

S-2006

ATTACHMENT A
Seven Basin States' Preliminary Proposa Regarding Colorado River Interim Operations

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1. Equalization: In years when Lake Powell content is projected on January 1 to be at or above the elevation stated in the Lake Powell Equalization Elevation Table, an amount of water will be released from Lake Powell to Lake Mead at a rate greater than 8,230,000 acre-feet per year to the extent necessary to equalize storage in the two reservoirs, or otherwise to release 8,230,000 acre-feet from Lake Powell.

2. Upper Elevation Balancing: In years when Lake Powell content is projected on January 1 to be below the elevation stated in the Lake Powell Equalization Elevation Table and at or above 3575 ft., the Secretary shall release 8,230,000 acre-feet from Lake Powell if the projected elevation of Lake Mead is at or above 1075 ft. If the projected elevation of Lake Mead is below 1075 ft., the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release no more than 9,000,000 acre-feet and no less than 7,000,000 acre-feet from Lake Powell.

3. Mid-Elevation Releases: In years when Lake Powell content is projected on January 1 to be below 3575 ft. and at or above 3525 ft., the Secretary shall release 7,480,000 acre-feet from Lake Powell if the projected elevation of Lake Mead is at or above 1025 ft. If the projected elevation of Lake Mead is below 1025 ft., the Secretary shall release 8,230,000 acre-feet from Lake Powell.

4. Lower Elevation Balancing: In years when Lake Powell content is projected on January 1 to be below 3525 ft., the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release no more than 9,500,000 acre-feet and no less than 7,000,000 acre-feet from Lake Powell.

Coordinated Operation of Lakes Powell and Mead as described herein will be presumed to be consistent with the Section 602(a) storage requirement contained in the Colorado River Basin Project Act.

The objective of the operation of Lakes Powell and Mead as described herein is to avoid curtailment of uses in the Upper Basin, minimize shortages in the Lower Basin and not adversely affect the yield for development available in the Upper Basin.

The August 24-month study projections for the January 1 system storage and reservoir water surface elevations, for the following year, would be used to determine the applicability of the coordinated operation of Lakes Powell and Mead.

Section 3. Determination of Lake Mead Operation during the Interim Period

A. Interim Surplus Guidelines

S-2006

ATTACHMENT A
Seven Basin States' Preliminary Proposa Regarding Colorado River Interim Operations

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1. The Basin States recommend that the Secretary continue to implement the Interim Surplus Guidelines (ISG) except as modified by this proposal, including the following:
   a. Partial Domestic Surplus would be discontinued upon issuance of the Record Of Decision ("ROD"); and

   b. The ISG effective period would be extended through December 31, 2025.

2. During the years 2017 through 2025 the Secretary shall distribute Domestic Surplus water:

   a. For use by MWD, 250,000 acre-feet per year in addition to the amount of California's basic apportionment available to MWD.

   b. For use by SNWA, 100,000 acre-feet per year in addition to the amount of Nevada's basic apportionment available to SNWA.

   c. For use in Arizona, 100,000 acre-feet per year in addition to the amount of Arizona's basic apportionment available to Arizona contractors.

B. Flood Control Surplus

In years in which the Secretary makes space building or flood control releases pursuant to the Field Working Agreement, the Secretary shall determine a Flood Control Surplus for the remainder of that year or the subsequent year as specified in Section 7 of the ISG. In such years, releases will be made to satisfy all beneficial uses within the United States, including unlimited off-stream banking. Intentionally Created Surplus credits, as defined herein, would be reduced by the amount of any flood control release, if necessary until no credits are remaining. Under current practice, surplus declarations under the Treaty for Mexico are declared when flood control releases are made. Operation under a Flood Control Surplus does not establish any determination relating to implementation of the Treaty, including any potential changes in approach relating to surplus declarations under the Treaty. Such determinations must be addressed in a bilateral fashion with the Republic of Mexico.

C. Quantified Surplus
(70R Strategy)

In years when the Secretary determines that water should be released for beneficial consumptive use to reduce the risk of potential reservoir spills based on the 70R Strategy, the Secretary shall determine and allocate Quantified Surplus sequentially as follows:

1. Establish the volume of the Quantified Surplus. For the purpose of determining the existence, and establishing the volume, of Quantified

S-2006

4

ATTACHMENT A
Seven Basin States' Preliminary Proposa Regarding Colorado River Interim Operations

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Surplus, the Secretary would not consider the volume of Intentionally Created Surplus credits, as defined herein.

2. Allocate and distribute the Quantified Surplus 50% to California, 46% to Arizona and 4% to Nevada, subject to 3. through 5. that follow.

3. Distribute California's share first to meet basic apportionment demands and MWD's demands. Then distribute to California Priorities 6 and 7 and other surplus contracts. Distribute Nevada's share first to meet basic apportionment demands and SNWA's demands. Distribute Arizona's share to surplus demands in Arizona including off stream banking and interstate banking demands. Arizona, California and Nevada agree that Nevada would get first priority for interstate banking in Arizona.

4. Distribute any unused share of the Quantified Surplus in accordance with Section 1, Allocation of Unused Basic Apportionment Water Under Article II (B)(6).

5. Determine whether MWD, SNWA and Arizona have received the amount of water they would have received under Section 3 D of this proposal, Domestic Surplus, if a Quantified Surplus had not been declared. If they have not, then determine and meet all demands provided for in Section 3 D, Domestic Surplus.

D. Domestic Surplus

In years when Lake Mead elevation is projected on January 1 to be above 1145 ft and below 70R Strategy elevation determination, the Secretary would determine a Domestic Surplus in accordance with Section 2(B)(2) of the ISG between the effective date of the ROD and December 31, 2016 and in accordance with Section 3(A) (2) of this proposal between January 1, 2017 and December 31, 2025.

E. Normal Conditions

In years when Lake Mead elevation is projected on January 1 to be above elevation 1075 ft. and below 1145 ft., the Secretary would determine a normal operating condition. In any year when Lake Mead elevations are in this range, the Secretary may determine that Intentionally Created Surplus ("ICS") as described in Section 4 of this proposal is available. ICS credits may then be delivered pursuant to the provisions of Section 4.

F. Shortage Conditions

Shortages would be implemented in the Lower Division States and Mexico under the following conditions and in the following manner:

1. 400,000 acre foot shortage: In years when Lake Mead content is projected on January 1 to be at or below elevation 1075 ft. and at or above 1050 ft.,

ATTACHMENT A
Seven Basin States' Preliminary Proposa Regarding Colorado River Interim Operations

a quantity of 400,000 acre-feet shall not be released or delivered in the Lower Division States and Mexico.

2. 500,000 acre foot shortage: In years when Lake Mead content is projected on January 1 to be below elevation 1050 ft. and at or above 1025 ft. a quantity of 500,000 acre-feet shall not be released or delivered in the Lower Division States and Mexico.

3. 600,000 acre foot shortage: In years when Lake Mead content is projected on January 1 to be below 1025 ft., a quantity of 600,000 acre-feet shall not be released or delivered in the Lower Division States and Mexico.

4. The three conditions described above are illustrated in Figure 2.

Figure 2

Lake Mead Step Shortage		
Mead Elevation (ft)	Stepped Shortage	Mead Live Storage
1075 to 1050	400 kaf	9.37 to 7.47 maf
<1050 to 1025	500 kaf	7.47 to 5.80 maf
<1025 to 1000	600 kaf	5.80 to 4.33 maf
<1000	Increased reductions to be consistent with consultation(s)	<4.33 maf

5. The United States, through the appropriate mechanisms, should implement a shortage pursuant to Article 10 of the 1944 Treaty in any year in which the Secretary has declared that a shortage condition exists pursuant to Art. II(B)(3) of the Decree. The total quantity of water that will not be released or delivered to Mexico shall be based on Lower Basin water deliveries during normal water supply conditions. The proportion of the shortage that shall be borne by Mexico will be 17% (1.5 maf / 9 maf x 100% = 17%).

6. Arizona and Nevada will share shortages based on a shortage sharing agreement. In the event that no agreement has been reached, Arizona and Nevada will share shortages in accordance with the 1968 Colorado River Basin Project Act, the Decree, other existing law as applicable, and the Interstate Banking Agreement between Arizona and Nevada parties.

7. Whenever Lake Mead reaches elevation1025 ft., the Secretary will consult with the States to determine whether Colorado River hydrologic conditions, together with the delivery of 8.4 million acre-feet of Colorado River water to Lower Basin users and Mexico, will cause the elevation of Lake Mead to fall below 1000 ft. Upon such a determination, the

Secretary shall consult with the states to discuss further measures that may be undertaken to avoid or reduce further increases in shortage determinations. If increased reductions are required, the Secretary shall implement the reductions consistent with the law of the river.

8. The States will evaluate factors at critical elevations that may avoid shortage determinations as reservoir elevations approach critical thresholds. The States may provide operational recommendations surrounding the critical elevations at some later date.

Section 4. System Efficiency, Extraordinary Conservation and Augmentation Projects

The States propose that the Secretary develop a policy and accounting procedure concerning augmentation, extraordinary conservation, and system efficiency projects, including specific extraordinary conservation projects, tributary conservation projects, introduction of non-Colorado River System water, system efficiency improvements and exchange of non-Colorado River System water. The accounting and recovery process would be referred to as "Intentionally Created Surplus" consistent with the concept that the States will take actions to augment storage of water in the Lower Colorado River Basin. The water would be distributed pursuant to Section II(B)(2) of the Decree and forbearance agreements between the States. The ICS credits may not be created or released without such forbearance agreements.

A. The purposes of the Lake Mead Intentionally Created Surplus ("ICS") program are to:

1. Help avoid shortages to the Lower Basin. For the purposes of determining calendar year declarations of Domestic Surplus, Normal and Shortage conditions, any ICS credits would be considered system water;

2. Benefit both Lake Mead and Lake Powell; and

3. Increase the surface elevations of both Lakes Powell and Mead to higher levels than would have otherwise occurred.

B. Extraordinary Conservation Storage Credits

1. Users of Colorado River water may create ICS credits through extraordinary conservation under the following conditions:

a. A Boulder Canyon Project Act Section 5 Contractor ("Contractor") shall repay all outstanding system payback obligations before it can create ICS credits.

b. ICS credits can only be created if such water could have otherwise been beneficially used.

S-2006

ATTACHMENT A
Seven Basin States' Preliminary Proposa Regarding Colorado River Interim Operations

c. A Contractor notifies Reclamation by September 15 of the amount of ICS credits it wishes to create for the subsequent year.

2. ICS credits may be created only through extraordinary conservation activities. These activities include:

a. Fallowing of land that currently is, historically was, and otherwise would have been in the next year, irrigated.

b. Canal lining programs

c. Desalination programs

d. Extraordinary conservation programs existing as of January 1, 2006

e. Other extraordinary conservation measures as agreed upon by the States

3. If conditions during the year change due to weather or other unforeseen circumstances, a Contractor may request a mid-year modification of its water order to reduce the amount of ICS credits created during that year. A Contractor cannot increase the amount of ICS credits it had previously scheduled to create during the year.

4. Any ICS credits would be used first to offset any overrun for that year or future year(s).

5. The maximum amount of ICS credits that can be created during any year through extraordinary conservation is limited to each state as listed below.

a. California: 400,000 acre-feet per year

b. Nevada: 125,000 acre-feet per year

c. Arizona: 100,000 acre-feet per year

6. The maximum cumulative amount of ICS credits created through extraordinary conservation that would be available at any one time is:

a. 1,500,000 acre-feet for California;

b. 300,000 acre-feet for Nevada; and

c. 300,000 acre-feet for Arizona.

7. No category of surplus water can be used to create ICS credits.

S-2006

ATTACHMENT A
Seven Basin States' Preliminary Proposa Regarding Colorado River Interim Operations

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8. At the time the ICS credits are created by extraordinary conservation, the Contractor will dedicate 5% of the ICS credits to the system on a one-time basis to provide a water supply benefit to the system. Additionally, ICS credits will be subject to annual evaporation loss (estimated to be no more than 3% annually) during each year in which no shortage has been declared. The Secretary will not assess any other charge for creating ICS credits.

9. Contractors that have created ICS credits may recover them under the following conditions:

   a. A Contractor may request delivery of ICS credits it has created at the time it submits its annual water order for the following year. The ICS credits would be added to the Contractor's approved water order for that year upon approval by Reclamation.
   b. The amount of ICS credits that may be recovered by California in any one year is limited to 400,000 acre-feet, by Nevada 300,000 acre-feet and Arizona 300,000 acre-feet; provided that the May 1, 24-month study for that year does not indicate that a shortage condition would be declared in the current or succeeding year.

   c. If extraordinary weather conditions or water emergencies occur, a Contractor may request that Reclamation increase its use of ICS credits for that year.

   d. A Contractor may request to reduce its use of ICS credits during the year for any reason, including reduction in water demands.

   e. If Reclamation releases water for flood control purposes, ICS credits shall be reduced on a pro-rata basis among all holders of ICS credits-- if necessary until no credits remain. In determining the amount of Quantified Surplus, Reclamation shall not consider the volume of ICS credits that will be available.

10. Contractors may begin to create ICS through extraordinary conservation 1) beginning in 2006 as a pilot program (which may be lost if the Secretary does not adopt an extraordinary conservation program as part of the Coordinated Operation of Lakes Powell and Mead) or 2) after adoption of the Coordinated Operation for Lakes Powell and Mead until 2025. Any ICS credits under this program remaining at the end of the program would remain available for recovery for up to 10 years following termination of the Program.

C. Tributary Conservation

The Secretary should develop procedures in consultation with the States that would permit Contractors to purchase and fallow annual or permanent water rights on tributaries within the Lower Division States that have been used for a significant period of years and were created prior to Congress' adoption of the Boulder Canyon Project Act that, when retired, and verified by the Secretary, contribute water to the Colorado River mainstream for diversion by the Contractor. The water recovered by the Contractor may be used for municipal and industrial purposes only. This water would be in addition to the State's basic apportionment and would be available during declared shortages.

It is intended that the water would be taken on a real-time basis and that not more than 95% of such water will be recovered; however, if storage were required, such stored water would be subject to all provisions applicable to ICS credits created through extraordinary conservation.

D. System Efficiency Projects

A Contractor may make contributions of capital to the Secretary for use in Secretarial projects designed to realize efficiencies that save water that would otherwise be lost from the Colorado River System in the United States. The Secretary in consultation with the States will identify system efficiency projects, terms for capital participation in such projects, and types and amounts of benefits the Secretary would provide in consideration of non-federal capital contributions to system efficiency projects, including a portion of the water saved by the project. Water made available to Contractors by the Secretary would be considered Intentionally Created Surplus. System efficiency projects are only intended to provide temporary water supplies and would not be available for permanent use.

Benefits to the total water available within the Colorado River System in the United States should be substantial, taking into account any benefit provided to any non-federal capital contributor. In those cases in which benefits are provided to a non-federal capital contributor in the form of a portion of the water saved by the system efficiency project, the water provided to the capital contributor should be characterized as Colorado River surplus water intentionally created by the system efficiency project. The ICS credits should be provided to the capital contributor pursuant to its BCPA § 5 surplus contract. The Secretary should first obtain the waiver or forbearance of any other BCPA § 5 surplus contractor(s) that may possess any right to the delivery of the same water, so that the Secretary may deliver it to the capital contributor pursuant to Article II (B)(6) of the Decree. The ICS credits should be provided to the capital contributor on a predetermined schedule of annual deliveries for a period of years as agreed by the Secretary and Contractor. The ICS credits would not be stored, and therefore would not spill from system reservoirs. Delivery of ICS credits during shortage conditions will be determined on a project-by-project basis.

E. Introduction and Recovery of Non-Colorado River System Water

The Secretary should develop procedures, in consultation with the States, that would prospectively allow non-Colorado River System water in a Lower Division State to be introduced into, conveyed through, and diverted from system reservoirs, or otherwise through the Colorado River System. The non-Colorado River System water may be

ATTACHMENT A
Seven Basin States' Preliminary Proposa Regarding Colorado River Interim Operations

introduced either (1) directly from the non-Colorado River System source, or (2) as effluent resulting from use of the non-Colorado River System water in the introducing entity's service area, assuming water quality concerns are adequately addressed by the Contractor introducing the water. This water is in addition to a state's basic apportionment and may be used during declared shortages.

Contractors proposing to introduce, convey and recover such non-Colorado River System water should make sufficient arrangements, contractual or otherwise, with the Secretary so as to guarantee that any such action causes no harm to the Secretary's management of the Colorado River System. Such arrangements would provide that the introduction, conveyance and recovery of such water be done pursuant to appropriate permits or other authorizations as required by state law, that the actual amount of water introduced, conveyed and recovered would be reported to the Secretary on an annual basis, and that no more than 95% of such water introduced will be recovered. The non-Colorado River System water would be intended to be taken on a real-time basis, and hence would not spill from system reservoirs. However, if storage were required such stored water would be subject to all provisions applicable to ICS created through extraordinary conservation. Any agreements made with the Secretary to introduce and recover this water will survive the termination of the Coordinated Operations of Lakes Powell and Mead.

Weather modification projects should be pursued as a means of augmenting Colorado River System water supplies. However, increases in water supply that result from weather modification projects are not included within the projects defined in this Section and would not create any additional supply for a Contractor or State that engages in a weather modification project.

Section 5. Non-Colorado River System Water Exchanges

Contractors in Arizona, California, or Nevada may secure an additional water supply by funding the development of a non-Colorado River System water supply in one Lower Division State for use in another State by exchange. The new water supply developed would be consumptively used in the State in which it was developed by a Contractor and that Contractor would intentionally reduce its consumptive use of Colorado River water. This would allow the Contractor(s) in the other Lower Division State(s) that provided the funding to consumptively use the Colorado River water that was intentionally unused through an agreement with the Secretary of the Interior. Through the cooperation of the International Boundary and Water Commission, United States and Mexico, similar agreements could be established by which non-Colorado River System water supplies in Mexico could be developed for use in the United States by exchange.

It could be necessary for a State or other lower priority Contractors in the State in which consumptive use was intentionally reduced to agree to forebear their use of such water depending on the then-existing priority system to use of Colorado River water, to avoid a claim against the water being delivered to the Contractor that funded the new water supply. As an alternative to forbearance, an offer by the Contractor developing the non-Colorado River System water to allow the lower priority Contractor to pay the cost of developing a portion or all of the non-

ATTACHMENT A
Seven Basin States' Preliminary Proposa Regarding Colorado River Interim Operations

Colorado River System water supplies to be developed, would be utilized to protect such a lower priority Contractor's position in the then-existing priority system. A refusal of an offer to pay the cost of developing a portion or all of the non-Colorado River System water supplies to be developed would constitute the lower-priority Contractor's waiver of a right to challenge the exchange.

Section 6. Accounting Mechanisms

The operating alternatives discussed in Sections 4 and 5 will require new or modified Colorado River accounting mechanisms. No specific accounting mechanism to allow these types of operations is proposed for evaluation in Reclamation's current NEPA process. However, the description and evaluation of such accounting mechanisms would provide Contractors with the assurance that if such accounting mechanism were adopted in the Record of Decision, funds spent to propose such an arrangement in the future would not be spent in vain.

Section 7. Effective Period

The proposed interim operations will be in effect 30 days from the publication of the Secretary's Record of Decision in the Federal Register. The proposed interim operations will, unless subsequently modified, remain in effect through December 31, 2025 (through preparation of the 2026 AOP), subject to a formal review of their effectiveness beginning no later than 2020.

Attachment B

Draft Agreement

This attachment to Appendix J contains the text of Attachment B to the Preliminary Basin States' Proposal.

ATTACHMENT B DRAFT AGREEMENT

AGREEMENT

The [name parties] hereby enter into this Agreement effective as of ______________.

RECITALS

A. Parties.

1. Arizona

   a. The Arizona Department of Water Resources, through its Director, is the successor to the signatory agency of the State for the 1922 Colorado River Compact, and the 1944 Contract for Delivery of Water with the United States, both authorized and ratified by the Arizona Legislature, A.R.S. §§ 45-1301 and 1311. Pursuant to A.R.S. §§ 45-107, the Director is authorized and directed, subject to the limitations in A.R.S. §§ 45-106, for and on behalf of the State of Arizona, to consult, advise and cooperate with the Secretary of the Interior of the United States with respect to the exercise by the Secretary of Congressionally authorized authority relative to the waters of the Colorado River (including but not limited to the Boulder Canyon Project Act, 43 U.S.C. § 617, and the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1501) and with respect to the development, negotiation and execution of interstate agreements. Additionally, under A.R.S. § 45-105(A)(9), the Director is authorized to "prosecute and defend all rights, claims and privileges of this state respecting interstate streams."

   b. Under A.R.S. § 11-951 *et. seq.*, the Director is authorized to enter into Intergovernmental Agreements with other public agencies, which includes another state; departments, agencies, boards and commissions of another state; and political subdivisions of another state.

2. California. The chairman of the Colorado River Board of California, acting as the Colorado River Commissioner pursuant to California Water Code section 12525, has the authority to exercise on behalf of California every right and power granted to California by the Boulder Canyon Project Act, and to do and perform all other things necessary or expedient to carry out the purposes of the Colorado River Board.

3. Colorado

   a. Section 24-1-109, Colorado Revised Statutes (2005) provides that "Interstate compacts authorized by law shall be administered under the direction of the office of the governor." This includes the Colorado River Compact and the Upper Colorado River Basin Compact. Section 37-60-109 provides that "the governor from time to time, with approval of the

1

S-2006

board, shall appoint a commissioner, who shall represent the state of Colorado upon joint commissions to be composed of commissioners representing the state of Colorado and another state or other states for the purpose of negotiating and entering into compacts or agreements between said states…" By Executive Order _____, issued __________, 2006, attached hereto as Exhibit _______ and incorporated herein by reference, the Governor appointed Upper Colorado River Commissioner Scott Balcomb to represent the State of Colorado.

b. Section 37-60-106, subsections (e) and (i), C.R.S. (2005), authorize the Colorado Water Conservation Board to "cooperate with the United States and the agencies thereof, and with other states for the purpose of bringing about the greater utilization of the water of the state of Colorado and the prevention of flood damages," and "to confer with and appear before the officers, representatives, boards, bureaus, committees, commissions, or other agencies of other states, or of the federal government, for the purpose of protecting and asserting the authority, interests, and rights of the state of Colorado and its citizens with respect to the waters of the interstate streams in this state." By resolution dated ______________, attached hereto as Exhibit __, and incorporated herein by reference, the Colorado Water Conservation Board authorized and directed its Director to negotiate with and enter into agreements with other state entities within the Colorado River Basin.

4. Nevada

a. The Colorado River Commission of the State of Nevada (CRCN) is an agency of the State of Nevada, authorized generally by N.R.S. §§ 538.041 and 538.251. CRCN is authorized by N.R.S. § 538.161 (6), (7) to enter into this Agreement. The CRCN, in furtherance of the State of Nevada's responsibility to promote the health and welfare of its people in Colorado River matters, makes this Agreement to supplement the supply of water in the Colorado River which is available for use in Nevada, augment the waters of the Colorado River, and facilitate the more flexible operation of dams and facilities by the Secretary of the Interior of the United States. The Chairman of the Commission, signatory hereto, serves as one of the Governor's representatives as contemplated by Section 602(b) of the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1552(b) and the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act.

b. The Southern Nevada Water Authority (SNWA) is a Nevada joint powers agency and political subdivision of the State of Nevada, created by agreement dated July 25, 1991, as amended November 17,1994 and January 1,1996, pursuant to N.R.S. §§ 277.074 and 277.120. SNWA is authorized by N.R.S. § 538.186 to enter into this Agreement and, pursuant

286 U.S. 494 (1922). *See Hinderlider v. La Plata River & Cherry Creek Ditch Co.,* 304 U.S. 92 (1938). In signing this Agreement, the State Engineer intends that this Agreement be mutually and equally binding between the Parties.

B. Background

1. Federal law and practice (including Section 602(b) of the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1552(b), and the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act), contemplate that in the operation of Lakes Powell and Mead, the Secretary of the Interior consults with the States through Governors' Representatives, who represent the Governors and their respective States. Through this law and practice, the Governors' Representatives have in the past reached agreements among themselves and with the Secretary on various aspects of Colorado River reservoir operation. This Agreement is entered into in furtherance of this law and practice.

2. On January 16, 2001, the Secretary adopted Colorado River Interim Surplus Guidelines (ISG) based on an alternative prepared by the Colorado River Basin States, for the purposes of determining annually the conditions under which the Secretary would declare the availability of surplus water for use within the states of Arizona, California and Nevada in accordance with and under the authority of the Boulder Canyon Project Act of 1928 (45 Stat. 1057) and the Decree of the United States Supreme Court in *Arizona v. California*, 376 U.S. 340 (1964). The ISG are effective through calendar year 2015 (through preparation of the 2016 Annual Operating Plan).

3. In the years following the adoption of the ISG, drought conditions in the Colorado River Basin caused a significant reduction in storage levels in Lakes Powell and Mead, and precipitated discussions by and among the Parties, and between the Parties and the United States through the Department of the Interior and the Bureau of Reclamation. The Parties recognize that the Upper Division States have not yet developed their full apportionment under the Colorado River Compact. Although the Secretary has not imposed any shortage in the Lower Basin, the Parties also recognize that with additional Upper Basin development and in drought conditions, the Lower Division States may be required to suffer shortages in deliveries of water from Lake Mead. Therefore, these discussions focused on ways to improve the management of water in Lakes Powell and Mead so as to enhance the protection afforded to the Upper Basin by Lake Powell, and to delay the onset and minimize the extent and duration of shortages in the Lower Basin.

4. Shortages in the Lower Basin will also trigger shortages in the delivery of water to Mexico pursuant to the Mexican Water Treaty of 1944, February 3, 1944, U.S.-Mex., 59 Stat. 1219, T.S. 994, 3 U.N.T.S. 313.

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4. Shortages in the Lower Basin will also trigger shortages in the delivery of water to Mexico pursuant to the Mexican Water Treaty of 1944, February 3, 1944, U.S.-Mex., 59 Stat. 1219, T.S. 994, 3 U.N.T.S. 313.

5. On May 2, 2005, the Secretary announced her intent to undertake a process to develop Lower Basin shortage guidelines and explore management options for the coordinated operation of Lakes Powell and Mead. On June 15, 2005, the Bureau of Reclamation published a notice in the *Federal Register*, announcing its intent to implement the Secretary's direction. The Bureau of Reclamation has proceeded to undertake scoping and develop alternatives pursuant to the National Environmental Policy Act (the NEPA Process), which the Parties anticipate will form the basis for a ROD to be issued by the Secretary by December 2007.

6. On August 25, 2005, the Governors' Representatives for the seven Colorado River Basin States wrote a letter to the Secretary expressing conceptual agreement in the development and implementation of three broad strategies for improved management and operation of the Colorado River: Coordinated Reservoir Management and Lower Basin Shortage Guidelines; System Efficiency and Management; and Augmentation of Supply.

7. On February 3, 2006, the Governors' Representatives transmitted to the Secretary their recommendation for the scope of the NEPA Process, which refined many of the elements outlined in the August 25, 2005 letter.

8. At the request of the Secretary, the Parties have continued their discussions relative to the areas of agreement outlined in the letters of August 25, 2005 and February 3, 2006.

9. In furtherance of the letters of August 25, 2005 and February 3, 2006, the Parties have reached agreement to take additional actions for their mutual benefit, which are designed to augment the supply of water available for use in the Colorado River System and improve the management of water in the Colorado River.

C. Purpose. The Parties intend that the actions by them contemplated in this Agreement will: improve cooperation and communication among them; provide additional security and certainty in the water supply of the Colorado River System for the benefit of the people served by water from the Colorado River System; and avoid circumstances which could otherwise form the basis for claims or controversies over interpretation or implementation of the Colorado River Compact and other applicable provisions of the law of the river.

AGREEMENT

In consideration of the above recitals and the mutual covenants contained herein, and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the Parties agree as follows:

1. Recitals. The Recitals set forth above are material facts that are relevant to and form the basis for the agreements set forth herein.

2. Definitions. As used in this Agreement, the following terms have the following meanings:

A. Colorado River System. This term shall have the meaning as defined in the Colorado River Compact.

B. ISG. The Colorado River Interim Surplus Guidelines adopted by the Secretary on January 16, 2001.

C. NEPA Process. The decision-making process pursuant to the National Environmental Policy Act, 42 U.S.C. §§ 4321 through 47, beginning with the Bureau of Reclamation's Notice to SolicitComments and Hold Public Meetings, 70 Fed. Reg. 34794 (June 15, 2005) and culminating in a Record of Decision.

D. Party or Parties. Any party or parties to this Agreement.

E. Parties' Recommendation. The Seven Basin States' Preliminary Proposal Regarding Colorado River Interim Operations, a copy of which is attached hereto and incorporated herein by this reference, presented by the Parties to the Secretary in furtherance of the States' letters of August 25, 2005 and February 3, 2006, and any modification of the Parties' Recommendation adopted by the Parties pursuant to this Agreement.

F. ROD. The Record of Decision anticipated to be issued by the Secretary after completion of NEPA Process, pursuant to her letter of May 2, 2005, and the Notice published in the Federal Register on September 30. 2005, 70 Fed. Reg. 57322.

G. Secretary. The Secretary of the Interior or the Bureau of Reclamation, as applicable.

H. State or States. Any of the states of Arizona, California, Colorado, Nevada, New Mexico, Utah or Wyoming, as context requires.

3. Support for Parties' Recommendation. After considering a number of alternatives, each Party has determined that the Parties' Recommendation is in the best interests of that Party, and promotes the health and welfare of that Party and of the Colorado River Basin States. In the NEPA Process, the Parties shall support the Secretary's adoption of the Parties' Recommendation in a ROD. If during the course of the NEPA Process any new information becomes available which causes any Party, in its sole and absolute discretion, to reassess any provision of the Parties' Recommendation, that Party shall immediately notify all other Parties in writing. The Parties shall jointly confer and, if they agree to any modification of the Parties' Recommendation, shall consult with the Secretary to advise her of such modification and request the adoption thereof in the ROD. If after such conference and consultation it is apparent there is an

S-2006

irreconcilable conflict between the Parties as to such modification, then any Party may upon written notice to the other Parties withdraw from this Agreement, and in such event this Agreement shall no longer be effective or binding upon such withdrawing Party. All withdrawing Parties hereby reserve all rights upon withdrawal from this Agreement to take such actions, including support of or challenges to the ROD, as they in their sole and absolute discretion deem necessary or appropriate. In the event of the withdrawal of any one or more Parties from this Agreement, this Agreement shall continue in full force and effect as to the remaining Parties. The remaining Parties may confer to determine whether to continue this Agreement in effect, to amend this Agreement, or to terminate this Agreement. In the event of termination, all Parties shall be relieved from the terms hereof, and this Agreement shall be of no further force or effect.

4. <u>ROD Consistent with the Parties' Recommendation</u>. In the event the Secretary adopts a ROD in substantial conformance with the Parties' Recommendation, the Parties shall take all necessary actions to implement the terms of the ROD, including the approval and execution of agreements necessary for such implementation.

5. <u>ROD Inconsistent with the Parties' Recommendation</u>. In the event the Secretary adopts a ROD that any Party, in its sole and absolute discretion, determines is not in substantial conformance with the Parties' Recommendation, such Party shall immediately notify all other Parties of such determination in writing. The Parties shall jointly confer, and consult with the Secretary as necessary, in order to determine whether the ROD is in substantial conformance with this Agreement, or whether any action, including the amendment of this Agreement, may resolve such concern. If after such conference and consultation it is apparent there is an irreconcilable conflict between the ROD and the concerns of such Party, then such Party may upon written notice to the other Parties withdraw from this Agreement, and in such event this Agreement shall no longer be effective or binding upon such withdrawing Party. All withdrawing Parties hereby reserve all rights upon withdrawal from this Agreement to take such actions, including support of or challenges to the ROD, as they in their sole and absolute discretion deem necessary or appropriate. In the event of the withdrawal of any one or more Parties from this Agreement, this Agreement shall continue in full force and effect as to the remaining Parties. The remaining Parties may confer to determine whether to continue this Agreement in effect, to amend this Agreement, or to terminate this Agreement. In the event of termination, all Parties shall be relieved from the terms hereof, and this Agreement shall be of no further force or effect.

6. <u>Additions to the ROD</u>. The Parties hereby request that the Secretary recognize the specific provisions of this Agreement as part of the NEPA Process and, if appropriate, include in the ROD specific provisions that reference this Agreement as a basis for the ROD. The Parties also hereby request that the Secretary include in the ROD specific provision that the Secretary will first consult with all the States, through their designated Governor's Representatives, before making any substantive modification to the ROD. Finally, the Parties hereby request that the Secretary include in the ROD specific provision that upon a request by any State for modification of the ROD, or upon any request by any State to resolve any claim or controversy arising under this Agreement or

under the operations of Lakes Powell and Mead pursuant to the ROD, the ISG, or any other applicable provision of federal law, regulation, criteria, policy, rule or guideline, the Secretary shall invite all of the Governors, or their designated representatives, to consult with the Secretary in an attempt to resolve such claim or controversy by mutual agreement.

7. Consultation on Operations. After the Secretary commences operating Lakes Powell and Mead pursuant to the ROD, the Parties shall confer among themselves as necessary, but at least annually, to assess such operations. Any Party may request consultation with the other Parties on a proposed adjustment or modification of such operations, based on changed circumstances, unanticipated conditions, or other factors. Upon such request, the Parties shall in good faith confer to resolve any such issues, and based thereon may request consultation by the States with the Secretary on adjustments to or modifications of operations under the ROD. In any event, the Parties shall confer before December 31, 2020, to determine whether to extend this Agreement and recommend that the Secretary continue operations under the ROD for an additional period, or modify this Agreement and recommend that the Secretary modify operations under the ROD, or terminate this Agreement and recommend that the Secretary not continue operations under the ROD after the expiration thereof.

8. Development of System Augmentation. The Parties agree to diligently pursue system augmentation within the Colorado River System including but not limited to the determination of the feasibility of projects to increase precipitation in the basin or to augment available supplies through desalination. Additionally, the Parties agree to cooperatively pursue an interim water supply of at least a cumulative amount of 280,000 acre-feet for use in Nevada while long-term augmentation projects are being pursued. It is anticipated that this interim water supply will be made available in return for Nevada's funding of the Drop 2 Reservoir currently proposed for construction by the Bureau of Reclamation. Annual recovery of this interim water supply by Nevada will not exceed 40,000 acre-feet. All water available to Nevada in consideration for funding the Drop 2 Reservoir would remain available during all shortage conditions declared by the Secretary.

In consideration of the Parties' diligent pursuit of long-term augmentation and the availability of the interim water supply, the Southern Nevada Water Authority (SNWA) agrees that it will withdraw right-of-way Application No. N-79203 filed with the Bureau of Land Management on October 1, 2004 for the purpose of developing Permit No. 58591 issued by the Nevada State Engineer in Ruling No. 4151.

The SNWA will not re-file such right-of-way application or otherwise seek to divert the water rights available under Permit No. 58591 from the Virgin River prior to 2014 so long as Nevada is allowed to utilize its pre-Boulder Canyon Project Act Virgin and Muddy River rights in accordance with section 4(C) of the Parties' Recommendation in the form forwarded to the Secretary on February 3, 2006, and the interim water supply made available to Nevada is reasonably certain to remain available. The SNWA will not re-file such right-of-way application or otherwise seek to divert the water rights available under Permit No. 58591 from the Virgin River after 2014 so long as diligent pursuit of system augmentation is proceeding to provide Nevada an annual supply of 75,000 acre-feet by the year 2020. Prior to re-filing any applications with the Bureau of Land Management, SNWA and Nevada will consult with the other Basin States.

This agreement is without prejudice to any Party's claims, rights or interests in the Virgin or Muddy River systems.

9. Consistency with Existing Law. The Parties' Recommendation is consistent with existing law. The Parties expressly agree that the storage of water in and release of water from Lakes Powell and Mead pursuant to a ROD issued by the Secretary in substantial conformance with the Parties' Recommendation and this Agreement, and any agreements, rules and regulations adopted by the Secretary or the parties to implement such ROD, shall not constitute a violation of Article III(a)-(e) inclusive of the Colorado River Compact, or Sections 601 and 602(a) of the Colorado River Basin Project Act of 1968 (43 U.S.C. §§ 1551 and 1552(a)), and all applicable rules and regulations promulgated thereunder.

10. Resolution of Claims or Controversies. The Parties recognize that litigation is not the preferred alternative to the resolution of claims or controversies concerning the law of the river. In furtherance of this Agreement, the Parties desire to avoid litigation, and agree to pursue a consultative approach to the resolution of any claim or controversy. In the event that any Party becomes concerned that there may be a claim or controversy under this Agreement, the ROD, Article III(a)-(e) inclusive of the Colorado River Compact, or Sections 601 and 602(a) of the Colorado River Basin Project Act of 1968 (43 U.S.C. §§ 1551 and 1552(a)), and all applicable rules and regulations promulgated thereunder, such Party shall notify all other Parties in writing, and the Parties shall in good faith meet in order to resolve such claim or controversy by mutual agreement prior to any litigation. No Party shall initiate any judicial or administrative proceeding against any other Party or against the Secretary under Article III(a)-(e) inclusive of the Colorado River Compact, or Sections 601 and 602(a) of the Colorado River Basin Project Act of 1968 (43 U.S.C. §§ 1551 and 1552(a)), or any other applicable provision of federal law, regulation, criteria, policy, rule or guideline, and no claim thereunder shall be ripe, until such conference has been completed. In addition, all States shall comply with any request by the Secretary for consultation in order to resolve any claim or controversy. In addition, any State may invoke the provisions of Article VI of the Colorado River Compact. Notwithstanding anything in this Agreement to the contrary, the terms of this Paragraph 10 shall survive for a period of five years following the termination or expiration of this Agreement, and shall apply to any withdrawing Party after withdrawal for such period.

11. Reservation of Rights. Notwithstanding the terms of this Agreement and the Parties' Recommendation, in the event that for any reason this Agreement is terminated, or that the term of this Agreement is not extended, or upon the withdrawal of any Party from this Agreement, the Parties reserve, and shall not be deemed to have waived, any and all rights, including any claims or defenses, they may have as of the date hereof or as

may accrue during the term hereof, under any existing federal or state law or administrative rule, regulation or guideline, including without limitation the Colorado River Compact, the Upper Colorado River Basin Compact, the Decree in *Arizona v. California*, the Colorado River Basin Project Act of 1968, and any other applicable provision of federal law, rule, regulation, or guideline.

12. No Third-Party Beneficiaries. This Agreement is made for the benefit of the Parties. No Party to this Agreement intends for this Agreement to confer any benefit upon any person or entity not a signatory upon a theory of third-party beneficiary or otherwise.

13. Joint Defense Against Third Party Claims. In the event the Secretary adopts a ROD in substantial conformance with the Parties' Recommendation as set forth herein, they will have certain common, closely parallel, or identical interests in supporting, preserving and defending the ROD and this Agreement. The nature of this interest and the relationship among the Parties present common legal and factual issues and a mutuality of interests. Because of these common interests, the Parties will mutually benefit from an exchange of information relating to the support, preservation and defense of the ROD and this Agreement, as well as from a coordinated investigation and preparation for discussion of such interests. In furtherance thereof, in the event of any challenge by a third party as to the ROD or this Agreement (including claims by any withdrawing Party), the Parties will cooperate to proceed with reasonable diligence and to use reasonable best efforts in the support, preservation and defense thereof, including any lawsuit or administrative proceeding challenging the legality, validity or enforceability of any term of the ROD or this Agreement, and will to the extent appropriate enter into such agreements, including joint defense or common interest agreements, as are necessary therefor. Each Party shall bear its own costs of participation and representation in any such defense.

14. Reaffirmation of Existing Law. Nothing in this Agreement or the Parties' Recommendation is intended to, nor shall this Agreement be construed so as to, diminish or modify the right of any Party under existing law, including without limitation the Colorado River Compact, the Upper Colorado River Basin Compact, or the Decree in *Arizona v. California*. The Parties hereby affirm the entitlement and right of each State under such existing law to use and develop the water of the Colorado River System.

15. Term. This Agreement shall be effective as of the date of the first two signatories hereto, and shall be effective as to any additional Party as of the date of execution by such Party. Unless earlier terminated, this Agreement shall be effective for so long as the ROD and the ISG are in effect, and shall terminate upon the termination of the ROD and the ISG.

16. Authority. The persons and entities executing this Agreement on behalf of the Parties are recognized by the Parties as representing the respective States in matters concerning the operation of Lakes Powell and Mead, and as those persons and entities authorized to bind the respective Parties to the terms hereof. Each person executing this

Agreement has the full power and authority to bind the respective Party to the terms of this Agreement. No Party shall challenge the authority of any person or Party to execute this Agreement and bind such Party to the terms hereof, and the Parties waive the right to challenge such authority.

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Appendix K

Conservation Before Shortage II Proposal

A consortium of environmental non-governmental organizations (NGO) developed and submitted the Conservation Before Shortage II proposal to the Secretary of the Department of the Interior in a letter dated July 7, 2006. This proposal supplemented the original proposal (Conservation Before Shortage proposal) submitted by the consortium of NGOs to the Secretary on July 18, 2005. The consortium of NGOs includes: Defenders of Wildlife, Environmental Defense, National Wildlife Federation, Pacific Institute, Sierra Club, the Nature Conservancy, Rivers Foundation of the Americas, and the Sonoran Institute. The full text of the Conservation Before Shortage II proposal, supplemental information submitted therein, and the full text of the original Conservation Before Shortage proposal are provided in this appendix.

K.1 Conservation Before Shortage II: Proposal for Colorado River Operations

Defenders of Wildlife * Environmental Defense * National Wildlife Federation
The Nature Conservancy * Pacific Institute * Sierra Club * Sonoran Institute

July 7, 2006

The Honorable Dirk Kempthorne
Secretary, U.S. Department of the Interior
1849 C Street, NW
Washington, DC 20240

via email: strategies@lc.usbr.gov

Dear Secretary Kempthorne:

With this letter, we submit our proposal "Conservation Before Shortage II" for your consideration in the "Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead, Particularly Under Low Reservoir Conditions."

A year ago, we submitted our original proposal "Conservation Before Shortage" in anticipation of Reclamation's work to develop new shortage rules for the Colorado River. Since then, the Colorado River Basin States significantly changed the scope of Reclamation's deliberations with the submission of their own proposal. The new flexibility they propose with Intentionally Created Surplus (ICS), administered appropriately, could provide a framework for improving environmental conditions on the Colorado. We have therefore combined the ICS concept with a slightly modified version of our original proposal.

The original Conservation Before Shortage was a proposal to manage shortages in the Colorado River by asking water users to voluntarily engage in predictable, small-scale reductions in use – and receive compensation for those reductions – rather than face large-scale, involuntary, and uncompensated disruptions in water deliveries that could cut into municipal and agricultural water supplies and create unmitigated economic impacts. Conservation Before Shortage II combines such voluntary, market-based water conservation to protect against shortages on the Lower Colorado River with a voluntary, market-based mechanism to protect or enhance flow dependent environmental values.

With this letter, we submit a description of Conservation Before Shortage II (including relevant background, a description of the proposal itself, a rationale for the proposal, and the identification of several additional issues), as well as the original Conservation Before Shortage proposal, and an additional proposal to expand the ICS program to include Mexico.

1 of 2

We appreciate the effort Reclamation staff have made to help us understand the hydrologic impacts of our proposals through the use of their expertise in river operations modeling. We hope to continue this dialogue about management of Colorado River shortages with Interior and Reclamation, as well as the Colorado River Basin States, the International Boundary and Water Commission and representatives of the Republic of Mexico.

Thank you for your consideration, and please do not hesitate to contact any one of us if you have questions.

Sincerely,

Kara Gillon
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cc:
Herb Guenther, Arizona Department of Water Resources
Jerry Zimmerman, Colorado River Board of California
Pat Mulroy, Southern Nevada Water Authority.
Don Ostler, Upper Basin Colorado River Commission
Carlos Marin, International Boundary and Water Commission
Arturo Herrera, Comisión Internacional de Limites y Aguas

July 7, 2006

Conservation Before Shortage II:

Proposal for Colorado River Operations

I. Background/Context

In August of 2005, various non-governmental conservation organizations introduced the "Conservation Before Shortage" proposal into the U.S. Bureau of Reclamation's (Reclamation) process for the "Development of Lower Colorado River Basin Shortage Guidelines and Coordinated Management Strategies for Lakes Powell and Mead Under Low Reservoir Conditions" (Shortage Guidelines). The "Conservation Before Shortage" proposal suggested an approach to the management of shortages in the Lower Colorado through the implementation of a tiered program of voluntary and compensated water conservation, tied to the surface elevation of Lake Mead.

Since the time of that proposal, the seven Basin States have reached agreement on a far-reaching proposal to transform management of Colorado River system water through conjunctive management of Lakes Mead and Powell, modification and extension of the existing Interim Surplus Criteria, and the adoption of shortage guidelines. Perhaps most significantly, the Basin States' proposal introduces a series of new mechanisms to increase flexibility within the Lower Basin delivery system and water allocations, including the creation of a new category of water: "Intentionally Created Surplus" (ICS). ICS can be generated through extraordinary conservation measures, funding of system efficiency improvements, and recognition of water exchanges.

As currently constituted, the Basin States' proposal is largely concerned with water deliveries between and among the Basin States, with ICS programs and related mechanisms confined to the states of the Lower Basin. While these programs will clearly benefit water management on the Colorado River system, we suggest that significant benefits for U.S. water users, Mexican water users, and the environment could be gained by expanding portions of the Basin States' proposal to include additional potential domestic water users, provide for direct federal participation, and leave the door open to potential international implementation of ICS programs.

In addition, we strongly suggest that there remain significant potential advantages to some of the concepts expressed in the original "Conservation Before Shortage" proposal, particularly the use of voluntary, market-based conservation as a method to mitigate involuntary shortages. By combining that proposal with an expanded ICS program we believe that "Conservation Before Shortage II" is a powerful tool for mitigating against shortages and helping to meet the federal government's bypass flow replacement obligations under the Colorado River Basin Salinity Control Act.

Conservation Before Shortage II meets the purposes identified in the Basin States' original proposal: delaying and minimizing the onset of shortage in the Lower Basin and the risk of curtailment in the Upper Basin through conservation, more efficient reservoir operations and water supply augmentation. It also meets multiple federal objectives on the Colorado River, including the watermaster's continued federal oversight and management of the river, the protection of important environmental resources, and replacement of the bypass flow.

Over the past several months, the conservation organizations that developed the original Conservation Before Shortage proposal have, with technical assistance from Reclamation's modeling staff, developed a revised version of the proposal (hereafter referred to as "CBS II"). This document describes the essential elements of the CBS II proposal, the rationale behind these elements, its relationship to the states' proposal, and the significant potential benefits associated with the CBS II approach.

II. Elements of Conservation Before Shortage II

A. Shortage Guidelines to Reduce Deliveries/Releases from Lake Mead

Shortage Conditions

At elevations below 1000 feet, the Secretary would impose involuntary shortage conditions to the extent necessary to maintain an elevation of 1000 feet (absolute protection of elevation 1000 feet).[1]

Conservation Conditions

In years when the August 24-month study projects the elevation of Lake Mead on January 1 will fall within the elevation ranges for "conservation conditions" identified below, on behalf of the Secretary of the Interior (Secretary), Reclamation will engage in a program to purchase ICS credits in the amounts corresponding to those ranges. To the extent permitted by law and through the appropriate authorities, Reclamation will also seek to generate such ICS credits by purchasing water from users in Mexico (temporarily reducing deliveries of Colorado River water to Mexico). Federal ICS creation requirements would follow identical triggers and reductions to the involuntary shortages proposed under the Basin States' alternative:

- Elevation greater than 1050 to 1075 feet: 400,000 acre-feet
- Elevation greater than 1025 to 1050 feet: 500,000 acre-feet
- Elevation greater than 1000 to 1025 feet: 600,000 acre-feet

Reclamation would maintain an accounting system to track cumulative Main Outlet Drain Extension bypass flow replacement obligations (to the extent not otherwise satisfied via other mechanisms) and banked federal ICS credits. ICS credits created when the elevation of Lake Mead is at or below 1075 feet would first be credited against the cumulative bypass flow "deficit." Federal ICS credits created in excess of this deficit would be credited to the federal ICS account up to the amount of the federal cap of 1.5 million acre feet (see below). Federal ICS credits created in excess of the federal cap would become system water.

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[1] In the event that a shortage is declared when Lake Mead is at or below elevation 1000 feet, and a bi-lateral determination of an extraordinary drought is also made under the 1944 Treaty, deliveries to Mexico would be reduced in the same proportion as consumptive uses in the Lower Basin are reduced.

All funding for creation of federal ICS up to the amount of the 1.5 million acre foot cap would be provided by the federal government in recognition of the bypass flow replacement and environmental benefits. Thereafter, 50% of funding would be provided by the federal government, with the remaining 50% derived from fees assessed against Lower Basin water and power users using the mechanisms described in the original CBS proposal (see Attachment A).

B. Coordinated Reservoir Operations (Lake Mead and Lake Powell).

CBS II does not address coordinated reservoir operations. However, for the purpose of highlighting the differences between CBS II and the Basin States' alternative in Reclamation's modeling exercise, reservoir operations at Lakes Mead and Powell would be coordinated as described in the Basin States Alternative.

C. Lake Mead Storage and Delivery of Conserved and Non-system Water

ICS credits generated via extraordinary conservation activities, tributary conservation, system efficiency projects, and other mechanisms would be handled under rules identical to the Basin States Alternative, except as follows:

- ICS credits could be generated by entities that are not current Colorado River delivery contract holders (although a delivery contract with the Secretary would be required for the storage and delivery of ICS credits). Entities eligible for participation in the ICS program would include:
    - U.S. federal agencies
    - State agencies
    - Private entities, including U.S. non-governmental organizations
    - Mexican federal agencies
    - Mexican water users
- All participating entities would follow the Basin States rules for storage and withdrawal of ICS credits (including restrictions on creation and use of ICS credits during shortage and surplus conditions, 5% system set-aside for creation of ICS[2], and reductions to stored ICS to account for evaporation losses), except:

[2] The Basin States' proposal provides that at the time ICS credits are created by extraordinary conservation, the entity creating the credits will dedicate 5% of the ICS credits to the system on a one-time basis to provide a water supply benefit to the system, while 10% of the ICS credits would be set aside under the Reservoir Storage Alternative. Quite possibly, the set-aside rate of 10% may be too modest. We suggest that Reclamation analyze the benefits and costs of a larger set-aside.

- U.S. federal government would be permitted to purchase or create and bank ICS credits during Conservation Conditions (see below), but would be subject to the same rules for delivery and use of ICS credits as other users.

- Mexico would be permitted to create, bank, and deliver ICS credits during "Normal," "Full Domestic Surplus," and 70(r) surplus conditions but not during Conservation, Shortage or Flood Control Surplus conditions. Same-year ICS reallocations within Mexico that do not result in system storage would not be subject to the 5% system set-aside (as this would not alter Treaty deliveries). Water banked by Mexico in Lake Mead would be subject to the 5% system set-aside as well as evaporative loss charges. Mexico's participation in the ICS program would operate under a Treaty minute reflecting procedures to alter delivery schedules to accommodate transfers of ICS within Mexico, as well as procedures for temporary reductions and corresponding increases in Treaty deliveries to allow for banking in Lake Mead.

- The maximum amount of ICS credits that could be created in any one year would be limited to 950,000 acre-feet per year, allocated among the participants as follows:
  - California contractors: 400,000 acre-feet per year (state proposal)
  - Nevada contractors: 125,000 acre-feet per year (state proposal)
  - Arizona contractors: 100,000 acre-feet per year (state proposal)
  - United States: 100,000 acre-feet per year (except during Conservation Conditions, see above) (potentially allowing use of water for environmental projects)
  - Mexico (government/users): 125,000 acre-feet per year (enough water to bank and deliver 200,000 acre-feet of a 250,000 acre-foot flood flow every 5 years with the last 50,000 acre-feet scheduled as part of Mexico's annual delivery in the year of the flood flow release, plus allow for other environmental, municipal, industrial, and other uses, accounting for the 5% system set-aside and up to 5% annual evaporation loss for banked water)
  - All other users: 100,000 acre-feet per year

- The maximum cumulative amount of ICS credits that would available at any one time would be 4,200,000 acre-feet, allocated as follows:
  - California contractors: 1,500,000 acre-feet (state proposal)
  - Nevada contractors: 300,000 acre-feet (state proposal)
  - Arizona contractors: 300,000 acre-feet (state proposal)

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- United States: 1,500,000 acre-feet (3-5 years of Conservation Conditions acquisitions, 15 years of ICS recovery)
- Mexico: 400,000 acre-feet (enough water to bank 200,000 acre-feet of a 250,000 acre-foot flood flow every 5 years with the last 50,000 acre-feet scheduled as part of Mexico's annual delivery in the year of the flood flow release, plus approximately 2-3 years cumulative storage for other uses)
- All other: 200,000 acre-feet (2 years storage to allow for purchase and storage of water during cheaper market conditions)

- The maximum amount of ICS credits that could be recovered in any one year would be limited to 1.6 million acre-feet per year, allocated as follows:
  - California contractors: 400,000 acre-feet (state proposal)
  - Nevada contractors: 300,000 acre-feet (state proposal)
  - Arizona contractors: 300,000 acre-feet (state proposal)
  - United States: 100,000 acre-feet (maximum volume of federally-banked ICS that could be recovered each year for environmental use, including MSCP, at Mead elevations above 1075 feet) (10 years worth of recovery)
  - Mexico: 400,000 acre-feet (enough to provide for unlikely confluence of 250,000 acre-feet flood flow plus significant non-environmental use in one year)
  - All other: 100,000 acre-feet (enough to implement restoration in the limitrophe reach, plus water available for additional projects).
- During Conservation Conditions, the federal government is required to acquire ICS from U.S. and/or Mexican users pursuant to shortage guidelines in volumes of 400,000, 500,000, and 600,000 acre-feet (see II.*A*, above).

D. Interim Surplus Guidelines for deliveries/releases from Lake Mead and all other operation criteria

CBS II does not address the Interim Surplus Guidelines or other operating criteria. However, for the purpose of highlighting the differences between CBS II and the Basin States' alternative in Reclamation's modeling exercise, all other river operation criteria, including operation of the Interim Surplus Guidelines, would be the same as proposed in the Basin States Alternative.

III. Rationale for Conservation Before Shortage II

Conservation Before Shortage II is founded on the principle that the Secretary should take greater responsibility to operate the Colorado River in a manner that minimizes shortages in the Lower Basin and avoids the risk of curtailment in the Upper Basin through conservation, more efficient reservoir operations, and increased flexibility in the management of river resources, while protecting or enhancing environmental values associated with the Colorado River. Three elements of CBS II highlight this principle:

> (1) voluntary, market-based water conservation as an alternative to and mitigation mechanism against involuntary, uncompensated shortages on the Lower Colorado River;
>
> (2) voluntary, market-based mechanisms to protect or enhance flow dependent environmental values, in close alignment with applying such mechanisms to mitigate against involuntary, uncompensated shortages; and
>
> (3) potential expansion of ICS programs (pending appropriate diplomatic consultations) to include water users in Mexico and to improve the management of Colorado River water supplies in both countries.

A. Voluntary, Market-Based Conservation as an Alternative to Involuntary Shortage

As discussed in the original Conservation Before Shortage proposal (see Attachment A), we believe that there are significant potential advantages to the use of voluntary, market-based conservation as an alternative to and as a means of mitigating against involuntary shortages.

- Based on extensive modeling performed for the Lower Basin states, reductions of 400,000, 500,000 and 600,000 acre-feet at Lake Mead elevations 1075 feet, 1050 feet and 1025 feet, respectively, appear to provide optimal results in preventing larger involuntary shortages that perform better than the 200,000, 400,000, and 600,000 acre-foot reductions proposed in the original CBS proposal.

- It is desirable to protect the elevation of Lake Mead at no less than 1000 feet under any condition to protect Southern Nevada Water Authority's lower intake structures, as well as the new minimum power pool if proposed low-pressure turbines are installed at Hoover Dam.

- It is preferable for Lower Basin water users to voluntarily engage in predictable, small-scale reductions in use – and receive compensation for those reductions – rather than face large-scale, involuntary and uncompensated disruptions in water deliveries that could cut into municipal and agricultural water supplies and create unmitigated economic impacts.

- There is a large volume of Colorado River water which could be temporarily conserved through voluntary, market-based mechanisms such as part-year fallowing or forbearance agreements, dry year options, or other similar arrangements to reduce Lower Basin consumptive use on an occasional, temporary basis as an alternative to involuntary shortages to low-priority users.[3]

- Users of Colorado River water in Mexico may wish to participate in short-term, voluntary and compensated conservation agreements, to reduce the probability of larger, uncompensated future reductions due to a declaration of shortage under the 1944 Treaty with Mexico.[4]

The ICS program suggested in the Basin States' proposal will likely result in the identification of numerous opportunities for extraordinary conservation activities that could be used to accomplish reductions in water use in the Lower Basin. These mechanisms could not be utilized by other water users when the elevation of Lake Mead is at or below 1075 feet, creating a readily available supply of ICS credit-eligible water that could instead be utilized by the federal government as a means of temporarily reducing water use on a voluntary, compensated basis.

CBS II would also create an obvious means of implementing a significant portion of the federal government's bypass flow replacement obligation. The recently published report led by the Central Arizona Water Conservancy District "Balancing Water Needs on the Lower Colorado River: Recommendations of the Yuma Desalting Plant/Cienega de Santa Clara Workgroup," includes recognition that replacement of the MODE bypass flow is primarily necessary during shortage conditions to ensure that accumulated system water deficits resulting from the bypass flow do not result in shortages to Lower Basin users. One of the primary recommendations in the report is the creation of a "shortage alleviation trust fund" which would be used, in combination with fallowing programs or other conservation mechanisms, to provide replacement water to compensate for accumulated bypass flow deficits during shortage conditions. The recommendations of the workgroup have been widely circulated among Lower Basin water users and have received significant support among both water users, water managers, and environmental interests.

Use of the ICS mechanism by the federal government when Lake Mead elevation is at or below 1075 feet would provide an ideal means of implementing this recommendation of the YDP/Cienega de Santa Clara workgroup. ICS credits that the federal government would be required to purchase when Lake Mead elevation is at or below 1075 feet could be retired for the benefit of the system to the extent necessary to eliminate any accumulated bypass flow replacement deficit; only after this deficit is extinguished would ICS credits accrue to the federal government for other uses.

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[3] Some 4.5 million acre-feet of Colorado River water are used to irrigate crops in the Lower Basin states, and more than 1 million acre-feet are used to irrigate crops in Mexico. Conservation of between 400,000 and 600,000 acre-feet through the use of part-year fallowing programs, dry year options, or other similar arrangements would constitute only 7-11% of total Lower Basin agricultural use in the United States and Mexico. (However, as even small-scale reductions in agricultural water use may have third-party impacts, provision should be made to support community economic development in affected areas.) Conversely, even under the Basin States' tiered shortage proposal, involuntary shortages could have significant economic consequences, disrupting water banking plans in Arizona and cutting low-priority municipal and agricultural use in the U.S. and Mexico (resulting in unpredictable loss of farm income, economic disruptions from municipal shortfalls, or requiring expensive municipal conservation efforts or efforts to secure agricultural water to support hardened municipal demand).

[4] Such an agreement would likely require a new Minute to the 1944 Treaty with Mexico. Fallowing agreements in Mexico would have to be administered by the appropriate authorities.

B. Voluntary, Market-Based Conservation to Protect or Enhance Environmental Flows.

This proposal suggests two mechanisms for protecting and enhancing environmental flows in close alignment with the mechanisms to mitigate involuntary and uncompensated shortages, although other mechanisms may also be appropriate for consideration. First, extending the ICS program to include a broader range of participants than current Colorado River contractors provides an opportunity to ensure that some portion of the water developed via extraordinary conservation activities could be dedicated to environmental uses, via the participation of interested parties (such as conservation organizations) in ICS creation. There are several proposed restoration efforts in the United States – such as a restoration proposal for the limitrophe reach of the Colorado River – which could potentially benefit from access to ICS water supplies during normal conditions.

Second, direct participation of the federal government in the ICS program could be an excellent mechanism for purchasing water for environmental purposes or other public benefit uses by the federal government. Although these credits would only be available for use when the elevation of Lake Mead is greater than 1075 feet, they could be used to provide "bridge" supplies for restoration projects, run pilot restoration projects, or meet other interim water supply needs.

C. ICS for Mexico

As discussed in detail in a draft proposal entitled *Taking ICS to Mexico: International Opportunities in the Seven States Agreement* (see Attachment B), ICS credits could be used to firm urban water supplies in both countries, implement long-studied environmental restoration projects in the Colorado River Delta, and increase flexibility in Mexico's agricultural sector – creating economic, environmental, and social benefits in both countries while offering the United States and Mexico a venue for cooperation in the otherwise contentious area of water management at the border. In addition, during shortage conditions, extension of the ICS program to include Mexico would expand the pool of participants who could provide voluntary, compensated reductions in water use as an alternative to involuntary shortages in the United States.

An extension of the ICS program to include Mexico would likely require the adoption of a new Minute to the Treaty of 1944, and would obviously require diplomatic discussions and negotiations likely to occur in a different venue than Reclamation's domestic process to develop Shortage Guidelines. However, we strongly suggest that the current federal process should leave the door open to the eventual approval of a binational extension of the ICS program, to limit the costs of future review of such a program and encourage the initiation of binational discussions about such a program. Since critical elements of the Basin States' proposal – most notably the proposed shortage policy and proposed policies for water exchanges – will already require consultation with Mexico and/or the adoption of a new Minute, these opportunities could be considered in the same diplomatic process

IV. Additional Issues

To characterize the impact that these concepts would have on river management outcomes, we have attempted to minimize the differences (and thus the number of modeling variables at play) between CBS II and the Basin States' proposal. While we do not necessarily agree with or endorse all of the approaches suggested in the Basin States' proposal, we have not attempted to alter many of its basic elements, including the proposed modification and extension of the Interim Surplus Guidelines, new conjunctive management of Lakes Mead and Powell, or the imposition of Shortage Criteria only through 2026. However, CBS II incorporates these elements of the Basin States' proposal for comparative and analytical purposes only.

We do not assume the various proposals under consideration, including CBS II and the Basin States' proposals, are consistent with the existing law. Reclamation should clarify, during the environmental review process, how or whether these proposals would function within existing laws.

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Attachment A

Conservation Before Shortage Proposal

This attachment to Appendix K contains the text of the Conservation Before Shortage proposal submitted on July 18, 2005.

Conservation Before Shortage

Proposed Shortage Criteria for
Colorado River Operations

I. Background/Context

The effects of a multi-year drought have had a tremendous impact on storage in the Colorado River basin. Although above-average precipitation in the Lower Basin has led to small recoveries in system storage over the winter of 2004-2005, total system storage on the Colorado River has decreased by more than 40% over the past several years. As a result, there is a real possibility that the Secretary of the Interior will declare an actual shortage on the lower Colorado River in the near future. A shortage declaration would reduce deliveries to the Central Arizona Project (CAP) and to southern Nevada (which are among the first in line for cuts in the event of a shortage).

The surface elevation of Lake Mead dropped more than 80 feet from the end of 2000 through the end of 2004; Lake Powell dropped by more than 115 feet in this period. The Bureau of Reclamation's (Reclamation's) Riverware model of the Colorado, based on historic flow records, projects that reservoir levels at Lake Powell could head quickly towards the minimum power pool if the drought continues, and reservoir levels at Lake Mead could fall below the elevation of southern Nevada's upper intakes or remain in a long-term decline that will be difficult to reverse until Powell begins to re-fill. In addition, the model predicts that even if precipitation levels returned to average today, it could take 10-20 years for the Colorado River reservoir system to recover fully (during which time continued development of water supplies in the Upper Basin will further shrink available supplies). As a result, it is time to begin a long-delayed discussion about the method for defining, mitigating, and sharing shortages on the Colorado River.

Although the Secretary of the Department of the Interior (Secretary) has the authority to declare a shortage on the Colorado River, thereby reducing deliveries to some Lower Colorado River contractors, to date no criteria exist for determining when such a shortage will be declared. In June 2005, the Department of the Interior (DOI) noticed its intent to begin a public scoping process for the development of "Lower Basin Shortage Guidelines," (70 Fed.Reg. 34794). In 2004, DOI initiated a series of technical meetings with the Colorado Basin states to discuss drought issues, and the seven Basin states met frequently among themselves throughout the winter of 2004-2005 to discuss potential shortage criteria. Non-governmental organizations (NGOs) were not invited to participate in these discussions; however, several NGOs with interest and expertise in Colorado River issues began meeting over the winter to develop an alternative shortage proposal. These organizations met with Reclamation staff to review the results of technical modeling runs developed in support of the states' discussions, and Reclamation has provided additional modeling data to these interested NGOs in response to their inquiries and to evaluate potential shortage criteria.

These meetings led to the development of this document, which proposes an approach to the management of shortages in the Lower Colorado through the implementation of a tiered conservation program that is tied to the surface elevation of Lake Mead.

II. Rationale for this Proposal

The basic rationale behind this "Conservation Before Shortage" proposal is that shortage criteria should attempt to maximize the reliability and predictability of water deliveries on the Lower Colorado by introducing increased flexibility into the management of river resources when shortage conditions are imminent.

Principles:

- It is desirable to protect the elevation of Lake Mead at 1050 feet (the current minimum power pool) to the extent feasible without implementing shortages that would involuntarily curtail deliveries to Lower Basin users.
- It is desirable to protect the elevation of Lake Mead at no less than 1000 feet under any condition in order to protect Southern Nevada Water Authority's lower intake structures, as well as the new minimum power pool if proposed low-pressure turbines are installed at Hoover Dam.
- It is desirable to avoid shortages in the Lower Basin above 500,000 acre-feet whenever possible (the approximate level at which shortages would cut into CAP's deliveries beyond those currently utilized for water banking).
- It is preferable for Lower Basin water users to voluntarily engage in predictable, small-scale reductions in use – and receive compensation for those reductions – rather than face large-scale, involuntary, and uncompensated disruptions in water deliveries that could cut into municipal and agricultural water supplies and create unmitigated economic impacts.
- Minimizing large, forced disruptions to normal deliveries as a result of shortage declarations will minimize the threat of unmitigated environmental impacts in the Lower Colorado River and Delta as a result of significantly decreased deliveries to low-priority users and corresponding return flows that support environmental values.
- Market-based programs, with low transaction costs and appropriate mitigation of third-party impacts, can offer a reasonable mechanism for minimizing the risk and impacts of shortage.[1]
- Users of Colorado River water in Mexico may wish to participate in short-term conservation agreements, to reduce the probability of larger, uncompensated future reductions due to a declaration of shortage under the 1944 Treaty with Mexico.
- Water can be obtained from agricultural users in the United States, and could be obtained in Mexico with an appropriate agreement,[2] through the use of voluntary, market-based forbearance programs. Economic studies of Lower Basin agricultural use, as well as recent leases of water from farmers in this area, suggest that there is a large volume of water in the basin that could be obtained for $20 - 100 per acre-foot (see Figure 9).

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[1] Some 4.5 million acre-feet of Colorado River water are used to irrigate crops in the Lower Basin states, and more than 1 million acre-feet are used to irrigate crops in Mexico. Conservation of between 200,000 and 600,000 acre-feet through the use of part-year fallowing programs, dry year options, or other similar arrangements would constitute only 4-11% of total Lower Basin agricultural use in the United States and Mexico. (However, as even small-scale reductions in agricultural water use may have third-party impacts, some portion of funds accrued for the purchase of water should be set aside to support community economic development in affected areas.) Conversely, without these small-scale reductions, water users would likely be faced with the need to curtail large amounts of water quite abruptly, with significant economic consequences. (Shortages of nearly 2 million acre-feet in a single year are predicted by Reclamation's model when the 1000 feet elevation is protected at Lake Mead without conservation measures).

[2] Such an agreement would likely require a new Minute to the 1944 Treaty with Mexico. Fallowing agreements in Mexico would have to be administered by the appropriate authorities.

III. Conservation Before Shortage Policy

The "Conservation Before Shortage" policy essentially consists of two sets of criteria tied to projected elevations at Lake Mead on January 1 of a given year, according to the Bureau of Reclamation's August 24-month study. These criteria consist of three "conservation triggers," which impose progressively increasing conservation goals as lake levels drop from 1100 feet to 1050 feet, and a "shortage trigger," which imposes involuntary shortages in the Lower Basin as are necessary to accomplish absolute protection of Lake Mead at a minimum elevation of 1000 feet.

(A) Normal Conditions

In years when the 24-month study projects the elevation of Lake Mead on January 1 will be at or above 1100 feet, the Secretary of the Interior (Secretary) shall determine a Normal or Surplus (as defined by the Interim Surplus Guidelines) year.

(B) Conservation Triggers

First Conservation Trigger: Below 1100 Feet at Lake Mead

In years when the 24-month study projects the elevation of Lake Mead on January 1 will be at or above 1075 feet but below 1100 feet, the Secretary will seek to conserve 200,000 acre-feet of water. On behalf of the Secretary, Reclamation will preferentially seek to achieve this 200,000 acre-feet of savings by means of voluntary conservation agreements (including forbearance agreements) with Lower Basin delivery-contract holders. Additionally, Reclamation will, to the extent permitted by law and through the appropriate authorities, seek forbearance or other such water conservation agreements with Colorado River users in Mexico. In the case of such agreements, U.S. deliveries of Colorado River water to Mexico at the Northerly International Boundary will be reduced by the total volume indicated by these binational agreements.

Second Conservation Trigger: Below 1075 Feet at Lake Mead

In years when the 24-month study projects that the elevation of Lake Mead on January 1 will be at or above 1050 feet but below 1075 feet, the Secretary will seek to conserve 400,000 acre-feet of water. Reclamation will preferentially seek to achieve this 400,000 acre-feet of savings by means of voluntary conservation agreements (including forbearance agreements) with Lower Basin delivery-contract holders. Additionally, Reclamation will, to the extent permitted by law and through the appropriate authorities, seek forbearance or other such water conservation agreements with Colorado River users in Mexico. In the case of such agreements, U.S. deliveries of Colorado River water to Mexico at the Northerly International Boundary will be reduced by the total volume indicated by these binational agreements.

Third Conservation Trigger: Below 1050 Feet at Lake Mead

In years when the 24-month study projects that the elevation of Lake Mead on January 1 will be below 1050 feet (minimum power pool absent the installation of low-pressure turbines), the Secretary will seek to conserve 600,000 acre-feet of water. Reclamation will preferentially seek to achieve this 600,000 acre-feet of savings by means of voluntary conservation agreements (including forbearance agreements) with Lower Basin delivery-contract holders. Additionally, Reclamation will, to the extent permitted by law and through the appropriate authorities, seek forbearance or other such water conservation agreements with Colorado River users in Mexico. In the case of such agreements, U.S. deliveries of Colorado River water to Mexico at the Northerly International Boundary will be reduced by the total volume indicated by these binational agreements.

(C) Shortage Trigger

Absolute Protection of Lake Mead Elevation 1000 Feet

The Secretary shall not permit the elevation of Lake Mead to drop below elevation 1000 feet (minimum low-pressure power pool and Southern Nevada Water Authority intakes) at any time. Shortages to Colorado River contractors shall be implemented in the Lower Basin and in Mexico[3] to the extent necessary to prevent such declines.

(D) Funding Mechanisms

In recognition of the federal government's continuing national obligation to replace the MODE bypass flow to Mexico, 43 U.S.C. § 1571(c), the federal government will assume responsibility for the cost of all conservation agreements up to the volume of the bypass flow that the Secretary has not otherwise replaced in the year that a conservation trigger becomes effective. Given the national interest in minimizing both environmental impacts and economic disruptions resulting from the involuntary curtailment of deliveries to Colorado River users, the federal government would also assume responsibility for half of the cost of any additional agreements required to generate conserved water for the "Conservation Before Shortage" policy, pursuant to the Secretary's authority under the Reclamation States Emergency Drought Relief Act of 1991 (Drought Relief Act),[4] conservation authorities in the Farm Bill, or other appropriate authority that may be granted by Congress.

To the extent that conservation of water is required beyond that to be funded by the federal government in the manner described above, conservation activities would be funded through one or both of the following:

Power Pool Protection Fund

The priority of water used for power generation is considered to be tertiary to that of irrigation and domestic use under the Law of the River. As a result, Hoover and Glen Canyon Dams are operated to maintain deliveries to water users regardless of the impact of declining reservoir levels on power production. However, one of the more significant corollary benefits of the conservation program described in this proposal, beyond the primary benefit of protecting water users from involuntary and uncompensated shortages, would be the preservation of power production at Hoover Dam at higher levels and for longer durations by reducing deliveries for irrigation, domestic use, and underground storage in a manner that would not otherwise occur under current practices.

[3] In the event that a shortage is declared and is also considered to be an extraordinary drought under the 1944 Treaty, deliveries to Mexico will be reduced in the same proportion as consumptive uses in the United States are reduced.
[4] The Reclamation States Emergency Drought Relief Act of 1991, 43 U.S.C. §§ 2201 *et seq.*, provides the Secretary of Interior the authority to purchase water "from willing sellers, including, but not limited to, water made available by Federal Reclamation project contractors through conservation or other means with respect to which the seller has reduced the consumption of water." 43 U.S.C. § 2211(c).

Given the significant loss in generating capacity that has already occurred as a result of declines in power pool elevations,[5] and the even more significant impacts that would be associated with a total loss of generating capacity, the implementation of "Conservation Before Shortage" would clearly benefit power purchasers and consumers. As such, it would seem reasonable to derive a percentage of the funding for the proposed voluntary conservation program from a modest, conditional surcharge on power rates under existing or renewed contracts for hydropower produced at Hoover Dam as a means to mitigate against the loss of power head and stave off the complete loss of power production at Hoover Dam.[6] This surcharge could be imposed in years when Reclamation's August 24-month study projects that the storage in Lake Mead falls below fifty percent of its active capacity. The revenues generated by this surcharge could be collected in a "power pool protection fund," to be maintained by Reclamation for expenditure when and if lake elevations reach a conservation "trigger."

Temporary Cost Recovery/Delivery Surcharges

Pursuant to the Drought Relief Act, the Secretary of Interior is authorized to engage in water purchases from willing sellers and to seek cost recovery for water delivered from the users of that water under temporary contracts. 43 U.S.C. §2211(c), §2212(a),(c). Reclamation could utilize this authority to purchase water through temporary, part-year fallowing arrangements, dry-year options, or similar mechanisms, and would seek cost recovery from Colorado River users. In recognition of the Basin-wide interest in alleviating the impacts of drought and reducing uncertainty on the Lower Colorado, and in the interests of encouraging extraordinary conservation to minimize the likelihood of significant delivery interruptions, the cost of some portion of conservation agreements, including those with Colorado River users in Mexico, could be funded through a conservation surcharge imposed on a per-acre-foot basis on all Lower Basin contractors.

Anticipated Cost of Conservation

Current short-term leasing agreements between farmers and irrigation districts or municipal water agencies, as well as recent research on the net returns per acre-foot of irrigation water, suggest that "Conservation Before Shortage" water could be obtained for $20 - 100 per acre-foot. To ensure that such water remains available in times of increased scarcity (when market forces might otherwise increase the cost), the Secretary should be granted the authority to enter into "Conservation Before Shortage option agreements," similar to existing dry-year leasing agreements/interruptible supply agreements that have been enacted within the basin states.

[5] Largely as a result of declining reservoir elevations, power production at Hoover and Glen Canyon has declined steadily since the onset of drought conditions in the Colorado River Basin. Annual power production at Hoover fell from 5,697 gigawatt-hours (GWh) in 1998 to 4,094 GWh in 2003, according to Western Area Power Administration (WAPA) Annual Reports, 1998 – 2003. A portion of hydropower revenues currently supports the two Upper Basin endangered fish recovery programs, the Glen Canyon Adaptive Management Program, and the Colorado River Salinity Control Program; alternative sources of revenue should be identified and implemented to fully fund these recovery programs. The Department of the Interior should also work proactively with WAPA to identify alternative sources of power for those Indian tribes that have experienced power shortages, or drastic increases in power costs, due to the declining production associated with falling reservoir levels.

[6] The rates for power produced at Hoover Dam have increased as reservoir levels and power production have declined, but may still remain well below open market rates. Although annual revenues tend to vary from year to year, revenues from Hoover Dam power production have generally been in the range of $50 million annually.

IV. Analysis: Benefits of Conservation Before Shortage Policy

To date, actual shortage criteria for the Colorado River have not been defined. For the purposes of comparison, a ‘baseline’ was defined as the current operating conditions for the Colorado River, with the addition of a policy requiring the absolute protection of Lake Mead at 1000 feet (that is, Hoover Dam would not release any water to cause the elevation of Lake Mead to drop below 1000 feet). The baseline policy does *not* provide for the implementation of conservation measures. These ‘baseline’ conditions, reflecting current operating conditions, are depicted in the following figures.

Analysis of the “Conservation Before Shortage” policy suggests that this policy could produce significant benefits for Basin water users by:

- Consistently maintaining reservoir storage and power head above baseline conditions in average to low flow conditions, resulting in increased power production and improved power revenues;
- Significantly reducing the likelihood of involuntary, uncompensated shortages in the Lower Basin and corresponding, unmitigated economic impacts;
- Significantly reducing the likelihood of involuntary and uncompensated shortages in the Lower Basin at levels above 500,000 acre-feet (the approximate level at which a shortage imposed by the Secretary would cut into CAP deliveries, by exceeding the ability of the Arizona Water Bank to readily buffer the shortage); and
- Eliminating the risk that elevations at Lake Mead will drop below minimum power head, improving the reliability of power production and associated revenues.

The analyses below show the impacts of the “Conservation Before Shortage” (CBS) policy on reservoir operations based on historic flows in the Colorado River Basin.

Modeling Assumptions

The proposed “Conservation Before Shortage” policy was modeled using Reclamation’s Riverware model, which is based on historical records of flows in the Colorado River Basin over approximately the past century. Conservation triggers, as described in Section III, were implemented at 1100 feet, 1075 feet and 1050 feet, with the assumption that required measures to reduce Lower Basin consumptive use by 200,000, 400,000, and 600,000 acre-feet, respectively, would be implemented in years when the January 1 elevation at Lake Mead is below the triggers. An absolute protection trigger was implemented at Lake Mead elevation 1000 feet, with releases from Lake Mead to meet delivery obligations to Lower Basin users reduced as necessary to maintain that level. To avoid even modestly under-predicting the elevations of Mead and Powell pools, particularly in the near term, this modeling has assumed that the schedule of Upper Basin depletions will effectively begin with the last reported actual level for CY 2000, will increase at a slower rate than projected by the Upper Colorado River Basin Commission through CY 2009, and will increase at the rate projected by the Commission thereafter.[7]

For purposes of the model, the minimum objective release out of Lake Powell was assumed to be 8.23 maf per year (reflecting current operating conditions).[8] Alternative scenarios for conjunctive management were not modeled, and the protection of a minimum power pool at Lake Powell was not incorporated into this proposal; either or both of these assumptions would affect the elevation of Lake Powell. Model runs used end-of-year 2004 elevations at Lake Mead and Lake Powell to establish initial conditions for 2005, and were run through year 2025.

Protection of Lake Mead

Figures 1 -3 show the potential value of implementing the CBS policy, under a range of average to extremely low flow conditions. **These and following figures show that the CBS policy would greatly benefit the elevation of Lake Mead.**

As shown in Figure 1 below, under average conditions, the CBS policy would maintain reservoir elevations at Mead approximately 30 feet above the baseline policy. As shown by Figures 2 and 3, the CBS policy would significantly reduce the rate of decline in the lower 25th and in the very low 10th percentile reservoir elevations for Mead and maintain even these lower reservoir elevations above the 1000 foot protection level. Model runs showed essentially no impact of the CBS on the higher 90th percentile Mead elevations, so no figure is provided.

[7] *See* "Estimates of Future Depletions in the Upper Division States," Upper Colorado River Commission Memorandum, December 23, 1999. This schedule predicts a 440,000 acre-foot increase in Upper Basin depletions between 2000 and 2010 and a 542,000 acre-foot increase over actual CY2000 depletions, as reported in Reclamation's Consumptive Uses and Losses 1996-2000 report (see Tables UC-1 & UC-6). Actual increases in Upper Basin depletions water may not keep pace with this schedule, because water that would otherwise have been utilized has been and may continue to be physically unavailable for depletion in the Upper Basin due to drought conditions, and in other cases, projects that were proposed to have been constructed during this period may not yet have been or will not be completed through CY 2009. A slower rate of increase from 2000 to 2009 was modeled by subtracting four increments of 100,000 acre-feet from the Commission's schedule from CY 2005 to 2009. This and all other Riverware modeling exercises should be revised to reflect actual increases in Upper Basin depletions as soon as more current information becomes available.

[8] This assumption is not intended to endorse or reject the Secretary's current use of 8.23 maf as the minimum release objective for Powell, the protection of a minimum power pool at Powell, or proposals for the conjunctive management of the combined storage of Mead and Powell. Alternative release scenarios should be incorporated into the modeling for this proposal as they are developed. As a general matter, none of the assumptions used in this proposal should be construed as an interpretation of the 1922 Colorado River Compact, the 1944 Treaty with Mexico, or any other aspect of the Law of the River.

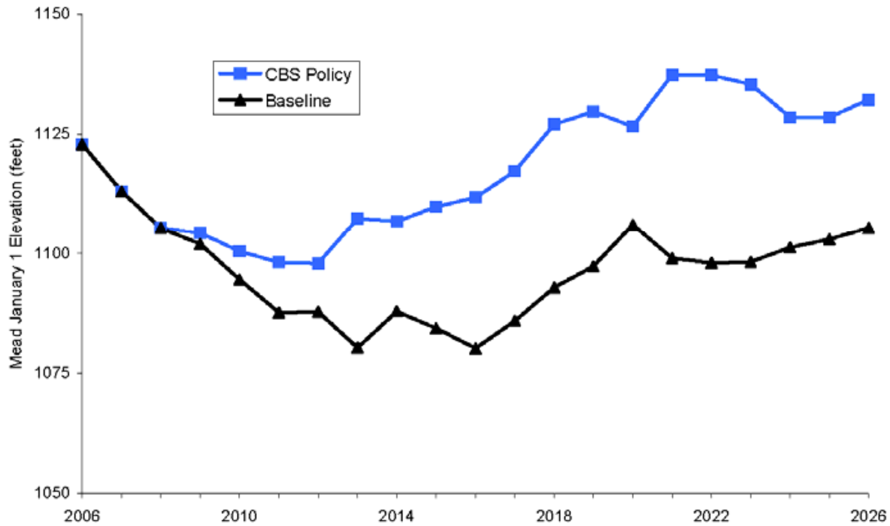

Figure 1. Impact of CBS policy on elevations at Lake Mead, at 50th percentile elevation.

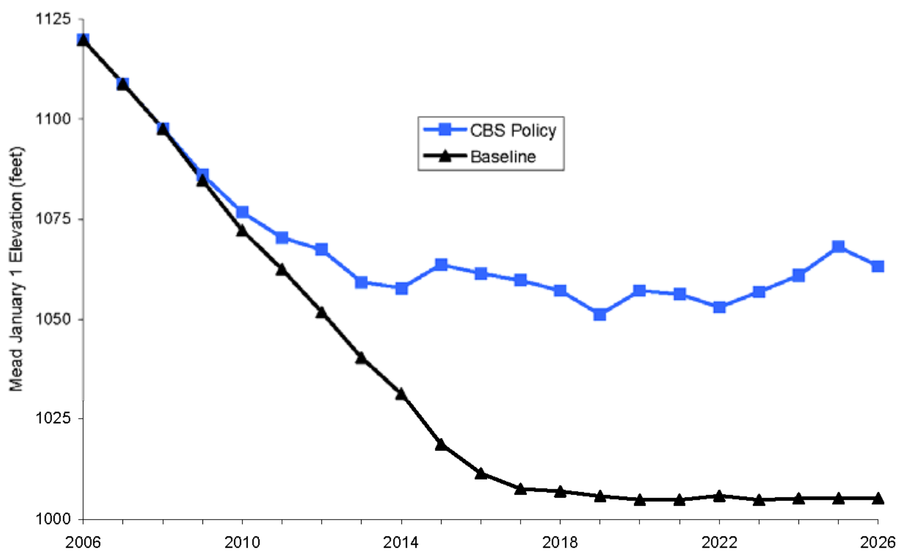

Figure 2. Impact of CBS policy on elevations at Lake Mead, at 25th percentile elevation.

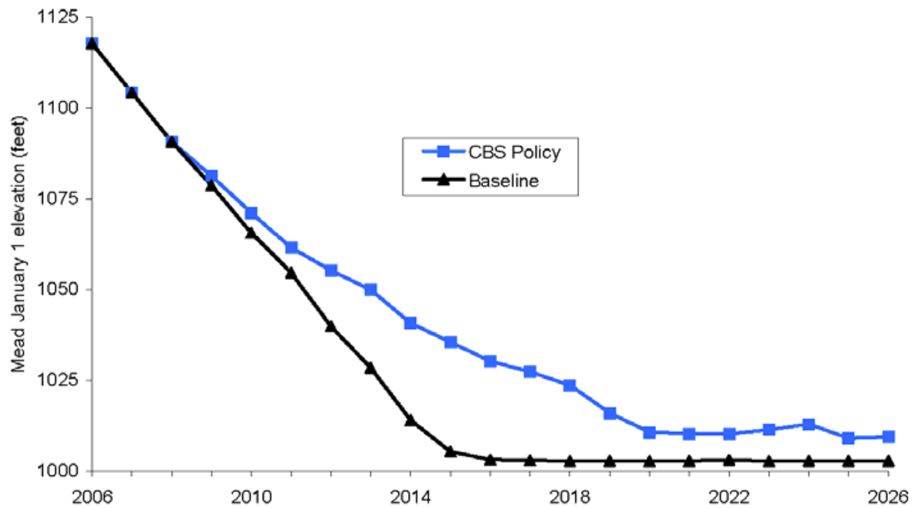

Figure 3. Impact of CBS policy on Lake Mead elevation, at 10[th] percentile elevation.

Probability of Shortages

As noted above, a primary goal of the CBS policy is to significantly reduce the probability of an involuntary, uncompensated shortage in excess of 500,000 acre-feet (the approximate level at which CAP deliveries would be reduced beyond that currently utilized for water banking). **As shown in Figure 4, below, the probability of shortages exceeding 500,000 acre-feet is reduced to 5% or less through the entire modeled period under the CBS policy. By contrast, the probability of shortage under the baseline policy rapidly approaches 30% during this same period. Furthermore, as shown in Figure 5, below, the CBS policy reduces the probability of any involuntary shortage by approximately 20% over the next 20 years.**

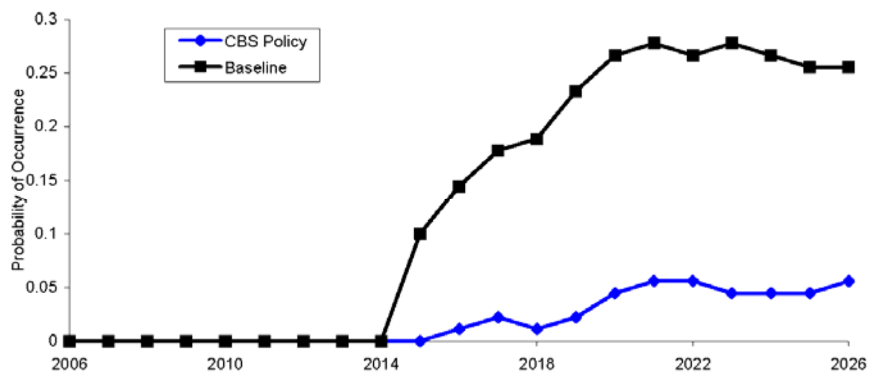

Figure 4. Impact of CBS policy on probability of involuntary Lower Basin shortage greater than 500,000 acre-feet.

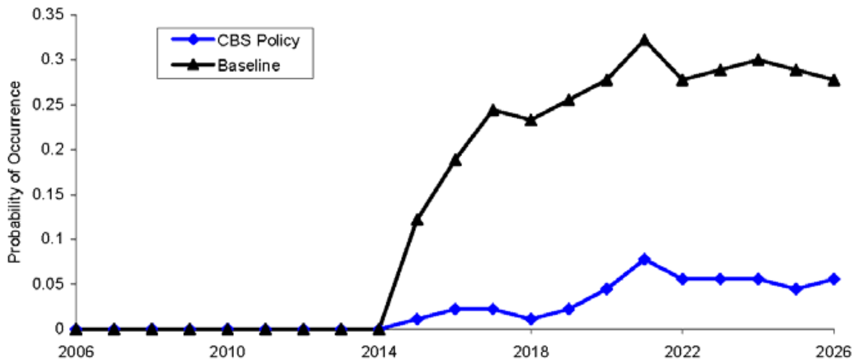

Figure 5. Impact of CBS policy on probability of any involuntary shortage in the Lower Basin.

Probability of Reaching Conservation Triggers

Figures 6 - 8, below, show the relative probability of reaching or exceeding any of the proposed conservation triggers at 1100 feet, 1075 feet and 1050 feet. As one might expect, the probability of reaching the first two triggers is highest in the earlier years of the modeled period, while the probability of reaching the third trigger is higher towards the end of the modeled period. However, the probability of reaching and continuing to remain below a given trigger for an extended period of time appears to be low because of the conservation measures tied to the triggers. For obvious reasons, trigger levels are most likely to be reached under low or very low flow conditions, and are rarely (if ever) reached under high flow conditions.

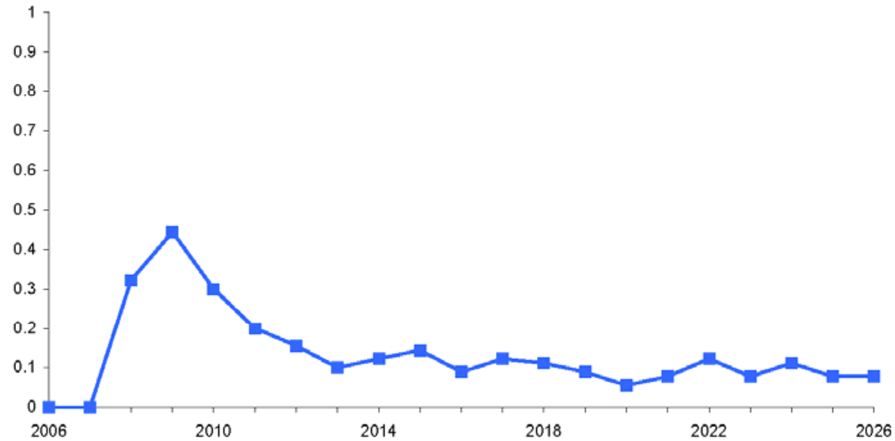

Figure 6. Probability of Lake Mead January 1 elevation occurring in a bounded range of 1100 feet to 1075 feet, with CBS policy in place.

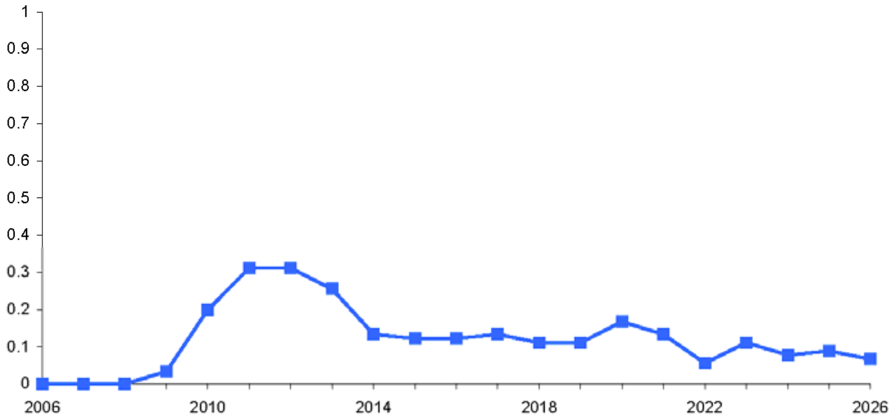

Figure 7. Probability of Lake Mead January 1 elevation occurring in a bounded range of 1075 feet to 1050 feet, with CBS policy in place.

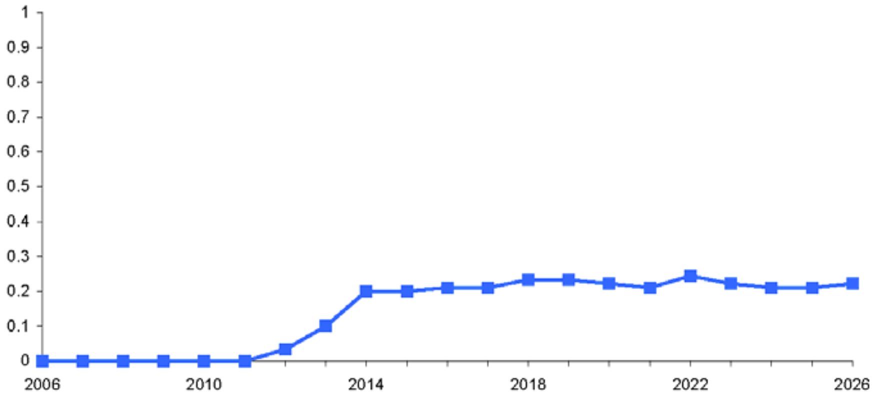

Figure 8. Probability of Lake Mead January 1 elevation occurring below 1050 feet, with CBS policy in place.

Cost of Implementing Conservation Triggers

The cost of implementing conservation triggers is directly related to the cost of obtaining water using the proposed voluntary, market-based conservation mechanisms. Recent purchases of water from farmers in the Lower Basin, as well as analysis of agricultural production in this area, suggest that there is a substantial volume of water used for irrigation which could potentially be obtained on a temporary basis for $20 - 100 per acre-foot. For example, in 2004, the Imperial Irrigation District acquired water from its farmers for less than $60 per acre-foot.

As shown in Figure 9, a recent economic study by Environmental Defense into the profits returned by field crops suggests that slightly more than 2.3 million acre-feet of agricultural water is being used by Lower Basin farmers in California and Arizona to produce profits of less than $100 per acre-foot; more than one million acre-feet of agricultural water is being used to produce profits of less than $20 per acre-foot. (Figures are based on the average volume of water applied to produce a crop unit and market rates for each crop, less costs of production.)

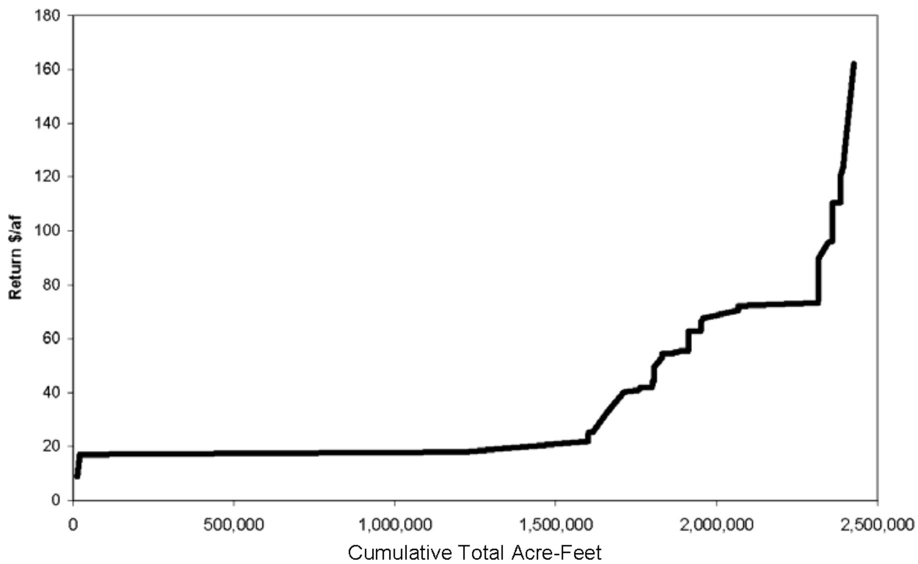

Figure 9. Profits per acre-foot returned on Colorado River water used in the production of selected crops in the Lower Colorado River Basin. [9]

While these figures do not necessarily reflect the amount at which any given water user would be willing to take part in a part-year fallowing program or agree to a dry-year option, they do suggest that if an open, market-based approach is used to identify potential participants, a number of water users in the Lower Basin would probably be willing to temporarily reduce or forgo the use of water for agricultural production in a price range between $20 and $100 per acre-foot (as the sale of water in this range would produce equal or greater monetary returns to the user than the use of water to irrigate crops).

In order to mitigate third-party impacts of fallowing, the federal government could establish a drought economic adjustment fund that would provide economic development grants to affected communities in the counties of origin. These funds preferentially would go to established county-based farm labor assistance programs to the extent that such programs exist, and could include lump sum payments to displaced workers based on a percentage of foregone annual income.

[9] This graph has not been published elsewhere. For methodology, please contact Jennifer Pitt at jpitt@environmentaldefense.org. A study using similar methodology, but limited to crop values in the Wellton-Mohawk Irrigation and Drainage District, has been published previously (Pitt et al., New Water for the Colorado River: Replacing the Bypass Flow, 6 U. Denver Water L. Rev. 68 (2002)). The study found a range of prices similar to that represented here for profits derived from water use in that area.

Using these assumptions for water acquisition costs, Table 1 suggests the approximate range of costs for implementing each of the conservation triggers under the CBS policy.

Table 1. Approximate federal and power/water user cost of implementation of CBS policy conservation trigger levels (assumes that water can be acquired temporarily for $20 - $100/acre-foot, and that the annual federal bypass obligation of 110,000 acre-feet has not otherwise been satisfied).

Trigger	Conservation required	Federal obligation (bypass + 50%)	Federal cost (millions)	Remaining Obligation	Water user cost (millions)	Power Surcharge (millions)	User cost per af (all Lower Basin users)
1075-1100	200,000 af	155,000 af	$3 - $15.4	45,000 af	$0.45 - $2.3	$0.45 - $2.3	$0.06 - $0.30
1050-1075	400,000 af	255,000 af	$5 - $25.4	145,000 af	$1.5 - $7.3	$1.5 - $7.3	$0.19 - $0.97
Below 1050	600,000 af	355,000 af	$7 - $35.4	245,000 af	$2.5 - $12.3	$2.5 - $12.3	$0.33 - $1.63

Cost of Not Implementing "Conservation Before Shortage" Policy

Although the "Conservation Before Shortage" policy would impose notable costs on water and power users, and on taxpayers generally, these costs should be compared with the much larger financial costs that would occur if the Secretary were to impose involuntary, uncompensated shortages, as well as the costs due to the lack of certainty and reliability that would exist without the CBS policy. The recent drought and decrease in power production at both Hoover Dam and Glen Canyon Dam point to the dramatic costs imposed by the loss of reservoir storage.

If Lake Mead falls to 1050 feet, power rates will need to be increased to an approximate composite rate of 2.31 cents/kWh, which is a 44.3% increase over current rates. Replacement power purchases would be (depending on the user) 2.9 to 3.7 times the Hoover rate. In FY03, replacement power may have cost customers an additional $24 million.

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Attachment B

Taking ICS to Mexico: International Opportunities in the Seven States Agreement

This attachment to Appendix K contains the text of a proposal to expand the ICS mechanism to include Mexico.

Taking ICS to Mexico:
International Opportunities in the Seven States Agreement

Introduction

The Seven Basin states recently reached agreement on a far-reaching proposal to improve the management of Colorado River system water through conjunctive management of Lakes Mead and Powell, modification and extension of the existing interim surplus guidelines, and the adoption of shortage guidelines. Perhaps most significantly, this agreement introduces of a series of new mechanisms to increase flexibility within the Lower Basin delivery system and water allocations, including the creation of a new category of water: "Intentionally Created Surplus," which can be generated through extraordinary conservation measures or the funding of system efficiency improvements, and the recognition of water exchanges.

At the present time, the states' proposal is largely concerned with operations between and among the Basin states, particularly the states of the Lower Basin, although some elements of the proposal (such as water exchanges) have apparently contemplated Mexican participation. However, it would appear that significant benefits for U.S. water users, Mexican water users, and the environment could also be derived from expressly extending portions of the proposed agreement to water users in Mexico – while helping Mexican users to more readily bear burdens that could otherwise be imposed by the alterations proposed in the states' accord.

In particular, an extension of proposed policies related to Intentionally Created Surplus (ICS), system efficiency improvements, and water exchanges to include water users in Mexico could provide significant assistance in resolving difficult issues related to urban, agricultural, and environmental water supplies in Mexico, while opening enormous opportunities for both U.S. and Mexican water users to obtain water supplies via funding of irrigation efficiency improvements, the construction of urban water infrastructure, water supply replacement or enhancement, desalination, and other projects. These credits could be used to firm up urban water supplies in both countries, engage in long-studied environmental restoration projects in the Delta, and increase flexibility in Mexico's agricultural sector – creating economic, environmental, and social benefits in both countries while offering the United States and Mexico a venue for cooperation in the otherwise contentious area of water management at the border.

These outcomes would meet all three of the purposes identified in the Basin States' original proposal: improving cooperation and communication, providing additional security and certainty in the water supply of the Colorado River System, and avoiding circumstances which could otherwise form the basis for claims or controversies over the Colorado River Compact and other applicable provisions of the Law of the River.

While an extension of this agreement to include Mexico would likely need to occur on a different timeframe than for the domestic implementation of the agreement, the domestic process should at least not close the door on an international program, and would preferably encourage the initiation of binational discussions on the issue. Since critical elements of the states' current proposal – most notably the proposed shortage policy and proposed policies for unilateral water exchanges – will already require consultation with Mexico and/or the adoption of a new Minute, these opportunities could be considered in the same diplomatic process.

Binational Challenges for the Seven States' Agreement

Mexico has no storage system for Colorado River water, and as such, is effectively dependent on the U.S. reservoir system to guarantee water deliveries to meet municipal and agricultural demands. In addition, although the Mexicali Valley has significant groundwater resources, Mexico does not currently operate a water bank or other shortage mitigation program comparable to those in place in the United States (e.g., the Arizona Water Bank). At the same time, the lack of storage in Mexico effectively prevents Mexico from accumulating reserve supplies that could be used to meet environmental needs in Mexico (such as pulse flooding the in Delta region, which has been identified as a necessary precondition to effective restoration of key riparian areas). In the face of a rapidly growing population, ongoing efficiency and water accounting issues in its agricultural sector, and increasing pressure to protect and restore critical environmental resources in the Delta, Mexico faces a uniquely challenging situation with regard to the management of its water resources.

Of particular concern for Mexico in the states' proposal could be the provisions related to the implementation of shortages on the Lower Colorado. Although the Treaty of 1944 provides that Mexico is to share "proportionately" with U.S. users in times of "extraordinary drought," the precise meaning of this provision remains unclear, and it has never been invoked since the time of the Treaty's execution. The states' agreement, for the first time, unilaterally and precisely defines a set of proposed parameters under which shortages would be implemented against the Mexican allocation. Because Mexico has no readily available mechanisms to reduce or mitigate against shortage impacts on its users (such as reservoir storage or water banking), the potential for shortages will cause understandable concern for Mexican water users – similar to those that have arisen among low-priority users in the U.S.

Similarly, although conjunctive management of Lakes Mead and Powell as proposed in the states' agreement will doubtless help to reduce the probability that such shortages will actually occur, this will potentially come at the cost of decreasing the probability of future spills from these reservoirs in the future, since reservoirs may be drawn down further in the event of drought, increasing available capacity to absorb flood events in the future. The states' proposal also appears likely to create incentives to further increase the efficiency of U.S. water delivery systems by providing opportunities to receive ICS credits for the funding of these projects (e.g., Southern Nevada Water Authority's proposed funding of the Drop 2 reservoir); these projects will further reduce normal-year deliveries to Mexico. Combined with gradually increasing efficiency in agricultural water use, this will continue to pose challenges for the maintenance of critical environmental values in the Delta, which receive virtually all of their current water supplies from agricultural return flows, excess deliveries, canal leakage, and occasional flood events.

However, the states' proposal also offers a potential opportunity to promote binational solutions to these concerns as well as a broader suite of water issues in the border region – particularly insofar as it could be used to promote improvements in agricultural efficiency, water infrastructure, and municipal water quality and supply in Mexico. A brief discussion of these opportunities is provided below, together with examples of how particular programs might work. Of course, any projects undertaken would require the review, approval, and continuing oversight of both countries. However, it is critical to note that each of these programs could be undertaken without altering Mexico's basic Treaty entitlement to Colorado River water; any decrease (or increase) in Treaty deliveries would be matched by a mutually agreed-to compensation program or a proportionate increase (or decrease) in water deliveries in a later year. None of these programs would change Mexico's right to Colorado River water deliveries under the 1944 Treaty.

Expanding Three Elements of the States' Proposal to Mexico: How It Could Work

Intentionally-Created Surplus (ICS)

Under the states' proposal, a contractor could generate "ICS credits" by engaging in extraordinary conservation activities that have the effect of reducing the use of Colorado River water. These activities could include land fallowing, canal lining, desalination, or other extraordinary conservation measures agreed to by the states, so long as they result in the savings of water that would otherwise have been beneficially used as a part of a state's basic entitlement (surplus water cannot be used), the contractor plans and identifies the intended savings in advance (by September 15 of the preceding year), and the credits are first used to offset any delivery overruns.

These ICS credits would then be stored in Lake Mead for use by the contractor at some future time, subject to annual reductions to account for storage losses to reservoir evaporation, and a 5% "system tax" that would accrue to the benefit of the river system as a whole.The remaining credits could then be used during any year with "normal" operating conditions. During shortage or surplus conditions, the credits could not be used, and they would be reduced on a pro-rata basis in the event of a spill. However, for the purposes of determining calendar year declarations of surplus, normal, and shortage conditions, stored water that is subject to ICS credits would be considered system water – helping to keep reservoir levels higher in Powell and Mead and avoid shortages in the Lower Basin.

ICS credits would be subject to both yearly and cumulative maximums for each state, with California limited to no more than 400,000 acre-feet per year and a total credit of 1.5 million acre-feet, and Arizona and Nevada to 100,000 and 125,000 acre-feet per year, respectively, and total credits of 300,000 acre-feet. Recovery of ICS credits is similarly limited to 400,000 acre-feet annually for California and 300,000 acre-feet annually for Arizona and Nevada.

- How it could work in Mexico:[1]
    - Mexican users could engage in extraordinary conservation activities in Mexico with the effect of reducing actual beneficial use such that deliveries to Mexico under the Treaty could be temporarily reduced below 1.5 million acre-feet in any one year. This would generate ICS credits that would be available for delivery to Mexico in later years, under the same rules applicable to U.S. users, resulting in temporary increases in deliveries above the 1.5 million acre-foot Treaty obligation.
        - Example: Pronatura Sonora pays to temporarily fallow low-productivity lands in the Mexicali Valley, saving 30,000 acre-feet of water a year over a period of years. Treaty deliveries in each year are accordingly reduced below 1.5 million acre-feet, resulting in increased storage in Lake Mead. Pronatura receives an ICS credit which it can deliver to Mexico in a future year as a pulse flow for a riparian restoration project (after reducing the ICS credit for reservoir evaporation and paying the 5% system tax).

System Efficiency Projects

In addition to creating ICS through extraordinary conservation activities for existing uses of Colorado River water, the states' proposal allows for Colorado River users to receive ICS credits in exchange for making capital contributions to projects that would increase the overall efficiency of the Colorado River delivery system. The credits would comprise a portion of the water saved through the efficiency project, and would not be stored, but would rather be provided to the user that developed the credit on a predetermined schedule for some period of years.

- How it could work in Mexico: Mexican or U.S water users could fund delivery system efficiency improvements and receive proportionate amounts of temporary ICS credits for their investments that could be used under the same rules applicable under the states' proposal. These temporary credits would have the effect of either increasing (if funded by a Mexican user) or reducing (if funded by a U.S. user) Treaty deliveries to Mexico for an agreed period of time. After the temporary ICS credits expired, the system efficiency improvement would accrue to the country in which the project was undertaken.
    - Example: Metropolitan Water District develops a cooperative program with CNA and the U.S. federal government to invest in upgrades to the Mexicali Valley irrigation system, including canal lining and water

[1] The legal mechanism for implementing the extension of ICS and water exchanges to Mexico is discussed below.

accounting infrastructure, resulting in significant savings of water that would otherwise have been lost in the delivery system while improving or at least maintaining agricultural productivity. MWD receives a fixed amount of ICS credits for a period of years that can be used as a "bridge" supply until permanent water transfers from U.S. agricultural sources are completed. After the expiration of that period, all ICS credits revert to Mexico. Mexico, in turn, commits to dedicate a portion of the water saved to natural habitat restoration in the Colorado River Delta. With the approval of the U.S. Fish and Wildlife Service and appropriate international agreements, this could even result in some partial credit under the Multi-Species Conservation Program. Mexico uses the bulk of efficiency savings from the program to improve urban and agricultural water supplies, including offsetting expected impacts from the lining of the All-American Canal.

Water Exchanges

Finally, the states' proposal allows Colorado River users in the Lower Basin to secure additional water supplies by funding the development of a non-Colorado River System water supply in one state for use in another state by exchange. The new water supply would be used in place of the Colorado River water supply, allowing the user that provided the funding to use the Colorado River water that is no longer used through and agreement with the Secretary of the Interior. The states' proposal expressly contemplates exchanges with Mexico, albeit only unilateral exchanges in which non-Colorado River System supplies would be developed in Mexico, with the savings used in the United States.

- How it could work in Mexico: This program could be extended to a bilateral program in which water could be exchanged in either direction, with exchanges resulting in commensurate increases or decreases in Treaty deliveries (indeed, it is unclear why Mexico would agree to a purely unilateral program as proposed by the states).

Opportunities in Mexico

The examples cited above suggest just a few of the opportunities which could be explored if the states' proposal could be extended to users in Mexico - opportunities that could help not only to offset the impacts of the states' proposal, but also to meaningfully improve the tools available to meet human and environmental needs in the border region.

Over the years, there have been a number of proposals suggesting means by which the United States and Mexico might cooperate to improve both agricultural efficiency and municipal water quality in the border region. Notably, in 1991, the United States Bureau of Reclamation (BOR) and the Comisón Nacional del Agua (CNA) released a joint proposal entitled "International Cooperative Water Conservation and Irrigation Efficiency Improvement Program between the Republic of Mexico and the United States of America" that was championed by Dennis Underwood. This proposal noted similarities between cropping patterns and irrigation methods in the Imperial and Mexicali Valleys, and based on the experience of municipal and industrial users in California with investment in efficiency improvements (that were otherwise beyond the means of farmers in the region), suggested that similar investments in the Mexicali Valley could produce significant short and long-term water supply benefits.

Observations of water management in the Mexicali Valley suggest that there remain significant opportunities for improving water delivery and use through system automation, operational changes to improve the timing and quantity of deliveries, conversion to high capacity farm turnouts, canal lining, spill interception, land leveling, installation of canal turnouts for rapid delivery, improved cropping patterns, changed field irrigation practices and adaptation to low water-use technologies, improvements to drainage, and improved maintenance procedures. Water conserved from these efforts could be beneficial in terms of providing replacement supplies in the face of shortages, reducing dependence of local farmers on groundwater supplies, and providing environmental benefits.

For example, the Mexicali Irrigation District (DDR 0014) reports approximately 645,000 af/yr (800 mcm/yr) in conveyance losses that are recoverable (as opposed to conveyance losses that recharge groundwater supply[2]). Based on some extremely rough estimates, of this total conveyance loss, approximately 150,000 af/yr (200 mcm/yr) may be attributable to seepage from major canals. Much of this latter seepage apparently occurs along approximately 70 kilometers of unlined canal sections, which could potentially be lined, by one estimate, for around $600 million pesos (US $56 million). These include the Reforma canal (28 km, estimated lining cost $150 million pesos or US $13.7 million), the Revolución canal (20 km, no lining estimate available), the Alimenta del Sur canal (5.5 km, no lining estimate available), and the Nuevo Delta canal (16 km, lining cost $300 million pesos or US$27.4 million).[3] None of these sections reportedly cross or recharge aquifers from which significant amounts of groundwater are recovered or that support river flows or wetlands. The total estimated costs of all of these lining projects would likely be comparable to the $80-$90 million construction cost for the Drop 2 storage reservoir, but could potentially produce a far larger quantity of savings at a much lower cost per acre-foot.

The opportunities associated with an international expansion of the seven states proposal are not limited to agricultural water use. Mexico is currently experiencing increasing risks of shortages to municipal and industrial water supplies in the Mexicali Valley and the major communities to the west of the Valley – as well as significant concerns related to water quality due to high water salinity in the Mexicali Valley region and water

[2] The extent to which the aquifers are interconnected and to which such losses are recoverable without impacting groundwater recharge that is pumped for irrigation or that supports river flows or wetlands should be verified by geo-hydrologic investigation, modeling, and monitoring.

[3] These figures are rough estimates based on informal discussions with a former employee of CONAGUA and are provided for illustrative purposes only. The estimated costs for lining the Nuevo Delta canal reach are apparently high due the location of this reach over a geologic fault.

pollution. These concerns create a significant opportunity for the use of tools such as ICS and system efficiency investments to improve these supplies – and perhaps just as significantly, opportunities to invest in desalination or other technologies to replace low-quality Colorado River supplies or otherwise improve water quality for municipal use.

Creating a Delta Water Supply

These proposals would necessarily require consideration of environmental needs in the Colorado River Delta. As numerous studies have pointed out, the remaining Delta ecosystem largely depends on “system inefficiencies” for its water supply – such as return flows from agriculture, effluent flows, canal leakage, and releases in excess of Treaty requirements from the U.S. These proposals would create inevitable incentives to reduce these inefficiencies in Mexico (just as the states’ proposal creates incentives to reduce inefficiencies in the United States). As such, it is essential that any program in Mexico provide a mechanism for replacing (or improving) the Delta’s water supplies while meeting critical agricultural and municipal needs.

To a certain extent, this issue could be addressed through implementation of an ICS mechanism in Mexico. Several recent studies, including a recent Packard Report, “Immediate Options for Augmenting Water Flows to the Colorado River Delta in Mexico,” have investigated options related to taking existing, marginal agricultural lands in Mexico out of production and utilizing the water associated with those lands for environmental purposes. The Sonoran Institute and Pronatura Noroeste-Sonora, together with other NGO partners, are currently in the process of exploring just such an option, focusing on highly marginal lands in the southern portions of the Mexicali Valley where salt buildup and shallow groundwater create economic challenges for agricultural production. Although funding for these efforts has not yet been secured, mechanisms have been identified for holding water derived from these lands via water trusts, wheeling water to appropriate locations, and designating protected receiving areas in the riparian corridor to ensure that water is used for environmental benefit.

Nevertheless, reliance on non-governmental organizations alone will not guarantee the continued availability of water to support key ecosystem values in the Delta. To ensure the continued viability of the Delta ecosystem – and to avoid ongoing uncertainties for U.S. and Mexican water users associated with environmental challenges to water allocations – any international program should include a process for securing necessary environmental flows, such as the dedication of a portion of the proceeds of various water-saving programs to provide a permanent, reliable supply of water to replace current supplies and support environmental uses in the Delta.

Making a Binational Proposal Work: Changes to the States’ Proposal and the Treaty of 1944

Implementation of a binational program for Intentionally-Created Surplus, efficiency improvements, and water exchanges would of course require an alteration to the current framework of the Treaty of 1944 between the United States and Mexico. Currently, the

Treaty requires the delivery of 1.5 million acre-feet of water to Mexico annually, absent surplus or extraordinary drought.

It should be noted that none of the proposals discussed above would have the result of altering the basic entitlements of either the United States or Mexico under the Treaty; regardless of the program developed, Mexico would continue to have the same 1.5 million acre-foot entitlement to Colorado River water even if the precise timing (or the place) of the delivery of that entitlement was altered). As such, the implementation of such programs should not result in any conflict with other provisions of the Law of the River, and in particular the Colorado River Compact, since no change in position between the U.S. and Mexico would occur.

However, the implementation of the proposals discussed above would require temporary reductions or increases in deliveries above or below this basic number to the extent that water was stored or released from Lake Mead in response to programs generating ICS via extraordinary conservation or investment in system efficiency improvements, or else via water exchanges between parties in the U.S. and Mexico. As such, an appropriate alteration to the delivery rules under the Treaty would be required.

This could be effectively accomplished via the addition of a new Minute to the Treaty of 1944, adopted through the International Boundary and Water Commission (IBWC). Pursuant to the Treaty of 1944, IBWC is authorized to build and manage waterworks, to resolve problems and negotiate further agreements regarding international waters, and to settle treaty-interpretation disputes.[4] The Treaty grants broad jurisdiction to IBWC to "plan, build, and manage water works; to enter into further agreements regarding international waters," and to "settle all differences that may arise between the two Governments with respect to the interpretation or application of this Treaty, subject to the approval of the two Governments."[5] Assuming appropriate approvals could be obtained from the U.S. and Mexican federal governments, IBWC should thus have appropriate authority under the Treaty to implement a binational program for ICS, water efficiency improvements, and water exchanges based on the same rules applicable to the other Lower Basin states. In addition, any international agreement would need to address a number of technical issues that would be associated with these programs, including the development of appropriate accounting methods for water conservation, and the identification of conservation priorities and opportunities to which water generated for ecosystem use might be put.

Such a new Minute could be modeled after the new regulations or guidelines that would need to be adopted to implement the states' proposal in the U.S. As the shortage criteria for deliveries to Mexico and the states' existing proposal for unilateral water exchanges would also likely require implementation via a new Minute, these issues could be explored under the same diplomatic process.

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[4] *See* Mexico-U.S. Water Treaty of 1944, Art. 24, 59 Stat. at 1255-1257.
[5] *See* Mexico-U.S. Water Treaty of 1944, Art. 24(d).

Obviously, these proposals would require diplomatic discussions between the U.S. and Mexico before they could be appropriately implemented, which would place the implementation of an international ICS program on a different timeframe than that anticipated for the adoption of a domestic program. However, as the operation of such a program would likely require consideration of environmental concerns under the National Environmental Policy Act, as well as appropriate recognition in any guidelines that may be adopted by the Secretary to implement the states' agreement. For example, the rules used to guide the storage and release of ICS credit water would need to recognize the potential for delivery of ICS to Mexico pursuant to the Treaty of 1944, rather than solely by reference to Section II(B)(2) of the Decree and forbearance agreements between the states. Similarly, rules defining the maximum amount of ICS credits that could be generated in any one year, and the cumulative amount that could be subject to storage in Lake Mead, would also need to reference the potential for Mexican use of this system.

To ensure that a potential international program could be eventually implemented in conjunction with the states' proposed program, and assuming that there is interest among Mexican water users in such an international program, we suggest that the proposals discussed above should be appropriately considered as a part of the U.S. Bureau of Reclamation's ongoing public process for the "Development of Lower Colorado River Basin Shortage Guidelines and Coordinated Management Strategies for Lakes Powell and Mead Under Low Reservoir Conditions."

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Appendix L

Federal Register Notices

Four *Federal Register* notices have been issued to inform the public about the formulation of the interim operational guidelines and the preparation and availability of the EIS. The full text of the *Federal Register* notices is provided in this appendix.

L.1 Federal Register Volume 70, Number 114

34794 Federal Register / Vol. 70, No. 114 / Wednesday, June 15, 2005 / Notices

Bureau of Land Management lands, inquiries may also be directed to Taylor Brelsford, Subsistence Coordinator, Alaska State Office, 222 West 7th Avenue, #13, Anchorage, Alaska 99513; phone (907) 271–5806.

SUPPLEMENTARY INFORMATION: Regional Council discussion during the meeting will be devoted to the review and recommendation of the East Alaska Draft Resource Management Plan and Environmental Impact Statement.

Dated: June 7, 2005.

Henri R. Bisson,

State Director.

[FR Doc. 05–11774 Filed 6–14–05; 8:45 am]

BILLING CODE 4310–JA–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Colorado River Reservoir Operations: Development of Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice to solicit comments and hold public meetings on the development of management strategies for Lake Powell and Lake Mead, including Lower Basin shortage guidelines, under low reservoir conditions.

SUMMARY: The Secretary of the Interior (Secretary) has directed the Bureau of Reclamation (Reclamation) to develop additional Colorado River management strategies to address operations of Lake Powell and Lake Mead under low reservoir conditions. It is anticipated that, among other potential elements, these strategies could identify those circumstances under which the Department of the Interior (Department) would reduce annual water deliveries, and the manner in which annual operations would be modified.

DATES AND ADDRESSES: Two public meetings will be held to solicit comments on the content, format, mechanism, and analysis to be considered during the development of management strategies for Lake Powell and Lake Mead under low reservoir conditions. Oral and written comments will be accepted at the public meetings to be held at the following locations:

- *Tuesday, July 26, 2005*–10 a.m. to 12 noon, Henderson Convention Center, Grand Ballroom, 200 South Water Street, Henderson, Nevada.
- *Thursday, July 28, 2005*–10 a.m. to 12 noon, Hilton Salt Lake City Center, Topaz Room, 255 South West Temple, Salt Lake City, Utah.

Written comments on the proposed development of these strategies may be sent by close of business on *Wednesday, August 31, 2005,* to: Regional Director, Bureau of Reclamation, Lower Colorado Region, Attention: BCOO–1000, P.O. Box 61470, Boulder City, Nevada 89006–1470, fax at 702–293–8156, or e-mail at *strategies@lc.usbr.gov;* and/or Regional Director, Bureau of Reclamation, Upper Colorado Region, Attention: UC–402, 125 South State Street, Salt Lake City, Utah 84318–1147, fax at 801–524–3858, or e-mail at *strategies@uc.usbr.gov.*

FOR FURTHER INFORMATION CONTACT: Terrance J. Fulp, Ph.D., at 702–293–8500 or e-mail at *strategies@lc.usbr.gov;* and/or Randall Peterson at 801–524–3633 or e-mail at *strategies@uc.usbr.gov.* If special assistance is required regarding accommodations for attendance at either of the public meetings, please call Nan Yoder at 702–293–8495, fax at 702–293–8156, or e-mail at *nyoder@lc.usbr.gov* no less than 5 working days prior to the applicable meeting(s).

SUPPLEMENTARY INFORMATION: In recent years the Department has undertaken a number of initiatives to improve the efficient and coordinated operation and management of the Colorado River. For example, a number of Indian water rights settlements have been enacted and implemented, while additional settlements are under active negotiation. Important programs have been developed in the Upper and Lower Basins to address conservation of endangered species. Scientific investigations are proceeding under the framework of the Glen Canyon Adaptive Management Program to study the impacts to and improve the values for which the Grand Canyon National Park and the Glen Canyon National Recreation Area were established. In 2003, water users in California executed agreements that will assist California to limit its use of water from the Colorado River to its normal year apportionment of 4.4 million acre-feet (maf).

More recently a new management challenge has emerged on the Colorado River. The Colorado River Basin has experienced the worst five-year drought in recorded history. Drought in the Basin has impacted system storage, while demands for Colorado River water supplies have continued to increase. During the period from October 1, 1999, to October 1, 2004, storage in Colorado River reservoirs fell from 55.7 maf to 29.7 maf.

In the future, low reservoir conditions may not be limited to drought periods as additional development of Colorado River water occurs. The Colorado River is of strategic importance in the southwestern United States for water supply, hydropower production, recreation, fish and wildlife habitat, and other benefits. In addition, the Republic of Mexico has an allocation to the waters of the Colorado River pursuant to a 1944 treaty with the United States.

In a May 2, 2005, letter to the Governors of the Colorado River Basin States, issued in the context of the 2005 Annual Operating Plan mid-year review, the Secretary directed Reclamation to develop additional strategies to improve coordinated management of the reservoirs in the Colorado River system. Pursuant to that direction, Reclamation conducted a public consultation workshop on May 26, 2005, in Henderson, Nevada, and has prepared this **Federal Register** notice. In order to assure the continued productive use of the Colorado River into the future, Reclamation is soliciting public comments on, at a minimum, the development of management strategies for the operation of Lake Powell and Lake Mead under low reservoir conditions.

It is the Department's intent that the development of additional management strategies, including Lower Basin Shortage Guidelines, will provide guidance to the Secretary's Annual Operating Plan decisions, and provide more predictability to water users throughout the Basin, particularly those in the Lower Division States of Arizona, California, and Nevada. For example, in 2001 the Department adopted Interim Surplus Guidelines (66 FR 7772) that are used by the Secretary in making annual determinations regarding ''Normal'' and ''Surplus'' conditions for the operation of Lake Mead. Among other provisions, these Guidelines have allowed the Department and entities in Arizona, California, and Nevada that rely on the Colorado River greater predictability in identifying when Colorado River water in excess of 7.5 maf will be available for use within these three states. In contrast, at this time the Department does not have detailed guidelines in place for annual determinations of releases from Lake Mead of less than 7.5 maf to water users in the three Lower Division States (often referred to as a ''shortage'' condition on the lower Colorado River). Therefore, water users who rely on the Colorado River in these states are not currently able to identify particular reservoir conditions under which the Secretary would release less than 7.5 maf for use on an annual basis. Nor are these water users able to identify the amount of any potential future annual reductions in water deliveries. By developing additional management strategies, these users would be better able to plan for periods of less than full water deliveries. Additional operational tools may also facilitate conservation of reservoir storage, thereby minimizing the adverse effects of long-term drought or low-reservoir conditions in the Colorado River Basin.

Over the past year, the seven Colorado River Basin States have been proactively discussing strategies to address the current system-wide drought in the Colorado River Basin. In addition, Reclamation has conducted detailed briefings for stakeholders in the Colorado River Basin and other interested entities regarding future scenarios for Colorado River operations. Reclamation will integrate available technical information in the upcoming development of additional management strategies for Colorado River operations.

Reclamation intends to utilize a public process during the development of management strategies for Lake Powell and Lake Mead under low reservoir conditions. By this notice, Reclamation invites all interested members of the general public, including the seven Colorado River Basin States, Indian Tribes, water and power contractors, environmental organizations, representatives of academic and scientific communities, representatives of the recreation industry, and other organizations and agencies to present oral and written comments concerning the content, format, mechanism, and analysis to be considered during the development of these proposed strategies.

Reclamation has not yet determined the appropriate level of National Environmental Policy Act (NEPA) documentation for the upcoming development of additional management strategies. However, to ensure timely consideration of technical information and public comment, Reclamation is proceeding, at this time, as if the development of additional management strategies would require preparation of an Environmental Impact Statement. Information received by Reclamation pursuant to this **Federal Register** notice and the upcoming public meetings will be analyzed in order to define the nature of any proposed federal actions, the level of appropriate NEPA documentation, and the need, if any, for additional scoping activities. In addition to NEPA documentation, other compliance activities, as appropriate, will be undertaken pursuant to applicable Federal law.

Public Disclosure

Written comments, including names and home addresses of respondents, will be made available for public review. Individual respondents may request that their home address be withheld from public disclosure, which will be honored to the extent allowable by law. There may be circumstances in which respondents' identity may also be withheld from public disclosure, as allowable by law. If you wish to have your name and/or address withheld, you must state this prominently at the beginning of your comment. All submissions from organizations, business, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public disclosure in their entirety.

Dated: June 6, 2005.

Darryl Beckmann,

Deputy Regional Director—UC Region, Bureau of Reclamation.

Dated: June 7, 2005.

Robert W. Johnson,

Regional Director—LC Region, Bureau of Reclamation.

[FR Doc. 05–11776 Filed 6–14–05; 8:45 am]

BILLING CODE 4310–MN–P

DEPARTMENT OF JUSTICE

Office of Community Oriented Policing Services, Agency Information Collection Activities: Proposed Collection; Comments Requested

ACTION: 60-day notice of information collection under review: Annual Report to Congress—Expired COPS Awards Exceeding $5 Million.

The Department of Justice (DOJ) Office of Community Oriented Policing Services (COPS) has submitted the following information collection request to the Office of Management and Budget (OMB) for review and approval in accordance with the Paperwork Reduction Act of 1995. The proposed information collection is published to obtain comments from the public and affected agencies. The purpose of this notice is to allow for 60 days for public comment until August 15, 2005. This process is conducted in accordance with 5 CFR 1320.10.

If you have comments especially on the estimated public burden or associated response time, suggestions, or need a copy of the proposed information collection instrument with instructions or additional information, please contact Rebekah Dorr, Department of Justice Office of Community Oriented Policing Services, 1100 Vermont Avenue, NW., Washington, DC 20530.

Written comments and suggestions from the public and affected agencies concerning the proposed collection of information are encouraged. Your comments should address one or more of the following four points:

—Evaluate whether the proposed collection of information is necessary for the proper performance of the functions of the agency, including whether the information will have practical utility;
—Evaluate the accuracy of the agency's estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used;
—Enhance the quality, utility, and clarity of the information to be collected; and
—Minimize the burden of the collection of information on those who are to respond, including through the use of appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology, *e.g.*, permitting electronic submission of responses.

Overview of This Information Collection

(1) *Type of Information Collection:* New Collection.

(2) *Title of the Form/Collection:* Annual Report to Congress—Expired COPS Awards Exceeding $5 Million.

(3) *Agency form number, if any, and the applicable component of the Department sponsoring the collection:* Form Number: None. Office of Community Oriented Policing Services.

(4) *Affected public who will be asked or required to respond, as well as a brief abstract:* Primary: State, Local, or Tribal Government. Law enforcement agencies that are recipients of COPS grants over $5,000,000 that are programmatically and financially closed out or that otherwise ended in the immediately preceding fiscal year.

(5) *An estimate of the total number of respondents and the amount of time estimated for an average respondent to respond/reply:* It is estimated that approximately 10 respondents annually will complete the form within one hour.

(6) *An estimate of the total public burden (in hours) associated with the collection:* There are approximately 10 total annual burden hours associated with this collection.

L.2 Federal Register Volume 70, Number 189

57322 Federal Register / Vol. 70, No. 189 / Friday, September 30, 2005 / Notices

or faxed comments should be submitted by October 17, 2005.

John W. Roberts,

Acting Chief, National Register/National Historic Landmarks Program.

ARKANSAS

Faulkner County

Lee, Carl and Esther, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 17493 US 65S, Damascus, 05001170

Tyler—Southerland House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 36 Southerland, Conway, 05001168

Ward, Earl and Mildred, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 1157 Mitchell St., Conway, 05001169

Webb, Joe and Nina, House, (Mixed Masonry Buildings of Silas Owens, Sr. MPS) 2945 Prince, Conway, 05001171

Washington County

Prairie Grove Battlefield (Boundary Increase II), N of US 62, E of Prairie Grove, Prairie Grove, 05001167

COLORADO

Montrose County

North Rim Road, Black Canyon of the Gunnison National Park, Black Canyon of the Gunnison National Park, Crawford, 05001181

GEORGIA

Bartow County

ATCO–Goodyear Mill and Mill Village Historic District, Roughly bounded by Sugar Valley Rd., Cassville rd. and Pettit Creek, Wingfoot Trail and Litchfield St., Cartersville, 05001172

MAINE

Androscoggin County

Keystone Mineral Springs, Keystone Rd., Poland, 05001175

Cumberland County

Battery Steele, Florida Ave., Peaks Island, Portland, 05001176

Lakeside Grange #63, Main St., jct. of Main St. and Lincoln St., Harrison, 05001173

Hancock County

Garland Farm, 1029 ME 3, Bar Harbor, 05001174

MINNESOTA

Cook County

Grand Portage National Monument, Off US 61 within the area of the Grand Portage Indian Reservation, Grand Portage, 05001180

MISSOURI

Madison County

St. Louis, Iron Mountain and Southern Railroad Depot, Allen St., 150 ft. No of Jct. of Allen and Kelly Sts., Fredericktown, 05001178

MONTANA

Park County

Hepburn, John, Place, 626 E. River Rd., Emigrant, 05001177

New Mexico

Santa Fe County

Kelly, Daniel T., House, (Buildings Designed by John Gaw Meem MPS) 531 E. Palace Ave., Santa Fe, 05001182

OREGON

Multnomah County

Harrison Court Apartments, 1834 SW. 5th Ave., Portland, 05001179

[FR Doc. 05–19526 Filed 9–29–05; 8:45 am]

BILLING CODE 4312–51–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of intent to prepare an environmental impact statement (EIS) and notice to solicit comments and hold public scoping meetings on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead under low reservoir conditions.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA), the Bureau of Reclamation (Reclamation) proposes to conduct public scoping meetings and prepare an EIS for the development of Lower Colorado River Basin Shortage Guidelines and Coordinated Management Strategies for Operation of Lake Powell and Lake Mead Under Low Reservoir Conditions. The Secretary of the Interior (Secretary) has directed Reclamation to develop additional Colorado River management strategies to address operations of Lake Powell and Lake Mead under low reservoir conditions.

The proposed action is to develop these guidelines and strategies. Through the NEPA process initiated by this **Federal Register** notice, Reclamation is considering development of: (1) Specific guidelines that will identify those circumstances under which the Department of the Interior (Department) would reduce annual water deliveries from Lake Mead to the Lower Basin States below the 7.5 million acre-feet (maf) Lower Basin apportionment and the manner in which those deliveries would be reduced, and (2) coordinated management strategies for the operation of Lake Powell and Lake Mead.

Alternatives to be analyzed in the EIS have not been developed at this time and will be developed through the NEPA process, including through the upcoming EIS scoping meetings.

DATES AND ADDRESSES: Four public meetings will be held to solicit comments on the scope of specific shortage guidelines and other coordinated management strategies and the issues and alternatives that should be analyzed. Oral and written comments will be accepted at the public meetings to be held at the following locations:

- Tuesday, November 1, 2005—6 p.m. to 8 p.m., Hilton Salt Lake City Center, Topaz Room, 255 South West Temple, Salt Lake City, Utah.
- Wednesday, November 2, 2005—6 p.m. to 8 p.m., Adam's Mark Hotel, Tower Court D, 1550 Court Place, Denver, Colorado.
- Thursday, November 3, 2005—6 p.m. to 8 p.m., Arizona Department of Water Resources, Third Floor, Conference Rooms A&B, 500 North Third Street, Phoenix, Arizona.
- Tuesday, November 8, 2005—6 p.m. to 8 p.m., Henderson Convention Center, Grand Ballroom, 200 South Water Street, Henderson, Nevada.

Written comments on the proposed development of these strategies may be sent by close of business on *Wednesday, November 30, 2005*, to: Regional Director, Bureau of Reclamation, Lower Colorado Region, Attention: BCOO–1000, PO Box 61470, Boulder City, Nevada 89006–1470, faxogram at (702) 293–8156, or e-mail at *strategies@lc.usbr.gov*; and/or Regional Director, Bureau of Reclamation, Upper Colorado Region, Attention: UC–402, 125 South State Street, Salt Lake City, Utah 84318–1147, faxogram at (801) 524–3858, or e-mail at *strategies@uc.usbr.gov*.

FOR FURTHER INFORMATION CONTACT: Terrance J. Fulp, PhD., at (702) 293–8500 or e-mail at *strategies@lc.usbr.gov*; and/or Randall Peterson at (801) 524–3633 or e-mail at *strategies@uc.usbr.gov*. If special assistance is required regarding accommodations for attendance at any of the public meetings, please call Nan Yoder at (702) 293–8495, faxogram at (702) 293–8156, or e-mail at *nyoder@lc.usbr.gov* no less than 5 working days prior to the applicable meeting(s).

SUPPLEMENTARY INFORMATION: In recent years the Colorado River Basin experienced the worst five-year drought

in recorded history. Drought in the Basin has impacted system storage, while demands for Colorado River water supplies have continued to increase. In the future, low reservoir conditions may not be limited to drought periods as additional development of Colorado River water occurs. The Colorado River is of strategic importance in the southwestern United States for water supply, hydropower production, recreation, fish and wildlife habitat, and other benefits. In addition, the Republic of Mexico has an allocation to the waters of the Colorado River pursuant to a 1944 treaty with the United States.

In 2001, the Department adopted Interim Surplus Guidelines (66 FR 7772) that are used by the Secretary in making annual determinations regarding ''Normal'' and ''Surplus'' conditions for the operation of Lake Mead. Since adoption, these Guidelines have, among other operational and management benefits, allowed the Department and entities in Arizona, California, and Nevada that rely on the Colorado River greater predictability in identifying when Colorado River water in excess of 7.5 maf will be available for use within these three States. In contrast, at this time the Department does not have detailed guidelines in place for annual determinations of releases from Lake Mead of less than 7.5 maf to water users in the three Lower Division States of Arizona, California, and Nevada (often referred to as a ''shortage'' condition on the lower Colorado River). Therefore, water users who rely on the Colorado River in these States are not currently able to identify particular reservoir conditions under which the Secretary would release less than 7.5 maf for use on an annual basis. Nor are these water users able to identify the amount of any potential future annual reductions in water deliveries.

Over the past year, the seven Colorado River Basin States have been proactively discussing strategies to address the recent period of system-wide drought in the Colorado River Basin. In addition, Reclamation has conducted detailed briefings for stakeholders in the Colorado River Basin and other interested entities regarding future scenarios for Colorado River operations.

Currently, each year, the Secretary establishes an Annual Operating Plan (AOP) for the Colorado River Reservoirs. The AOP describes how Reclamation will manage the reservoirs over a 12-month period, consistent with the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Long-Range Operating Criteria), the Decree entered by the U.S. Supreme Court in the *Arizona* v. *California* litigation, and other provisions of applicable Federal law. Reclamation consults annually with the Colorado River Basin States, Indian tribes, and other interested parties in the development of the AOP. Further, as part of the AOP process, the Secretary makes annual determinations under the Long-Range Operating Criteria regarding the availability of Colorado River water for deliveries to the Lower Division States. To meet the consultation requirements of Federal law, Reclamation also consults with the Colorado River Basin States, Indian tribes, and other interested parties during the five-year periodic reviews of the Long-Range Operating Criteria.

During the mid-year review of the 2005 AOP conducted this past spring, the Department received conflicting recommendations from the Colorado River Basin States regarding operations of Glen Canyon Dam for the remainder of the 2005 water year. In a May 2, 2005, letter to the Governors of the Colorado River Basin States, issued to complete the 2005 AOP mid-year review, the Secretary directed Reclamation to develop additional strategies to improve coordinated management of the reservoirs in the Colorado River system. Pursuant to that direction, Reclamation conducted a public consultation workshop on May 26, 2005, in Henderson, Nevada; issued a **Federal Register** notice soliciting public comments on June 15, 2005; and conducted public meetings on July 26 and July 28, 2005, in Henderson, Nevada, and Salt Lake City, Utah, respectively. Reclamation received a broad range of public comments and suggestions from these discussions, not all of which can be addressed in this proposed process. In addition, some suggestions may be part of ongoing or future efforts.

In order to assure the continued productive management and use of the Colorado River into the future, Reclamation is now soliciting public comments on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead under low reservoir conditions. Reclamation will utilize a public process pursuant to NEPA. By this notice, Reclamation provides notice of its intent to prepare an EIS on this action, and provides notice of its upcoming EIS scoping meetings. Reclamation invites all interested members of the general public, including the seven Colorado River Basin States, Indian tribes, water and power contractors, environmental organizations, representatives of academic and scientific communities, representatives of the recreation industry, and other organizations and agencies to present oral and written comments concerning the format and scope of specific shortage guidelines and coordinated management strategies, and the issues and alternatives to be considered during the development of these proposed guidelines and strategies. Reclamation anticipates publishing a ''scoping report'' after completion of the public scoping meetings identified in this **Federal Register** notice.

All comments received will be considered as Reclamation develops formal alternatives under NEPA. Similar to the surplus guidelines referenced above, it is likely that these shortage guidelines will be interim in nature. It is the Department's intent that these guidelines and coordinated management strategies will provide guidance to the Secretary's AOP decisions, and provide more predictability to water users and the public throughout the Colorado River Basin, particularly those in the Lower Division States. The Department does not intend to evaluate the decommissioning of Glen Canyon Dam.

Public Disclosure

Written comments, including names and home addresses of respondents, will be made available for public review. Individual respondents may request that their home address be withheld from public disclosure, which will be honored to the extent allowable by law. There may be circumstances in which respondents' identity may also be withheld from public disclosure, as allowable by law. If you wish to have your name and/or address withheld, you must state this prominently at the beginning of your comment. All submissions from organizations, business, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public disclosure in their entirety.

Dated: September 22, 2005.

Rick L. Gold,

Regional Director—UC Region, Bureau of Reclamation.

Dated: September 22, 2005.

Jayne Harkins,

Deputy Regional Director—LC Region, Bureau of Reclamation.

[FR Doc. 05–19607 Filed 9–29–05; 8:45 am]

BILLING CODE 4310–MN–P

L.3 Federal Register Volume 71, Number 62

respondents will be available for public review at the Ely Field Office during regular business hours 7:30 a.m. to 4:30 p.m., Monday through Friday, except holidays. Individual respondents may request confidentiality. If you wish to withhold your name and address from public review or disclosure under the Freedom of Information Act, you must state this prominently at the beginning of your comments. Such requests will be honored to the extent allowed by law. All submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or business, will be made available for public inspection in their entirety.

FOR FURTHER INFORMATION CONTACT: Penny Woods, BLM Nevada State Office, (775) 861–6466. You may also contact Ms Woods to have your name added to the EIS mailing list.

SUPPLEMENTARY INFORMATION: The LCLA Groundwater Development Project is being proposed by the Lincoln County Water District (LCWD) and would be located in southeastern Lincoln County. The proposed project would develop and convey groundwater in the Tule Desert and Clover Valley hydrographic basins to land recently sold by the BLM that is approximately 2 miles north of Mesquite, Nevada. This private land comprises the LCLA development area and consists of approximately 13,000 acres. The volume of water to be transported through the proposed facilities would be approximately 23,824 acre-feet per year. The water would be used to support development in the LCLA development area.

The proposed facilities include approximately 8 groundwater production wells (16 inch diameter) located in the Tule Desert and Clover Valley hydrographic basins, a 23-mile long water transmission pipeline (24 inch diameter), and lateral pipelines (12 inch diameter) to connect the transmission pipeline to the productions wells. The proposed width of the right-of-way for the transmission pipeline would be 30 feet with a temporary width of 60 feet during construction. The proposed width of the right-of-way for the lateral pipelines would be 20 feet with a temporary width of 60 feet during construction. The productions well site rights-of-way would be 100 feet × 100 feet with a temporary construction area of 100 feet × 200 feet. Access roads approximately 12 feet in width would be needed from existing roads in the Tule Desert area to each well site.

The proposed production wells would be located in the well field area authorized for the Toquop Energy Project, which is a 1100 MW gas-fired power plant. The proposed transmission pipeline would follow the same alignment as the approved water pipeline for the power plant. From the power plant, the transmission pipeline would proceed to the LCLA development area.

Electric lines, communication lines, and a natural gas pipeline would be located within the proposed transmission pipeline right-of-way. A pipeline bringing reclaimed water from the LCLA development area to the already authorized Toquop Energy Project site would also be in the proposed right-of-way.

The facilities would be located within and/or across the following public lands north of Mesquite, Nevada:

Mount Diablo Meridian

Tps. 6 to 12 S., Rgs. 69 and 71 E., various sections.

A map of the proposed project is available for viewing at the Bureau of Land Management, Ely Field Office, 702 North Industrial Way, Ely NV 89301.

Dated: March 21, 2006.

Amy Lueders,

Associate State Director, Nevada.

[FR Doc. 06–2932 Filed 3–30–06; 8:45 am]

BILLING CODE 4310–HC–P

DEPARTMENT OF THE INTERIOR

National Park Service

Notice of Proposed National Natural Landmark Designation for the Irvine Ranch Land Reserve, CA

AGENCY: National Park Service, Interior.

ACTION: Notice of proposed National Natural Landmark designation.

SUMMARY: The National Park Service has evaluated and determined that the Irvine Ranch Land Reserve, located forty-five miles south of downtown Los Angeles, in Orange County, California appears to meet the criteria for national significance and proposes to recommend the site for designation as a National Natural Landmark. The public is invited to comment on this recommendation. The proposal will be considered by the National Park System Advisory Board at a meeting to be held on June 8, 2006 at Zion National Park, in the Majestic View Lodge, 2400 Zion Park Blvd., Springdale, Utah.

DATES: Written comments will be accepted until May 30, 2006.

ADDRESSES: Written comments should be sent to Steve Gibbons, National Natural Landmarks Coordinator, North Cascades National Park, 810 State Route 20, Sedro Woolley, Washington 98284, or to his Internet address: *Steve_Gibbons@nps.gov.*

FOR FURTHER INFORMATION CONTACT: Steve Gibbons at 360–856–5700, extension 306.

SUPPLEMENTARY INFORMATION: The Irvine Ranch Land Reserve represents significant biological resources of Mediterranean shrublands, including extensive areas of chaparral and coastal sage scrub associations. These chaparral and coastal sage scrub areas present one of the largest extant areas of this association remaining in the South Pacific Border Province. It is the presence of these large and relative undisturbed ecosystems and their inherent biological diversity that provide the uniqueness of this area. In commensurate with its biological significance the Irvine Ranch Land Reserve geologically represents a remarkably unique, long time-range stratigraphic succession that shows the linkage between tectonic framework, provenances, sedimentology, paleoenvironments, paleontology, paleoclimate, landscape evolution and geologic history. In this regard it is not only outstanding, but represents one of the most critical time intervals and locations in the evolution of the South Pacific Border Province.

Information on the National Natural Landmarks Program can be found in 36 CFR Part 62 or on the Internet at *http://www.nature.nps.gov/nnl.*

Dated: March 28, 2006.

Fran Mainella,

Director, National Park Service.

[FR Doc. 06–3161 Filed 3–30–06; 8:45 am]

BILLING CODE 4312–HJ–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead, Particularly Under Low Reservoir Conditions

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of public availability of a Scoping Summary Report on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake

16342 Federal Register / Vol. 71, No. 62 / Friday, March 31, 2006 / Notices

Powell and Lake Mead, particularly under low reservoir conditions.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended, and the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of NEPA, the Department of the Interior (Department) has issued a Scoping Summary Report on the development of Lower Basin shortage guidelines and coordinated management strategies for the operation of Lake Powell and Lake Mead, particularly under low reservoir conditions. The Scoping Summary Report provides a summary of the issues raised during the scoping process and describes the Department's current assessment of the proposed scope of the environmental analysis to be included in the draft environmental impact statement (EIS). The Department anticipates that the Draft EIS will be published in December 2006. The report also includes a summary of the issues raised and comments received during the scoping process. Among other things, the report identifies how the Department anticipates addressing these issues.

Dates and Addresses: The Department will accept, review, and incorporate, as appropriate, any additional public comments on the information contained in the Scoping Summary Report as part of the development of the Draft EIS, which the Department anticipates will be published in December 2006. The Department would prefer that any such comments be received by May 1, 2006, in order to allow full consideration during the development of the Draft EIS. Send written comments to: Regional Director, Bureau of Reclamation, Lower Colorado Region, Attention: BCOO–1000, P.O. Box 61470, Boulder City, Nevada 89006–1470; faxogram at (702) 293–8156; or e-mail at *strategies@lc.usbr.gov.*

The Scoping Summary Report is available on the Bureau of Reclamation's Web site at *http://www.usbr.gov/lc/region/g4000/strategies/index.html.* If you would like a printed copy of the report, please contact Nan Yoder at telephone (702) 293–8500; facsimile (702) 293–8156; e-mail: *strategies@lc.usbr.gov.*

FOR FURTHER INFORMATION CONTACT: Terrance J. Fulp, Ph.D., at (702) 293–8500 or e-mail at *strategies@lc.usbr.gov;* and/or Randall Peterson at (801) 524–3633 or e-mail at *strategies@lc.usbr.gov.*

SUPPLEMENTARY INFORMATION: The Department is publishing the Scoping Summary Report as a voluntary effort to assist in public understanding of this important process. Based upon information presented in the report and all information submitted to the Department as part of this process, the Department is now undertaking preparation of a Draft EIS.

Proposed Federal Action

The Bureau of Reclamation, acting on behalf of the Secretary of the Interior (Secretary), proposes to take action to adopt specific Colorado River Lower Basin shortage guidelines and coordinated reservoir management strategies to address operations of Lake Powell and Lake Mead, particularly under low reservoir conditions. This action will provide a greater degree of certainty to all water users and managers in the Colorado River Basin by providing more detailed objective guidelines for the operation of Lake Powell and Lake Mead and by allowing water users in the Lower Basin to know when, and by how much, water deliveries will be reduced in drought and other low reservoir conditions. In addition, this action is designed to delay the onset and magnitude of shortages and maximize the protection afforded to water supply, hydropower production, recreation, and environmental benefits by water storage in Lakes Powell and Mead. As a result of analysis of comments and public input received to date, the Department anticipates that the elements of the proposed action will include:

(1) Adoption of guidelines that will identify those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Lower Division states (Arizona, California, and Nevada) below 7.5 million acre-feet (maf) (a "Shortage") pursuant to Article II(B)(3) of the Supreme Court Decree in *Arizona* v. *California*; [1]

(2) adoption of guidelines for the coordinated operation of Lake Powell and Lake Mead that are designed to provide improved operation of the two reservoirs, particularly under low reservoir conditions;

(3) adoption of guidelines for the storage and delivery of water in Lake Mead to increase the flexibility to meet water use needs from Lake Mead, particularly under low reservoir conditions. These guidelines are anticipated to address the storage and delivery of non-system water, exchanges, and water conserved by extraordinary measures; and

(4) modification of the substance and term of the existing Interim Surplus Guidelines, published in the **Federal Register** on January 25, 2001 (66 FR 7772–7782), from 2016 to coincide with the proposed new guidelines described above.

The Secretary proposes that these guidelines will be interim in nature and will extend through 2025. Adoption of new guidelines along with modification of existing operational guidelines for a consistent interim period will provide the opportunity to gain valuable experience for operating the reservoirs under the modified operations and should improve the basis for making additional future operational decisions, whether during the interim period or thereafter.

It is the intent of the Department to adopt and implement the above proposed action in a manner that is consistent with applicable Federal law,[2] and further, in a manner that does not require any additional statutory authorization. In this regard, Reclamation proposes to implement the proposed action consistent with the Colorado River Compact of 1922, the Decree entered by the United States Supreme Court in the case of *Arizona* v. *California,* and other provisions of applicable Federal law. It is the intent of the Department that the proposed action will be consistent with and provide implementing guidance that would be used each year by the Department in implementing the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Long-Range Operating Criteria or LROC).

Purpose and Need for the Proposed Federal Action

The purpose of the proposed action is to adopt additional operational strategies to improve the Department's annual management and operation of key Colorado River reservoirs while also providing mainstream users of Colorado River water, particularly those in the Lower Division states of Arizona, California, and Nevada, a greater degree

[1] The Department intends to meet any consultation requirements identified in Article II(B)(3) of the Supreme Court Decree in *Arizona* v. *California* through the ongoing NEPA process initiated by the **Federal Register** Notice of September 30, 2005 (70 FR 57322–57323).

[2] The treaties, compacts, decrees, statutes, regulations, contracts, and other legal documents and agreements applicable to the allocation, appropriation, development, exportation, and management of the waters of the Colorado River Basin are often referred to as the "Law of the River." There is no single, universally-agreed upon definition of the "Law of the River," but it is useful as a shorthand reference to describe this longstanding and complex body of legal agreements governing the Colorado River.

of predictability with respect to the amount of annual water deliveries in future years, particularly under low reservoir conditions.

The need for the proposed action is based on a number of important considerations including the following reasons:

• The Colorado River flows through the driest portion of the continental United States and is the primary source of water to a region that has experienced continued population growth over recent decades.

• The Colorado River is of strategic importance in the southwestern United States for water supply, hydropower production, flood control, recreation, fish and wildlife habitat, and other benefits. In addition, the United States has a delivery obligation to the Republic of Mexico for certain waters of the Colorado River pursuant to the 1944 U.S.-Mexico Water Treaty.

• The Colorado River Basin experienced the worst five-year drought in recorded history in 2000 through 2004. This drought has impacted system storage, while demands for Colorado River water supplies have continued to increase. During the period from October 1, 1999, to October 1, 2004, storage in Lakes Powell and Mead fell from 47.6 maf (approximately 95% of capacity) to 23.1 maf (approximately 46% of capacity). This drought was also the worst sustained drought experienced in the Colorado River Basin at a time when all major storage facilities were in place, and when use by the Lower Division states met or exceeded the annual "normal" apportionment of 7.5 maf pursuant to Article II(B)(1) of the Decree. Moreover, entering the five year drought period with Lake Powell and Lake Mead reservoir storage capacity at 95% fortuitously provided for sufficient water supplies to meet basin demands. This may not be the case in the future. Among other factors, these conditions led the Department to conclude that additional management guidelines are necessary and desirable for the efficient, and coordinated, management of the major mainstem Colorado River reservoirs.

• In the future, low reservoir conditions will likely not be limited to drought periods because of anticipated future demands on Colorado River water supplies. Projected future increases in Colorado River water demands are expected to increase the frequency and magnitude that Colorado River reservoirs are drawn down to low reservoir conditions.

• As a result of actual operating experience and through reviews of the LROC and preparation of Annual Operating Plans, particularly during recent drought years, the Secretary has determined a need for more specific guidelines, consistent with the Decree and other applicable provisions of Federal law, to assist in the Secretary's determination of annual water supply conditions in the Lower Basin. The increased level of predictability is needed by the entities that receive Colorado River water to better plan for and manage available water supplies, and to allow such entities to better integrate the use of Colorado River water with other water supplies that they rely on. To date, storage of water and flows in the Colorado River Basin have been sufficient so that it has not been necessary to reduce Lake Mead annual releases below 7.5 maf; nor has the Department yet identified when water supplies would be reduced, by how much, or who would experience specified reductions.

• After public consultation meetings held in the summer of 2005, the Secretary has also determined the desirability of developing additional operational guidelines that will provide for releases greater than or less than 8.23 maf from Lake Powell.

• To further enhance this coordinated reservoir approach, the Secretary has also determined a need for guidelines that provide water users with the opportunity to conserve, store, and take delivery of water in and from Lake Mead for the purposes of enhancing existing water supplies, particularly under low reservoir conditions.

• Lastly, the Secretary has determined the need to modify and extend the Interim Surplus Guidelines to coincide with the duration of the proposed new guidelines. This will provide an integrated approach for reservoir management and more predictability for future Colorado River Basin water supplies.

Results of Scoping Input

The description of the Proposed Federal Action and the Purpose and Need for the Proposed Federal Action described in this Notice and in the Scoping Summary Report available at Reclamation's Web site noted above, was refined to reflect information and comments received during the scoping meetings and in written and oral scoping comments submitted to the Department.[3] The Proposed Federal Action has been crafted to reflect, among others, three important considerations that were identified by commentors:

(1) *Importance of Encouraging Conservation of Water:* Many comments submitted to the Department focused on the importance of encouraging and utilizing water conservation as an important tool to better manage limited water supplies and therefore minimize the likelihood and severity of potential future shortages. *See e.g.*, comment G–0003, "Conservation Before Shortage" proposal submitted to the Department on July 18, 2005, which is available in its entirety in Appendix W of the Scoping Summary Report. Water conservation can occur through a number of approaches that will be identified in the Draft EIS, including: Extraordinary conservation, forbearance, financial incentives to maximize conservation, dry-year options, and associated storage and recovery methodologies and procedures to address conservation actions by particular parties.

(2) *Importance of Consideration of Reservoir Operations at all Operational Levels:* Comments submitted to the Department urged the Department to consider and analyze management and operational guidelines for the full range of operational levels at Lake Powell and Lake Mead. *See e.g.*, comment S–2006, "Basin States' Preliminary Proposal Regarding Colorado River Interim Operations" submitted to the Department on February 3, 2006, which is available in its entirety in Appendix Q of the Scoping Summary Report. It was suggested that this approach is integral to the prudent development of new low-reservoir operational guidelines, as the approach and management of these reservoirs at higher elevations has a direct impact on available storage, thereby affecting the likelihood and severity of potential future shortages.

(3) *Term of Operational Guidelines:* Comments submitted to the Department urged the Department to consider interim, rather than permanent, additional operational guidelines. *See e.g.*, comment letters L–2002 through 2006 submitted to the Department by several Arizona municipalities which are available in their entirety in Appendix W of the Scoping Summary Report. In this manner, the Department would have the ability to use actual operating experience for a period of years, thereby facilitating a better understanding of the operational effects of the new guidelines; modifications would then be made, if necessary, during or preferably at the end of the interim period. In particular, the

[3] The Scoping Summary Report also addresses in Section 5.0 those issues raised during scoping that have been determined to be beyond the proposed scope of the EIS.

Department was also urged to consider adopting additional operational guidelines for both low and higher reservoir elevations for a consistent period of years. At this time, it is important to note, the Department has detailed operational guidelines for declaration of surplus conditions at higher elevations of Lake Mead through 2016, but does not have similar detailed operational guidelines for either Lake Powell or the lower operational levels of Lake Mead.

Public Disclosure

Written comments, including names and home addresses of respondents, will be made available for public review. Individual respondents may request that their home address be withheld from public disclosure, which will be honored to the extent allowable by law. There may be circumstances in which respondents' identity may also be withheld from public disclosure, as allowable by law. If you wish to have your name and/or address withheld, you must state this prominently at the beginning of your comment. All submissions from organizations, business, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public disclosure in their entirety.

Dated: March 18, 2006.

Robert W. Johnson,

Regional Director, Lower Colorado Region, Bureau of Reclamation.

Dated: March 16, 2006.

Rick L. Gold,

Regional Director, Upper Colorado Region, Bureau of Reclamation.

[FR Doc. E6–4713 Filed 3–30–06; 8:45 am]

BILLING CODE 4310–MN–P

DEPARTMENT OF THE INTERIOR

Office of Surface Mining Reclamation and Enforcement

Notice of Proposed Information Collection for 1029–0025, 1029–0040 and 1029–0104

AGENCY: Office of Surface Mining Reclamation and Enforcement.

ACTION: Notice and request for comments.

SUMMARY: In compliance with the Paperwork Reduction Act of 1995, the Office of Surface Mining Reclamation and Enforcement (OSM) is announcing its intention to request renewed approval for the collections of information for 30 CFR 733, Maintenance of state programs and procedures for substituting federal enforcement of state programs and withdrawing approval of state programs; 785, Requirements for permits for special categories of mining; and 876, Acid mine drainage treatment and abatement program.

DATES: Comments on the proposed information collection activities must be received by May 30, 2006, to be assured of consideration.

ADDRESSES: Comments may be mailed to John A. Trelease, Office of Surface Mining Reclamation and Enforcement, 1951 Constitution Ave., NW., Room 202—SIB, Washington, DC 20240. Comments may also be submitted electronically to *jtreleas@osmre.gov.*

FOR FURTHER INFORMATION CONTACT: To request a copy of the information collection request, explanatory information and related forms, contact John A. Trelease, at (202) 208–2783 or via e-mail at the address listed above.

SUPPLEMENTARY INFORMATION: The Office of Management and Budget (OMB) regulations at 5 CFR 1320, which implement provisions of the Paperwork Reduction Act of 1995 (Pub. L. 104–13), require that interested members of the public and affected agencies have an opportunity to comment on information collection and recordkeeping activities [see 5 CFR 1320.8(d)]. This notice identifies information collections that OSM will be submitting to OMB for approval. These collections are contained in (1) 30 CFR 733, Maintenance of state programs and procedures for substituting federal enforcement of state programs and withdrawing approval of state programs; (2) 30 CFR 785, Requirements for permits for special categories of mining; and (3) 30 CFR 876, Acid mine drainage treatment and abatement program. OSM will request a 3-year term of approval for each information collection activity.

Comments are invited on: (1) The need for the collection of information for the performance of the functions of the agency; (2) the accuracy of the agency's burden estimates; (3) ways to enhance the quality, utility and clarity of the information collection; and (4) ways to minimize the information collection burden on respondents, such as use of automated means of collection of the information. A summary of the public comments will accompany OSM's submission of the information collection request to OMB.

The following information is provided for the information collection: (1) Title of the information collection; (2) OMB control number; (3) summary of the information collection activity; and (4) frequency of collection, description of the respondents, estimated total annual responses, and the total annual reporting and recordkeeping burden for the collection of information.

Title: Maintenance of state programs and procedures for substituting federal enforcement of state programs and withdrawing approval of state programs, 30 CFR 733.

OMB Control Number: 1029–0025.

Summary: This part provides that any interested person may request the Director of OSM to evaluate a State program by setting forth in the request a concise statement of facts that the person believes establishes the need for the evaluation.

Bureau Form Number: None.

Frequency of Collection: Once.

Description of Respondents: Any interested person (individuals, businesses, institutions, organizations).

Total Annual Responses: 1.

Total Annual Burden Hours: 100.

Title: Requirements for permits for special categories of mining, 30 CFR 785.

OMB Control Number: 1029–0040.

Summary: The information is being collected to meet the requirements of section 507, 508, 510, 515, 701 and 711 of Public Law 95–87, which requires applicants for special types of mining activities to provide descriptions, maps, plans and data of the proposed activity. This information will be used by the regulatory authority in determining if the applicant can meet the applicable performance standards for the special type of mining activity.

Bureau Form Number: None.

Frequency of Collection: Once.

Description of Respondents: Applicants for coalmine permits and State Regulatory Authorities.

Total Annual Responses: 228.

Total Annual Burden Hours: 16,146.

Title: Acid mine drainage treatment and abatement program, 30 CFR 876.

OMB Control Number: 1029–0104.

Summary: This part establishes the requirements and procedures allowing states and Indian tribes to establish acid mine drainage abatement and treatment programs under the Abandoned Mine Land fund as directed through Public Law 101–508.

Bureau Form Number: None.

Frequency of Collection: Once.

Description of Respondents: State governments and Indian tribes.

Total Annual Responses: 1.

Total Annual Burden Hours: 350.

Dated: March 27, 2006.

Kathryn S. O'Toole,

Acting Chief, Division of Regulatory Support.

[FR Doc. 06–3130 Filed 3–30–06; 8:45 am]

BILLING CODE 4310–05–M

L.4 Federal Register Volume 72, Number 39

9026 Federal Register / Vol. 72, No. 39 / Wednesday, February 28, 2007 / Notices

Procedure will now read "Describe the records sought."

Dated: February 22, 2007.

Robert Roudabush,

Acting Assistant Director, Renewable Resources and Planning, Bureau of Land Management.

INTERIOR/LLM–2

SYSTEM NAME:

Range Management System—Interior, LLM–2.

SYSTEM LOCATION:

U.S. Department of the Interior, Bureau of Land Management, Denver Federal Center, Bldg. 50, Denver, Colorado 80225.

CATEGORIES OF INDIVIDUALS COVERED BY THE SYSTEM:

Individuals to whom BLM issues grazing permits or leases.

CATEGORIES OF RECORDS IN THE SYSTEM:

The records, paper and electronic, contain the lessee's or permittee's name, address, the Bureau's assigned case file number, grazing allotment descriptions, grazing applications, grazing preference summary and history, copies of the grazing permit or lease, grazing fee billing statements, grazing exchange-of-use agreement, evidence of ownership or control of base property, notice of lienholder interest in base property, corporate or partnership documentation, affiliate documentation, notice of authorized representative, livestock control agreements, copies of brand registration, closed unauthorized use case records, Cooperative Range Improvement Agreements, Range Improvement Permits, Assignment of Range Improvements, grazing decisions, and correspondence to, or received from, the permittee or lessee.

AUTHORITY FOR MAINTENANCE OF THE SYSTEM:

43 U.S.C. 315, et seq.

ROUTINE USES OF RECORDS MAINTAINED IN THE SYSTEM, INCLUDING CATEGORIES OF USERS AND THE PURPOSES OF SUCH USES:

The primary uses of the records are (a) to identify the permittees and lessees authorized to graze lands administered by the Bureau of Land Management, (b) to print statements of grazing preference, grazing authorizations, billings for grazing fees due, and other reports, (c) to maintain the information required to administer livestock grazing on public rangelands in accordance with applicable laws and regulations, and (d) to provide information concerning the grazing permittees and lessees for administrative use.

Disclosures outside the Department of the Interior may be made: (1) To the Department of Justice, or to a court, adjudicative or other administrative body, or to a party in litigation before a court or adjudicative or administrative body, when (a) the Department or any component of the Department, any Departmental employee acting in his or her official capacity, or any Departmental employee acting in his or her individual capacity where the Department of Justice has agreed to represent the employee is a party in the suit and (b) we deem the disclosure to be relevant and necessary to the proceeding, and compatible with the purpose for which we compiled the information; (2) to Federal, State, or local agencies to manage their activities related to BLM's grazing program; and (3) to a congressional office from the record of an individual in response to a written inquiry the individual has made to the congressional office.

DISCLOSURE TO CONSUMER REPORTING AGENCIES:

Disclosures pursuant to 5 U.S.C. 552a(b)(12): Disclosures may be made to consumer reporting agencies as defined in the Fair Credit Reporting Act (15 U.S.C. 1681a(f)) or the Federal Claims Collection Act of 1966 (31 U.S.C. 3701(a)(3)).

POLICIES AND PRACTICES FOR STORING, RETRIEVING, ACCESSING, RETAINING, AND DISPOSING OF RECORDS IN THE SYSTEM:

STORAGE:

Computer magnetic tape and/or manual index. Paper case records are maintained in locking filing cabinets at BLM field offices.

RETRIEVABILITY:

Indexed by name of permittee or lessee and grazing authorization number.

SAFEGUARDS:

Maintained with safeguards meeting the requirements of 43 CFR 2.51 for manual and automated records. Access to records in the system is limited to authorized personnel whose official duties require such access. Paper records are maintained in locked file cabinets and/or in secured rooms. Electronic records conform to Office of Management and Budget and Departmental guidelines reflecting the implementation of the Federal Information Security Management Act. The electronic data will be protected through user identification, passwords, database permissions, and software controls. Such security measures will establish access levels for different types of users. A Privacy Impact Assessment was completed on the system to ensure that privacy protection measures were in place.

RETENTION AND DISPOSAL:

BLM Manual(s) 1220, Records and Information Management, Appendix II, GRS/BLM Combined Records Schedule, Schedule 20, Item 42. Destroyed when superseded or no longer needed for administrative purposes.

SYSTEM MANAGER(S) AND ADDRESS:

Chief, Division of Rangeland Management, U.S. Department of the Interior, Bureau of Land Management, (WO–220), 1849 C St., NW., Washington, DC 20240.

NOTIFICATION PROCEDURE:

To determine whether records are maintained on you in this system, write to the System Manager. See 43 CFR 2.60.

RECORD ACCESS PROCEDURES:

To see your records, write to the System Manager. Describe the records sought. If copies are desired, indicate the maximum you are willing to pay. See 43 CFR 2.63.

CONTESTING RECORD PROCEDURES:

To request corrections or the removal of material from your files, write the System Manager. See 43 CFR 2.71.

RECORD SOURCE CATEGORIES:

Grazing Permittees or Lessees

EXEMPTIONS CLAIMED FOR THE SYSTEM:

None.

[FR Doc. E7–3477 Filed 2–27–07; 8:45 am]

BILLING CODE 4310–10–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

[DES–07–05]

Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of Availability and Notice of Public Hearings for the Draft Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended, and the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions

of NEPA, the Department of the Interior (Department), acting through the Bureau of Reclamation (Reclamation), has prepared a draft environmental impact statement (Draft EIS) on the proposed adoption of specific Colorado River Lower Basin shortage guidelines and coordinated reservoir management strategies to address operations of Lake Powell and Lake Mead, particularly under low reservoir conditions. This action is proposed in order to provide a greater degree of certainty to U.S. Colorado River water users and managers of the Colorado River Basin by providing detailed and objective guidelines for the operations of Lake Powell and Lake Mead, thereby allowing water managers and water users in the Lower Basin to know when, and by how much, water deliveries will be reduced in drought and other low reservoir conditions. The Department proposes that these guidelines be interim in duration and extend through 2026.

Cooperating agencies are the Bureau of Indian Affairs, the U.S. Fish and Wildlife Service, the National Park Service (NPS), the Western Area Power Administration (Western), and the United States Section of the International Boundary and Water Commission.

DATES AND ADDRESSES: A public review period commences with the publication of this notice. Comments on the Draft EIS must be submitted no later than Monday, April 30, 2007, to: Regional Director, Lower Colorado Region, Bureau of Reclamation, *Attention:* BCOO–1000, P.O. Box 61470, Boulder City, Nevada 89006–1470; faxogram at (702) 293–8156; or e-mail at *strategies@lc.usbr.gov*.

Reclamation will conduct three public hearings to receive written or oral comments from the public on the Draft EIS at the following locations:

- Tuesday, April 3, 2007—6 p.m. to 9 p.m., Henderson Convention Center, Sierra Room, 200 South Water Street, Henderson, Nevada.
- Wednesday, April 4, 2007—6 p.m. to 9 p.m., Phoenix Airport Marriott, Buckhorn Room, 1101 North 44th Street, Phoenix, Arizona.
- Thursday, April 5, 2007—6 p.m. to 9 p.m., Hilton Salt Lake City Center, Canyon Room A & B, 255 South West Temple, Salt Lake City, Utah.

If special assistance is required regarding accommodations for attendance at any of the public hearings, please contact Nan Yoder at (702) 293–8495, faxogram at (702) 293–8156, or e-mail at *nyoder@lc.usbr.gov* no less than 5 working days prior to the applicable meeting(s).

The Draft EIS is electronically available for viewing and copying at Reclamation's project Web site at: *http://www.usbr.gov/lc/region/programs/strategies.html*. Alternatively, a compact disc or hard copy is available upon written request to: Regional Director, Lower Colorado Region, Bureau of Reclamation, Attention: BCOO–1000, P.O. Box 61470, Boulder City, Nevada 89006–1470; faxogram at (702) 293–8156; or e-mail at *strategies@lc.usbr.gov*.

Copies of the Draft EIS are available for public inspection and review at the following locations:

- Bureau of Reclamation, Lower Colorado Regional Office, 400 Railroad Avenue, Boulder City, Nevada.
- Bureau of Reclamation, Upper Colorado Regional Office, 125 South State Street, Room 7220, Salt Lake City, Utah.
- Bureau of Reclamation, Phoenix Area Office, 6150 West Thunderbird Road, Glendale, Arizona.
- Bureau of Reclamation, Yuma Area Office, 7301 Calle Agua Salada, Yuma, Arizona.
- Bureau of Reclamation Library, Denver Federal Center, 6th Avenue and Kipling, Building 67, Room 167, Denver, Colorado.
- Department of the Interior, Natural Resources Library 1849 C Street NW., Washington, DC.
- Yuma County Library, 185 South Main Street, Yuma, Arizona.
- Palo Verde Valley Library, 125 West Chanslor Way, Blythe, California.
- Mohave County Library, 1170 Hancock Road, Bullhead City, Arizona.
- Laughlin Library, 2840 South Needles Highway, Laughlin, Nevada.
- Las Vegas Clark County Library, 833 Las Vegas Boulevard N, Las Vegas, Nevada.
- James I. Gibson Library, 280 Water Street, Henderson, Nevada.

FOR FURTHER INFORMATION CONTACT: Terrance J. Fulp, Ph.D., at (702) 293–8500 or e-mail at *strategies@lc.usbr.gov*; and/or Randall Peterson at (801) 524–3633 or e-mail at *strategies@lc.usbr.gov*.

SUPPLEMENTARY INFORMATION: During the period from 2000–2006, the Colorado River has experienced the worst drought conditions in approximately one hundred years of recorded history. During this period, storage in Colorado River reservoirs has dropped from nearly full to less than 60 percent of capacity at the end of 2006. Currently, the Department does not have specific operational guidelines in place to address the operation of Lake Mead and Lake Powell during drought and low reservoir conditions.

Accordingly, the Department proposes the adoption of specific interim guidelines for Lower Basin shortages and coordinated operations of Lake Powell and Lake Mead. The proposed federal action will be implemented through the adoption of interim guidelines in effect through 2026 that would be used each year by the Department in implementing the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968, through issuance of the Annual Operating Plan for Colorado River Reservoirs.

The proposed federal action considers four operational elements that collectively are designed to address the purpose and need for the proposed federal action. These elements are addressed in each of the alternatives described and analyzed in the Draft EIS. The interim guidelines would be used by the Secretary of the Department of the Interior (Secretary) to:

- Determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) below 7.5 million acre-feet (a "Shortage") pursuant to Article II(B)(3) of the United States Supreme Court in the case of *Arizona* v. *California*, 547 U.S.____(2006);
- Define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;
- Allow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions; and
- Determine those conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing Interim Surplus Guidelines (ISG), published in the **Federal Register** on January 25, 2001 (66 FR 7772), and the term of the ISG from 2016 to 2026.

The purpose of the proposed federal action is to: (1) Improve Reclamation's management of the Colorado River by considering the trade-offs between the frequency and magnitude of reductions of water deliveries, and considering the effects on water storage in Lake Powell and Lake Mead, water supply, power production, recreation, and other environmental resources; (2) provide mainstream U.S. users of Colorado River water, particularly those in the Lower Division states, a greater degree of predictability with respect to the amount of annual water deliveries in future years, particularly under drought and low reservoir conditions; and, (3) provide additional mechanisms for the storage and delivery of water supplies in Lake Mead.

The Draft EIS presents four possible action alternatives for implementation, plus a ''No Action Alternative.'' Reclamation has not identified a preferred alternative in this Draft EIS. The preferred alternative will be identified following public comments on the Draft EIS and will be expressed in the Final EIS. The action alternatives reflect input from Reclamation staff, the cooperating agencies, stakeholders, and other interested parties. Reclamation received two written proposals for alternatives that met the purpose and need of the proposed federal action, one from the Basin States and another from a consortium of environmental organizations. These proposals were used and refined by Reclamation to formulate two of the alternatives considered and analyzed in this Draft EIS: the Basin States Alternative and the Conservation Before Shortage Alternative. A third alternative (Water Supply Alternative) was developed by Reclamation and a fourth alternative (Reservoir Storage Alternative) was developed in coordination with the NPS and Western.

The Basin States Alternative proposes a coordinated operation of Lake Powell and Lake Mead that would minimize shortages in the Lower Basin and avoid the risk of curtailments of use in the Upper Basin. This alternative also provides a mechanism, Intentionally Created Surplus (ICS), for promoting water conservation in the Lower Basin.

The Conservation Before Shortage Alternative includes voluntary, compensated reductions in water use to minimize involuntary shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin. This alternative also provides a mechanism for promoting water conservation in the Lower Basin by expanding the ICS mechanism.

The Water Supply Alternative is intended to maximize water deliveries at the expense of retaining water in storage in the reservoirs for future use. This alternative would implement shortages only when insufficient water to meet entitlements is available in Lake Mead.

The Reservoir Storage Alternative would keep more water in storage in Lake Powell and Lake Mead by reducing water deliveries and increasing shortages to benefit power and recreational interests; and this alternative also provides a mechanism for promoting water conservation in the Lower Basin.

Public Disclosure

It is our practice to make comments, including names, home addresses, home telephone numbers, and e-mail addresses of respondents, available for public review. Individual respondents may request that we withhold their names and/or home addresses, etc., but if you wish us to consider withholding this information you must state this prominently at the beginning of your comments. In addition, you must present a rationale for withholding this information. This rationale must demonstrate that disclosure would constitute a clearly unwarranted invasion of privacy. Unsupported assertions will not meet this burden. In the absence of exceptional, documentable circumstances, this information will be released. We will always make submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, available for public inspection in their entirety.

Dated: February 2, 2007.

Willie R. Taylor,

Director, Office of Environmental Policy and Compliance.

[FR Doc. E7–3447 Filed 2–27–07; 8:45 am]

BILLING CODE 4310–MN–P

DEPARTMENT OF LABOR

Employment and Training Administration

[TA–W–60,281]

Airtex Products LP, Including On-Site Leased Workers of Staffmark and Aid Temporary Services, Inc.; Marked Tree, Arkansas; Notice of Revised Determination on Reconsideration of Alternative Trade Adjustment Assistance

By letter dated February 8, 2007, a company official requested administrative reconsideration regarding Alternative Trade Adjustment Assistance (ATAA) applicable to workers of the subject firm. The negative determination was signed on January 24, 2007, and was published in the **Federal Register** on February 14, 2007 (72 FR 7087).

The workers of Airtex Products LP, including on-site leased workers of Staffmark and Aid Temporary Services, Inc., Marked Tree, Arkansas were certified eligible to apply for Trade Adjustment Assistance (TAA) on January 24, 2007.

The initial ATAA investigation determined that there was not a significant number of workers in the workers' firm that are 50 years of age or older, and that the skills of the subject worker group are easily transferable to other positions in the local area.

In the request for reconsideration, the company official resubmitted correct employment numbers which show that a significant number or proportion of the worker group of the subject firm are fifty years of age or older. The company official also provided new information confirming that the skills of the workers at the subject firm are not easily transferable in the local commuting area.

Additional investigation has determined that the workers possess skills that are not easily transferable. A significant number or proportion of the worker group are age fifty years or over. Competitive conditions within the industry are adverse.

Conclusion

After careful review of the additional facts obtained on reconsideration, I conclude that the requirements of Section 246 of the Trade Act of 1974, as amended, have been met for workers at the subject firm.

In accordance with the provisions of the Act, I make the following certification:

All workers of Airtex Products LP, including on-site leased workers of Staffmark and Aid Temporary Services, Inc., Marked Tree, Arkansas, who became totally or partially separated from employment on or after October 20, 2005 through January 24, 2009, are eligible to apply for trade adjustment assistance under Section 223 of the Trade Act of 1974 and are also eligible to apply for alternative trade adjustment assistance under Section 246 of the Trade Act of 1974.

Signed in Washington, DC, this 21st day of February, 2007.

Elliott S. Kushner,

Certifying Officer, Division of Trade Adjustment Assistance.

[FR Doc. E7–3460 Filed 2–27–07; 8:45 am]

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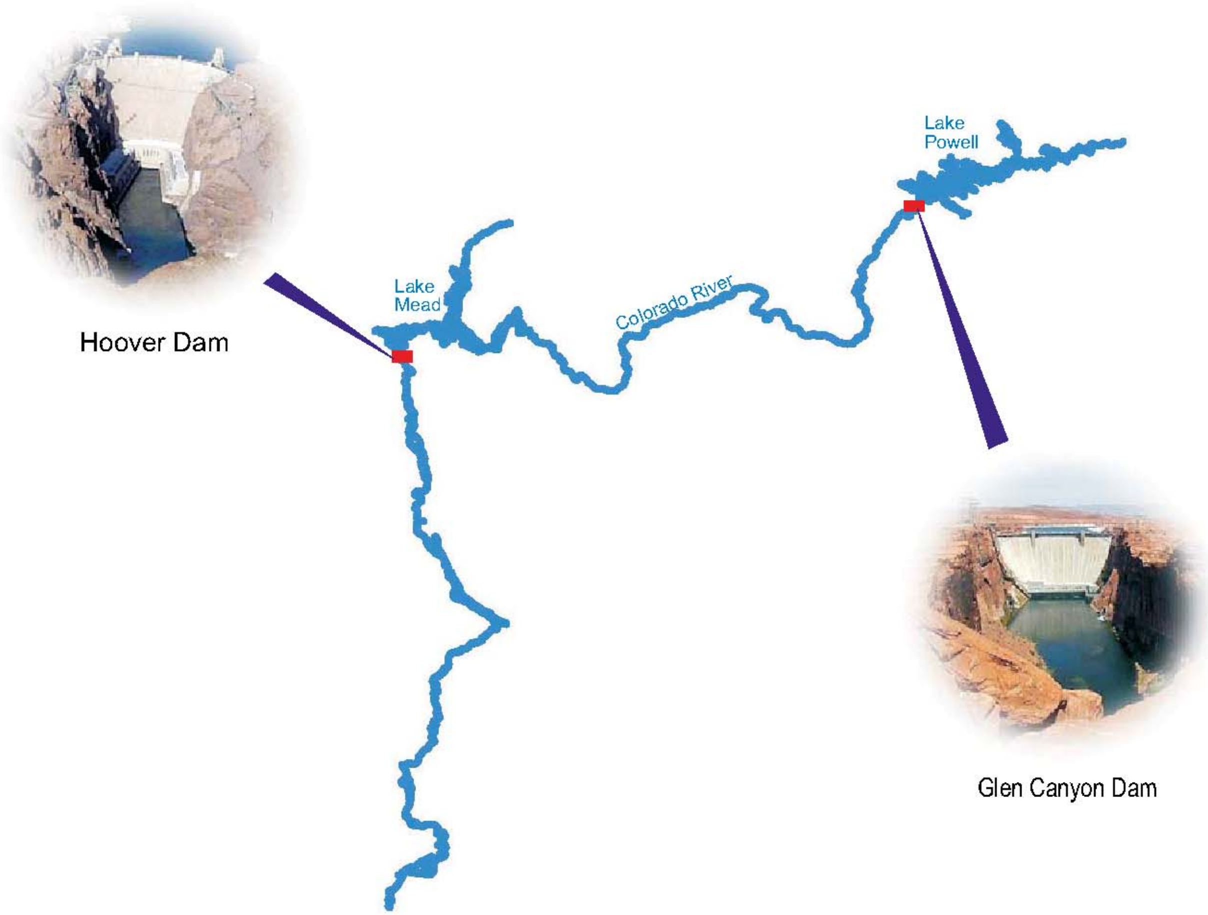
RECLAMATION
Managing Water in the West

Final

Environmental Impact Statement



Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Volume III – Appendices M through U

U.S. Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions

October 2007

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Final
Environmental Impact Statement

Volume III
Appendices M through U

U.S. Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions
October 2007

Table of Contents

Volume III - Appendices: Table of Contents

R. BIOLOGICAL ASSESMENT

Appendix M

Modeling Assumptions: Lake Mead Storage and Delivery of Conserved System and Non-system Water

Four of the action alternatives assume some form of a Lake Mead storage and delivery mechanism for conserved system and non-system water (the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative). This appendix describes the modeling assumptions used in the CRSS model to represent the creation and delivery of storage credits. At this time, the specific entities that may participate in the storage and delivery mechanism and the magnitude and timing of the storage and delivery of the conserved water are unknown. However, modeling assumptions with respect to the entities that might participate and their respective level of participation were needed to enable the evaluation of the mechanisms considered under each alternative and their potential effects on environmental resources. These assumptions are a reasonable and appropriate representation of potential conservation activities and the storage and delivery of water under the alternatives for purposes of environmental analyses.

Table of Contents

List of Tables

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M.1 Introduction

As described in the Draft EIS, the proposed federal action is comprised of four key elements, one of which is a mechanism for "Lake Mead Storage and Delivery of Conserved System or Non-system Water" (Section 1.2 and Section 2.1). Four of the five action alternatives in the Final EIS (Basin States, Conservation Before Shortage, and Reservoir Storage alternatives and the Preferred Alternative) included some expression of a storage and delivery mechanism. Intentionally Created Surplus (ICS), as proposed by the Basin States and Conservation Before Shortage alternatives, is one way to implement this element and is the mechanism proposed by the Preferred Alternative. Reclamation has published draft guidelines in the Final EIS that describe the proposed administration of the ICS mechanism (Appendix S). In this appendix, however, the storage and delivery mechanism is described in more general terms for modeling purposes only.

At this time, it is unknown which entities might participate in a Lake Mead mechanism that allows the storage and delivery of conserved system and non-system water. Furthermore, the timing and magnitude of the storage and delivery of conserved water is unknown. However, modeling assumptions with respect to the entities that might participate and their respective level of participation were needed to enable the evaluation of the mechanism and its potential effects on environmental resources, particularly to reservoir storage and river flows downstream of Lake Mead.

The proposed federal action is for the purpose of adopting additional operational guidelines to improve the Department's annual management and operation of key Colorado River reservoirs for an interim period through 2026. However, in order to assess the potential effects of the proposed federal action in this Final EIS, certain modeling assumptions are used that display projected water deliveries to Mexico. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State. [1]

For two of the action alternatives (the Conservation Before Shortage Alternative and the Reservoir Storage Alternative), it was assumed that storage credits would be generated and used

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[1] Notwithstanding the lack of an existing mechanism to implement such modeling assumptions, Reclamation utilized these assumptions for a number of reasons, including the following: (1) a larger volume of potential storage in Lake Mead is identified; (2) the maximum potential impacts on river flows downstream of Hoover Dam are identified; (3) the alternative proponent's recommendations as to participating entities and levels of participation are modeled; (4) the arbitrary assignment of water conservation amounts to entities in the Lower Basin states is avoided; and (5) the modeling impacts of a program of potential future cooperation between the United States and Mexico are identified.

for environmental purposes. These modeling assumptions were utilized in this Final EIS in order to analyze the potential impacts to environmental resources of the storage and delivery mechanism, particularly with regard to reservoir elevations and river flow impacts. The use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, these releases could be made under current management of the river.

M.2 General Modeling Assumptions

Four alternatives assume some form of a Lake Mead storage and delivery mechanism for conserved system and non-system water (the Basin States, Conservation Before Shortage and Reservoir Storage alternatives, and the Preferred Alternative). This section explains the general modeling assumptions regarding how storage credits are generated and delivered within the CRSS model. Examples of the accounting of storage credits within the model are also presented below.

M.2.1 Generation of Storage Credits

When storage credits are created, the model assumes either a delivery from Lake Mead is decreased or a new gain to the system is introduced, resulting in an increase to Lake Mead storage. If the reduced delivery is located downstream of Lake Mead, creation of the storage credit results in a reduction in the release from Lake Mead and river flow downstream.

At the beginning of each year, the model assumes that storage credits will be generated based on annual schedules and that the scheduled amount does not change throughout the year. The ability to store conservation credits in Lake Mead is assumed to be in effect from 2008 through 2026 (i.e., conserved water is assumed to not be stored in Lake Mead after 2026).

The activity resulting in the creation of credits is assumed to originate from a point on the Colorado River located furthest downstream in order to evaluate the maximum effects of the storage and delivery mechanism on river flows. In general, water conserved for use by a particular state is assumed to be generated by an entity within that state that had an annual depletion schedule sufficiently large enough to accommodate the reductions. In the case of the Conservation Before Shortage and Reservoir Storage alternatives, which assume unassigned storage and delivery activities and/or storage and delivery activities for Mexico and the federal government, and the Preferred Alternative, which analyzes additional activities to disclose the environmental impacts of a larger ICS program, these activities were assumed to occur within Mexico because this is the last major user in the lower part of the river and again, this permitted evaluation of the potential effects on river flow reductions[2].

[2] Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

A one-time system assessment is assumed to be dedicated to the system upon the creation of a storage credit. The system assessment is assumed to be five percent of the volume of water conserved for the Basin States and Conservation Before Shortage alternatives and for the Preferred Alternative. For the Reservoir Storage Alternative, the system assessment is assumed to be ten percent of the volume of water conserved. For example, if an entity wishes to receive credit for 100 kaf, then the credits that must be generated become:
100 kaf / (1 - system assessment).

The model assumes that the accounting of storage credits occurs annually, at the end of the calendar year. Storage credits in Lake Mead are assumed to be subject to the following rules:

- an annual three percent deduction for evaporation. The deduction is applied at the end of the year and is based on the available credits at the end of the previous year. Therefore, evaporation reductions are assumed to not apply to ICS credits created and delivered within the same year;
- no evaporation deductions occur during shortage conditions;
- under the Basin States and Conservation Before Shortage alternatives and the Preferred Alternative, if flood control releases occur, storage credits would be reduced on a pro-rata basis among all entities with stored water until no credits remain. For these alternatives and the Reservoir Storage Alternative, a reasonable approximation of this operation was made whereby storage credits were assumed to be eliminated and stored water reverted to system water when flood control releases are made;
- the total volume of storage credits in Lake Mead at any given time is not included in the determination of a Quantified Surplus using the 70R Strategy; and
- the amount of storage credits that may be generated in a single year is constrained by assumed maximum annual and maximum total limits. These assumed limits vary by alternative and are presented in Section M.3.

M.2.2 Delivery of Storage Credits

When storage credits are delivered from Lake Mead, the model assumes that a delivery from Lake Mead was increased for that year, resulting in a decrease in Lake Mead storage. If the increased delivery is located downstream of Lake Mead, delivery of the storage credit results in an increase in the release from Lake Mead and downstream river flows.

At the beginning of each year, the model assumes that storage credits will be delivered based on annual schedules and that the scheduled delivery amount does not change throughout the year. Although the ability to store conservation credits in Lake Mead is assumed to be in effect from 2008 through 2026 (i.e., conserved water may not be stored in Lake Mead after 2026), a ten-year period (2027 through 2036) was assumed for entities to take any storage credits remaining after the end of the interim period.

After 2026, some conservation activities assumed to be undertaken by Nevada are assumed to continue through 2060 (tributary conservation, groundwater return flows, and system augmentation described further in Section M.3.1). The model assumes delivery of that water to Nevada in the year that the conservation occurs.

M.2.3 Examples of Storage Credit Accounting

Table M-1 provides an example of storage credit accounting in CRSS. A Put refers to the creation of credits. A Take is the delivery of credits. Although most calculations in CRSS occur on a monthly basis, the model calculates available storage credits annually, at the end of the year. At the end of year n, the balance of storage credits is determined as,

$$Balance_n = Balance_{n-1} + Put(1 - Assessment\%) - Take - Evap\%(Balance_{n-1})$$

Table M-1
Example of Storage Credit Accounting (af)

Year	Put	Assessment[1]	Put Adjusted for Assessment	Requested Take	Actual Take	Evaporation	Balance
1	0	0	0	0	0	0	0
2	200,000	10,000	190,000	0	0	0	190,000
3	100,000	5,000	95,000	50,000	50,000	5,700	229,300
4	0	0	0	200,000	200,000	6,879	22,421
5	0	0	0	50,000	21,748	673	0

1 Assuming a system assessment of five percent.

Year 1: The storage credit balance is zero and there is no activity for this year.

Year 2: A put of 200 kaf is scheduled for this year. There is a 200 kaf reduction in delivery for this year. Assuming a system assessment of five percent, 190 kaf of storage credits are generated for this year and ten kaf (five percent of 200 kaf) is credited to the system. There are no takes scheduled. Evaporation is counted as three percent of the previous year's balance. Because the balance in Year 1 is 0, there is no evaporation loss deducted in Year 2.

Year 3: Applying the scheduled put and take values to the equation above, a storage credit balance of 229,300 af is created.

$$229{,}300 = 190{,}000 + 100{,}000(1 - 0.05) - 50{,}000 - 0.03(190{,}000)$$

Year 4: Applying the scheduled put and take values to the equation above, a storage credit balance of 22,421 af is created.

$$22{,}421 = 229{,}300 + 0(1 - 0.05) - 200{,}000 - 0.03(229{,}300)$$

Year 5: The requested take is higher than the available storage credits. Therefore the actual take is constrained by the available storage credits and is therefore limited to 21,748 af.

M.3 Modeling Assumptions Specific to Alternatives

Modeling assumptions with respect to the entities that might participate and their respective level of participation were needed to enable the evaluation of the potential effects of the mechanism for each alternative. These assumptions include the maximum amount of storage credits that may be created during any year, the maximum amount of storage credits that may be recovered during any year, and the maximum total amount of storage credits that may be available at any one time. In addition, assumptions with regard to the timing and magnitude of the storage and delivery of conserved water are needed. The assumptions made for each alternative are detailed in the following sections.

M.3.1 Basin States Alternative

The Basin States Alternative proposes the Intentionally Created Surplus (ICS) mechanism and assumes the levels of participation as shown in Table M-2 (Section 2.3).

Table M-2
Basin States Alternative
Volume Limitations of ICS

Entity	Maximum Annual ICS Creation (kaf)	Maximum Cumulative ICS (kaf)	Maximum Annual ICS Delivery (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Total	625	2,100	1,000

These volume limitations are recognized in CRSS as are other rules that specify under which water supply conditions ICS may be delivered or accounted for as summarized in Section M.3.5. The schedules for Arizona, California and Nevada were provided by the Arizona Department of Water Resources (ADWR), the Metropolitan Water District of Southern California (MWD) and the Southern Nevada Water Authority (SNWA), respectively, and are detailed below.

M.3.1.1 Arizona

In order to analyze the maximum effects on river flows, the model assumes that Arizona ICS is generated through extraordinary conservation by the Yuma County Water Users Association and are delivered to CAP. According to the schedules provided by ADWR, the creation of ICS begins in 2017, as shown in Table M-3. It was assumed that ICS is created and delivered during a Normal Condition.

M.3.1.2 California

In order to analyze the maximum effects on river flows, the model assumes that California ICS is generated through extraordinary conservation by the Imperial Irrigation District and are delivered to MWD. Schedules for the creation and delivery of ICS were provided by MWD. One hundred (100) schedules were provided, corresponding to the 100 hydrologic traces used in the ISM simulations (Section 4.2). As an example, one of these schedules is presented in Table M-3. In 2008, California is assumed to begin with an ICS account of 100 kaf due to pilot programs in place in 2006 and 2007. It was assumed that storage credits are created and delivered during a Normal Condition.

M.3.1.3 Nevada

As provided by SNWA, four different conservation activities are assumed to be undertaken by Nevada to generate ICS credits. Each activity is subject to different assumptions as to when ICS credits may be generated and used as described below. The schedules provided by SNWA are shown in Table M-3.

Tributary Conservation. It was assumed that water from extraordinary conservation on the Virgin River and Muddy River would generate ICS credits. This activity is assumed to be in place during the period 2009 through 2060. In the CRSS model, a gain to Lake Mead was introduced as the source of this ICS and it is assumed that delivery is taken by SNWA from Lake Mead. In general, it was assumed that credits may be created during all water supply conditions (except the Flood Control Surplus Condition) and may be delivered during a Normal Condition and a Shortage Condition. However, it was also assumed that SNWA would take ICS during a Full Domestic Surplus Condition, if needed, to avoid exceeding the maximum total amount of ICS. After 2026, it is assumed that the tributary conservation ICS would continue to be created each year and would be used in the same year. The system assessment is assumed to be in effect through 2060.

Groundwater. Nevada state groundwater introduced into Lake Mead or wastewater produced from Nevada state groundwater, are assumed to be available to SNWA during the period 2009 through 2060. In the CRSS model, a gain to Lake Mead was introduced as the source of groundwater and it was assumed that delivery is taken by SNWA from Lake Mead. It was assumed that such ICS may be created and delivered during a Normal Condition and a Shortage Condition. After 2026, it is assumed that such flows would continue to be created each year and would be used in the same year. The system assessment is assumed to be in effect through 2060.

System Augmentation. SNWA is assumed to receive water generated from future system augmentation projects (e.g., desalinization) beginning in 2020 through 2060. To account for water created through system augmentation, a gain was introduced to the system downstream of Imperial Dam. System augmentation water is assumed to be generated and taken during all water supply conditions except during a Flood Control Surplus Condition. After 2026, it is assumed that the system augmentation water would continue to be created each year and would be used in the same year. The system assessment for system augmentation is assumed to be in effect through 2060.

Drop 2 Storage Reservoir. The proposed Drop 2 Storage Reservoir Project is assumed to be in operation beginning in 2010 and assumed to conserve an average of 69 kafy, reducing the average delivery of non-storable flows to Mexico from 77 kafy to 8 kafy under all alternatives (Section 4.2). Under the four action alternatives that assume a storage and delivery mechanism, SNWA is assumed to use water conserved by the Drop 2 Storage Reservoir beginning in 2013 during a Surplus Condition (excluding the Flood Control Surplus Condition) and a Normal Condition. A system assessment is not applied to Drop 2 Storage Reservoir water. Nevada is assumed to take Drop 2 Storage Reservoir water at a maximum rate of 40 kaf each year until a total of 300 kaf has been taken. Thereafter, water conserved by the Drop 2 Reservoir is assumed to be system water.

Table M-3
Assumed Creation and Delivery Schedules for ICS Under the Basin States Alternative[1]

Year	Arizona		California2		Nevada					
	Extraordinary Conservation (af)		Extraordinary Conservation (af)		Tributary Conservation (af)		Groundwater (af)		System Augmentation (af)	
	Creation	Deliver	Creation	Deliver	Creation	Deliver	Creation	Deliver	Creation	Deliver
2008	0	0	400,000	0	0	0	0	0	0	0
2009	0	0	400,000	0	30,000	5,000	13,000	13,000	0	0
2010	0	0	400,000	0	30,000	5,000	13,000	13,000	0	0
2011	0	0	400,000	0	30,000	5,000	13,000	13,000	0	0
2012	0	0	400,000	0	30,000	5,000	13,000	13,000	0	0
2013	0	0	400,000	0	30,000	5,000	13,000	13,000	0	0
2014	0	0	100,000	0	30,000	5,000	13,000	13,000	0	0
2015	0	0	0	0	30,000	5,000	13,000	13,000	0	0
2016	0	0	300,000	0	30,000	5,000	13,000	13,000	0	0
2017	100,000	0	400,000	0	30,000	5,000	13,000	13,000	0	0
2018	100,000	0	300,000	0	30,000	5,000	13,000	13,000	0	0
2019	100,000	0	200,000	0	30,000	5,000	13,000	13,000	0	0
2020	0	300,000	0	100,000	30,000	5,000	80,000	80,000	75,000	75,000
2021	100,000	50,000	0	100,000	30,000	5,000	80,000	80,000	75,000	75,000
2022	100,000	0	0	200,000	30,000	5,000	80,000	80,000	75,000	75,000
2023	100,000	0	0	0	30,000	5,000	80,000	80,000	75,000	75,000
2024	50,000	0	100,000	0	30,000	5,000	80,000	80,000	75,000	75,000
2025	0	50,000	0	100,000	30,000	30,000	80,000	80,000	75,000	75,000
2026	0	50,000	0	400,000	30,000	30,000	80,000	80,000	75,000	75,000
2027	0	50,000	0	300,000	30,000	60,000	80,000	80,000	75,000	75,000
2028	0	50,000	0	200,000	30,000	60,000	80,000	80,000	75,000	75,000
2029	0	50,000	0	0	30,000	60,000	80,000	80,000	75,000	75,000
2030	0	50,000	0	0	30,000	60,000	80,000	80,000	75,000	75,000
2031	0	50,000	0	400,000	30,000	60,000	80,000	80,000	75,000	75,000
2032	0	50,000	0	400,000	30,000	60,000	80,000	80,000	75,000	75,000
2033	0	50,000	0	400,000	30,000	60,000	80,000	80,000	75,000	75,000
2034	0	50,000	0	400,000	30,000	60,000	80,000	80,000	75,000	75,000
2035	0	50,000	0	400,000	30,000	60,000	80,000	80,000	75,000	75,000
2036	0	50,000	0	400,000	30,000	60,000	80,000	80,000	75,000	75,000
2037	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2038	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2039	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2040	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2041	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2042	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2043	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2044	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2045	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2046	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000

Table M-3
Assumed Creation and Delivery Schedules for ICS Under the Basin States Alternative[1]

Year	Arizona		California2		Nevada					
	Extraordinary Conservation (af)		Extraordinary Conservation (af)		Tributary Conservation (af)		Groundwater (af)		System Augmentation (af)	
	Creation	Deliver	Creation	Deliver	Creation	Deliver	Creation	Deliver	Creation	Deliver
2047	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2048	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2049	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2050	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2051	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2052	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2053	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2054	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2055	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2056	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2057	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2058	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2059	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2060	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000

1 *Actual modeled delivery amounts may be less depending on availability, system assessment, and evaporation losses.*

2 *Reclamation was provided 100 distinct storage and delivery schedules by MWD to be used with the Index Sequential Method. The schedule in this table is an example of one schedule corresponding to one hydrologic sequence.*

M.3.2 Conservation Before Shortage

The Conservation Before Shortage Alternative assumes the levels of participation shown in Table M-4 (Section 2.4).

Table M-4
Conservation Before Shortage Alternative
Volume Limitations of ICS

Entity	Maximum Annual ICS Creation (kaf)	Maximum Cumulative ICS (kaf)	Maximum Annual ICS Delivery (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Unassigned	825	2,100	600
Total	1,450	4,200	1,600

These volume limitations are recognized in CRSS as are other rules that specify under which water supply conditions conserved system or non-system water may be delivered or stored as summarized in Section M.3.5. The schedules for the Conservation Before Shortage Alternative for the participation of the Lower Division states were assumed to be identical to those used in the Basin States Alternative (Table M-3). The schedules for the expanded participation by other entities (Unassigned in Table M-4) were provided by the non-governmental organizations (NGOs) and are detailed below.

The Conservation Before Shortage proposal includes voluntary, compensated reductions in water use prior to the imposition of involuntary shortages (Section 2.4). To model this proposal, it was assumed that storage credits of 400, 500 and 600 kafy would be created when Lake Mead was at specific elevations within the range of 1,075 feet msl and 1,025 feet msl (Section 2.4). For modeling purposes and to maximize river flow effects, these storage credits were assumed to be generated via extraordinary conservation within Mexico. The system assessment is applied when these storage credits are created and evaporation losses are applied to the account balance at the end of each year. The maximum positive volume for the account is assumed to be 1.5 maf and any additional water that is conserved above that amount is assumed to convert to system water.

It was assumed that these storage credits would remain in Lake Mead and would be counted toward the replacement of the bypass flows to the Cienega de Santa Clara in Mexico. The model maintains an accounting for the bypass flow replacement. In each year, the model releases 109 kaf (Section 4.2) for the bypass flows and deducts that amount from the bypass flow replacement account. Any deficit that accumulates in the account is tracked and offset at a later time when Lake Mead is below elevation 1,075 feet msl and storage credits are created.

The NGOs also postulated that storage credits would be generated by Mexico and be used for the purpose of environmental flows and other purposes in Mexico. These credits would be subject to the system assessment and evaporation losses and would be stored and delivered during a Surplus Condition or a Normal Condition, but not during a Flood Control Surplus Condition or a Shortage Condition. Two sets of flows are assumed to occur. The first are pulse flows to the Colorado River Delta flowing into the Gulf of California, assumed to occur every five years after the last flood control release, with the first flow scheduled for 2012 (referred to as Delta Pulse Flows in Table M-5). Each year, storage credits of 50 kaf are assumed to be generated. Delta pulse flows are of magnitude 250 kaf; however, in the fifth year, the storage credit of 50 kaf is assumed to be stored and delivered in the same year and a system assessment is not applied. The model assumes that Delta pulse flows would flow past the Northerly International Border (NIB) and are counted as an additional delivery to Mexico. The second set of flows (termed Other Flows Below NIB in Table M-5) are assumed also to occur every five years, with the first scheduled for 2010 at a volume of 80 kaf. Each year 40 kaf of storage credits is scheduled to be created for these flows. After 2010, these flows increase to a volume of 200 kaf and similar to the Delta Pulse Flows, in the fifth year the 40 kaf is assumed to be stored and delivered in the same year. The model also assumes that this water would flow past the NIB and is counted as an additional delivery to Mexico.

The NGOs postulated an additional activity to create 100 kafy of storage credits for environmental uses within the United States (termed Additional Environmental Uses in Table M-5). It was assumed that these credits would be created and delivered during a

Normal Condition and a Surplus Condition and would be subject to the system assessment and evaporation losses. For modeling purposes and to maximize river flow effects, this water was also a assumed to be generated via extraordinary conservation within Mexico.

The assumed schedules for these activities are presented in Table M-5.

Table M-5
Assumed Storage and Delivery Schedules for
Other Conservation Activities Under the Conservation Before Shortage Alternative[1] (af)

Year	Delta Pulse Flows		Other Flows Below NIB		Additional Environmental Uses	
	STORE	DELIVER	STORE	DELIVER	STORE	DELIVER
2008	52,632	0	42,105	0	105,263	100,000
2009	52,632	0	42,105	0	105,263	100,000
2010	52,632	0	0	80,000	105,263	100,000
2011	52,632	0	42,105	0	105,263	100,000
2012	50,000	250,000	42,105	0	105,263	100,000
2013	52,632	0	42,105	0	105,263	100,000
2014	52,632	0	42,105	0	105,263	100,000
2015	52,632	0	40,000	200,000	105,263	100,000
2016	52,632	0	42,105	0	105,263	100,000
2017	50,000	250,000	42,105	0	105,263	100,000
2018	52,632	0	42,105	0	105,263	100,000
2019	52,632	0	42,105	0	105,263	100,000
2020	52,632	0	40,000	200,000	105,263	100,000
2021	52,632	0	42,105	0	105,263	100,000
2022	50,000	250,000	42,105	0	105,263	100,000
2023	52,632	0	42,105	0	105,263	100,000
2024	52,632	0	42,105	0	105,263	100,000
2025	52,632	0	40,000	200,000	105,263	100,000
2026	52,632	0	42,105	0	105,263	100,000
2027	0	250,000	0	0	0	100,000
2028	0	0	0	0	0	100,000
2029	0	0	0	0	0	100,000
2030	0	0	0	200,000	0	100,000
2031	0	0	0	0	0	100,000
2032	0	250,000	0	0	0	100,000
2033	0	0	0	0	0	100,000
2034	0	0	0	0	0	100,000
2035	0	0	0	200,000	0	100,000
2036	0	0	0	0	0	100,000
2037	0	0	0	0	0	0
2038	0	0	0	0	0	0
2039	0	0	0	0	0	0
2040	0	0	0	0	0	0
2041	0	0	0	0	0	0
2042	0	0	0	0	0	0
2043	0	0	0	0	0	0
2044	0	0	0	0	0	0
2045	0	0	0	0	0	0
2046	0	0	0	0	0	0
2047	0	0	0	0	0	0

Table M-5
Assumed Storage and Delivery Schedules for
Other Conservation Activities Under the Conservation Before Shortage Alternative[1] (af)

Year	Delta Pulse Flows		Other Flows Below NIB		Additional Environmental Uses	
	STORE	DELIVER	STORE	DELIVER	STORE	DELIVER
2048	0	0	0	0	0	0
2049	0	0	0	0	0	0
2050	0	0	0	0	0	0
2051	0	0	0	0	0	0
2052	0	0	0	0	0	0
2053	0	0	0	0	0	0
2054	0	0	0	0	0	0
2055	0	0	0	0	0	0
2056	0	0	0	0	0	0
2057	0	0	0	0	0	0
2058	0	0	0	0	0	0
2059	0	0	0	0	0	0
2060	0	0	0	0	0	0

1 *Storage amounts are adjusted for system assessment. Actual modeled delivery amounts may be less depending on availability and evaporation losses.*

M.3.3 Reservoir Storage Alternative

The Reservoir Storage Alternative assumes the levels of participation as shown in Table M-6 (Section 2.6).

Table M-6
Reservoir Storage Alternative
Volume Limitations of Storage and Delivery Mechanism

Entity	Maximum Annual Storage of Conserved System or Non-system Water (kaf)	Maximum Total Storage of Conserved System or Non-system Water (kaf)	Maximum Annual Delivery of Conserved System or Non-system Water (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Unassigned	475	950	950
Total	1,100	3,050	1,950

These volume limitations are recognized in CRSS as are other rules that specify under which water supply conditions conserved system or non-system water may be delivered or stored as summarized in Section M.3.5. The schedules for the Reservoir Storage Alternative for the participation of the Lower Division states were assumed to be identical to those used in the Basin States Alternative (Table M-3). The schedules for the expanded participation by other entities (Unassigned in Table M-6) are detailed below.

Some of the activities assumed in the Conservation Before Shortage Alternative were also assumed for the Reservoir Storage Alternative. In particular, the schedules for the Delta Pulse Flows and Other Flows Below NIB (Table M-5) were assumed to be identical. Other additional activities were assumed for the Reservoir Storage Alternative in order to assess the potential effects of a storage and delivery mechanism with limits different from either the Basin States or the Conservation Before Shortage alternatives.

During all water supply conditions, except the Flood Control Surplus condition, storage credits are assumed to be created to replace bypass flows to the Cienega de Santa Clara in Mexico. The model assumes that 109 kafy is released from Lake Mead for the bypass flows (Section 4.2). Because the system assessment for the Reservoir Storage Alternative is assumed to be ten percent, storage credits of 121 kafy are assumed to be created each year to replace the bypass flows (termed Bypass Flow Replacement in Table M-7). For modeling purposes and to maximize river flow effects, this water was assumed to be generated via extraordinary conservation within Mexico.

It was also assumed that storage credits of 55 kafy would be created for environmental purposes (in the amount of 50 kafy after the system assessment) in the United States (termed Environmental Uses in Table M-7). These credits are assumed to be created and delivered during all conditions (except the Flood Control Surplus Condition). For modeling purposes and to maximize river flow effects, this water was assumed to be generated via extraordinary conservation within Mexico.

During a Normal Condition and a Surplus Condition, an additional 150 kafy is assumed to be created each year with a delivery of 100 kafy (termed "Additional Conservation Activities" in Table M-7). For modeling purposes and to maximize river flow effects, this water was assumed to be generated via extraordinary conservation within Mexico and delivered to SNWA at Lake Mead.

The assumed schedules for these activities are shown in Table M-7.

Table M-7
Assumed Storage and Delivery Schedules for Other Conservation Activities Under the Reservoir Storage Alternative[1]
(af)

Year	Environmental Uses		Bypass Flow Replacement		Additional Conservation Activities	
	STORE	DELIVER	STORE	DELIVER	STORE	DELIVER
2008	55,555	50,000	121,111	109,000	150,000	100,000
2009	55,555	50,000	121,111	109,000	150,000	100,000
2010	55,555	50,000	121,111	109,000	150,000	100,000
2011	55,555	50,000	121,111	109,000	150,000	100,000
2012	55,555	50,000	121,111	109,000	150,000	100,000
2013	55,555	50,000	121,111	109,000	150,000	100,000
2014	55,555	50,000	121,111	109,000	150,000	100,000
2015	55,555	50,000	121,111	109,000	150,000	100,000
2016	55,555	50,000	121,111	109,000	150,000	100,000
2017	55,555	50,000	121,111	109,000	150,000	100,000

Table M-7
Assumed Storage and Delivery Schedules for Other Conservation Activities Under the Reservoir Storage Alternative[1]
(af)

Year	Environmental Uses		Bypass Flow Replacement		Additional Conservation Activities	
	STORE	DELIVER	STORE	DELIVER	STORE	DELIVER
2018	55,555	50,000	121,111	109,000	150,000	100,000
2019	55,555	50,000	121,111	109,000	150,000	100,000
2020	55,555	50,000	121,111	109,000	150,000	100,000
2021	55,555	50,000	121,111	109,000	150,000	100,000
2022	55,555	50,000	121,111	109,000	150,000	100,000
2023	55,555	50,000	121,111	109,000	150,000	100,000
2024	55,555	50,000	121,111	109,000	150,000	100,000
2025	55,555	50,000	121,111	109,000	150,000	100,000
2026	55,555	50,000	121,111	109,000	150,000	100,000
2027	0	50,000	0	109,000	0	100,000
2028	0	50,000	0	109,000	0	100,000
2029	0	50,000	0	109,000	0	100,000
2030	0	50,000	0	109,000	0	100,000
2031	0	50,000	0	109,000	0	100,000
2032	0	50,000	0	109,000	0	100,000
2033	0	50,000	0	109,000	0	100,000
2034	0	50,000	0	109,000	0	100,000
2035	0	50,000	0	109,000	0	100,000
2036	0	50,000	0	109,000	0	100,000
2037	0	0	0	0	0	0
2038	0	0	0	0	0	0
2039	0	0	0	0	0	0
2040	0	0	0	0	0	0
2041	0	0	0	0	0	0
2042	0	0	0	0	0	0
2043	0	0	0	0	0	0
2044	0	0	0	0	0	0
2045	0	0	0	0	0	0
2046	0	0	0	0	0	0
2047	0	0	0	0	0	0
2048	0	0	0	0	0	0
2049	0	0	0	0	0	0
2050	0	0	0	0	0	0
2051	0	0	0	0	0	0
2052	0	0	0	0	0	0
2053	0	0	0	0	0	0
2054	0	0	0	0	0	0
2055	0	0	0	0	0	0
2056	0	0	0	0	0	0
2057	0	0	0	0	0	0
2058	0	0	0	0	0	0
2059	0	0	0	0	0	0
2060	0	0	0	0	0	0

[1] *Storage amounts are adjusted for system assessment. Actual modeled delivery amounts may be less depending on availability and evaporation losses.*

M.3.4 Preferred Alternative

The Preferred Alternative assumes the levels of participation as shown in Table M-8 (Section 2.7).

Table M-8
Preferred Alternative
Volume Limitations of ICS

Entity	Maximum Annual ICS Creation (kaf)	Maximum Cumulative ICS (kaf)	Maximum Annual ICS Delivery (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Total[1]	625	2,100	1,000
Additional Amounts	625	2,100	1,000
Total[2]	1,250	4,200	2,000

1 *It is anticipated that the ICS mechanism will be implemented to allow a maximum cumulative amount of ICS credits that would be available at any one time of up to 2.1 maf.*

2 *The analysis of potential effects in this Final EIS includes a maximum cumulative amount of ICS credits that would be available at any one time of up to 4.2 maf.*

These volume limitations are recognized in CRSS as are other rules that specify under which water supply conditions conserved system or non-system water may be delivered or stored as summarized in Section M.3.5. The schedules for the Preferred Alternative for the participation of the Lower Division states were assumed to be identical to those under the Basin States Alternative (Table M-3). The schedules for the expanded participation by other entities (Additional Amounts in Table M-9) are detailed below.

In order to analyze the maximum effects on river flows, the model assumed that additional amounts of storage credits are generated through extraordinary conservation within Mexico and delivered to Mexico[3]. It was assumed that these credits are stored and delivered during a Normal Condition.

[3] Notwithstanding the lack of an existing mechanism to implement such modeling assumptions, Reclamation utilized these assumptions for a number of reasons, including the following: (1) a larger volume of potential storage in Lake Mead is identified; (2) the maximum potential impacts on river flows downstream of Hoover Dam are identified; (3) the alternative proponent's recommendations as to participating entities and levels of participation are modeled; (4) the arbitrary assignment of water conservation amounts to entities in the Lower Basin states is avoided; and (5) the modeling impacts of a program of potential future cooperation between the United States and Mexico are identified.

Table M-9
Assumed Storage and Delivery Schedules for Other Conservation Activities Under the Preferred Alternative[1]

Year	Additional Amounts (af)		Year	Additional Amounts (af)		Year	Additional Amounts (af)	
	STORE	DELIVER		STORE	DELIVER		STORE	DELIVER
2008	350,000	0	2026	0	200,000	2044	0	0
2009	300,000	0	2027	0	250,000	2045	0	0
2010	625,000	300,000	2028	0	250,000	2046	0	0
2011	300,000	0	2029	0	250,000	2047	0	0
2012	250,000	100,000	2030	0	250,000	2048	0	0
2013	250,000	100,000	2031	0	250,000	2049	0	0
2014	250,000	0	2032	0	250,000	2050	0	0
2015	250,000	300,000	2033	0	250,000	2051	0	0
2016	250,000	200,000	2034	0	250,000	2052	0	0
2017	300,000	200,000	2035	0	250,000	2053	0	0
2018	300,000	400,000	2036	0	250,000	2054	0	0
2019	300,000	100,000	2037	0	0	2055	0	0
2020	300,000	100,000	2038	0	0	2056	0	0
2021	300,000	100,000	2039	0	0	2057	0	0
2022	300,000	100,000	2040	0	0	2058	0	0
2023	300,000	100,000	2041	0	0	2059	0	0
2024	300,000	0	2042	0	0	2060	0	0
2025	0	1,000,000	2043	0	0			

[1] *Actual modeled delivery amounts may be less depending on availability, system assessment and evaporation losses.*

M.3.5 Summary of Assumed Storage and Delivery Activities

A summary of the activities assumed to occur under the various water supply conditions (Surplus Condition, Normal Condition, and Shortage Condition) for each alternative is presented in Table M-10.

Table M-10
Modeling Assumptions for Storage and Delivery of Conserved System and Non-System Water

Water Supply Condition		BS, CBS, RS & PA [1]						CBS & RS	CBS	RS	PA
		California	Arizona	Nevada				Mexico[6]	Federal	Federal	Additional Amounts
		Extraordinary Conservation	Extraordinary Conservation	Tributary Conservation	Groundwater	System Augmentation	Drop 2 Reservoir [4]	Extraordinary Conservation	Extraordinary Conservation	Extraordinary Conservation	Extraordinary Conservation
Flood Control Surplus	Store	no	no	no	no	no	no	no	no	no	no
	Deliver	no	no	no	no	no	no	no	no	no	no
Quantified (70R) Surplus	Store	no	no	yes	no	yes	yes	yes	yes	yes	no
	Deliver	no	no	no	no	yes	yes	yes	yes	yes	no
Full Domestic Surplus	Store	no	no	yes	no	yes	yes	yes	yes	yes	no
	Deliver	no	no	yes	no	yes	yes	yes	yes	yes	no
Normal	Store	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
	Deliver	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Shortage (involuntary and voluntary compensated reductions)	Store	no	no	yes	yes	yes	no	no	no [5]	yes	no
	Deliver	no	no	yes	yes	yes	no	no	no	yes	no
System Assessment		yes	yes	yes	yes	yes	no	yes	yes	yes	yes
Period of Activity		2006-2026	2017-2026	2009-2060	2009-2060	2020-2060	Temporary	2008-2026	2008-2026	2008-2026	2008-2026

Notes:

1. *BS = Basin States Alternative, CBS = Conservation Before Shortage Alternative, RS = Reservoir Storage Alternative, PA = Preferred Alternative*
2. *yes = activity assumed to occur*
3. *no = activity assumed to not occur*
4. *Beginning in 2013, Nevada is assumed to receive 40 kafy of the water conserved by the Drop 2 Storage Reservoir during Normal Condition and Surplus Condition years until a total of 300 kaf has been credited to Nevada. Thereafter, water conserved by the Drop 2 Storage Reservoir is assumed to be system water.*
5. *Under the Conservation Before Shortage Alternative, extraordinary conservation is assumed to be undertaken by the federal government during voluntary compensated reductions but not during involuntary shortage conditions.*
6. *These modeling assumptions do not reflect policy decisions and are not intended to constitute interpretation or application of the 1944 Treaty.*

Appendix N

Analysis of Hydrologic Variability Sensitivity

This appendix contains a description of the analysis performed to evaluate the potential effects to the hydrologic resources of alternative hydrologic inflow sequences. Two methods for generating future hydrologic inflow sequences with increased hydrologic variability relative to the historical record are described, both using information derived from the most recently published (2007) streamflow reconstructions from tree-ring data. The modeling results using the alternative hydrologic inflow scenarios are compared to the results from the current method used by Reclamation, which is based on the 100-year historical record.

This appendix also includes an attachment, which was an appendix originally published in the Draft EIS of February 2007. The attachment documents the comparison of the same methods as described above applied to streamflow reconstructions from tree-ring data published in 2006. In addition, a third technique was compared at that time that was based on parametric stochastic models. The latter is also included in the attachment.

Table of Contents

List of Figures

List of Tables

List of Attachments

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N.1 Introduction

This appendix presents the analysis of the sensitivity of the hydrologic resources to alternative hydrologic inflow scenarios. As explained in Section 4.2 of this Final EIS, hydrologic variability was incorporated into the hydrologic modeling using the Index Sequential Method (ISM) (Reclamation 1985; Ouarda et al. 1997) applied to the 100-year natural flow[1] record (1906 to 2005). Two methods were used to generate future hydrologic inflow sequences with increased hydrologic variability relative to the historical record. Although these methods do not explicitly incorporate forecasts of future climate variability, the resulting sequences show a wider range of hydrologic variability, particularly with respect to longer wet and dry periods.

N.2 Development of Two Alternative Hydrologic Inflow Scenarios to Compare with the 1906 to 2005 Natural Flow Record using ISM

In its current configuration, the CRSS model requires monthly natural flows at 29 sites throughout the Colorado River system. There are 20 sites in the Upper Basin (above and including the Lees Ferry Gaging Station in Arizona) and nine sites in the Lower Basin. Natural flows for each of the 29 sites are needed in order simulate the future hydrologic conditions for each alternative hydrologic scenario.

N.2.1 Index Sequential Method Applied to the 1906 to 2005 Natural Flow Record

Under Reclamation current practice, the ISM is used to generate streamflows for input into CRSS. This stochastic method entails a sequential block bootstrap of the observed data, where the block size is determined by the simulation horizon. The ISM cycles through each year in the historic record generating 100 hydrologic sequences (or traces), assuming that the record "wraps around" at the end (i.e., 2005, 1906, 1907). Throughout this appendix, the ISM technique as applied to the 1906 to 2005 natural flow record is referred to as Direct Natural Flow Record (DNF).

Strengths of this method are that it is based on the best available measured data, provides the basis for a quantification of the uncertainty and an assessment of risk with respect to future inflows, and has been widely accepted by stakeholders on the Colorado River. Unfortunately, each trace will only consist of annual and monthly flow magnitudes and sequences that have occurred in the observed record, with the exception of new sequences being generated as a result of the wrap. Therefore, a wider range of plausible future streamflows (including flow magnitudes and wet and dry sequences not seen in the observed record) are not modeled with the ISM method.

[1] Natural flow is the observed flow adjusted for the effects of diversions and the operation of reservoirs upstream of the flow gage. The natural flow record is unbiased by past human development.

N.2.2 Direct Paleo (DP)

This technique uses streamflow reconstructions from tree-ring chronologies directly to generate future hydrologic sequences. The paleo-reconstruction of streamflow is typically based on a model derived from a multiple-linear regression analysis of the tree-ring chronologies that overlap the historical natural flow record. For this study, the sequence 1 paleo-reconstruction from Meko et al. (2007) was used. This paleo-reconstruction provides annual water year flows from year 762 to 2005 on the Colorado River at Lees Ferry. This sequence is of particular interest because it extends into the Medieval Climate Anomaly, a period of time (900 to 1300) when various paleoclimate data indicate hydrologic droughts in the western United States were abnormally widespread (Meko et al. 2007). Remnant preserved wood (tree-rings) were utilized to extend this reconstruction beyond the recent reconstruction described in Woodhouse et al. (2006), which was limited to the period 1492 to 1997.

The major strength of this method is that new sequences not seen in the observed, gaged record are available. One difficulty associated with preparation of tree-ring chronologies and the multiple-linear regression models used for the paleo reconstructions is the accurate representation of the magnitudes of the flows, particularly at the extremes, e.g., at the higher and the lower flows (Woodhouse and Brown 2001). In addition, reconstructions can vary based on the tree-ring samples used as well as the data processing techniques used to generate the streamflows from the tree-ring chronologies. For example, the Meko et al. (2007) paelo reconstruction used in this study is not the first reconstruction completed for Lees Ferry. At least four other streamflows reconstructions (Stockton and Jacoby, 1976; Hildalgo et al., 2000; Hirschboeck and Meko, 2005 and, Woodhouse et al., 2006) are available (see the Attachment A to this appendix) and each reconstruction has a different mean flow for the reconstructed period and each captures differing levels of hydrologic variability. Unfortunately, this makes choosing a particular reconstruction a non-trivial task.

The annual flows at Lees Ferry Gaging Station (site 20) were disaggregated, spatially and temporally, throughout the Colorado River Upper Basin using a nonparametric disaggregation method (Prairie 2006; Prairie et al. 2006). The disaggregation scheme ensures that the flows generated throughout the Upper Colorado River basin are spatially and temporally consistent among the 20 locations that characterize natural flow. The disaggregation method relies on the observed natural flow record (1906 to 2005) to model the spatial and temporal distribution properties of the monthly and annual flow at the 20 locations. From an annual flow at Lees Ferry, the disaggregation scheme temporally disaggregates this annual flow to a monthly time scale then the monthly flow is spatially disaggregated among the 20 Upper Basin sites. During the first step (temporal disaggregation) an annual flow is provided from the Meko et al. reconstruction. This annual flow is ranked among the first K nearest observed natural flows, where K is determined as the square root of the number of years in the observed record (e.g., 100 years). These K nearest observed flows are weighted such that the closed neighbor has the greatest weight and the farthest has the least weight. One of the weighted neighbors is randomly chosen and its corresponding year (termed an “analogue” year) is saved for use during the spatial disaggregation and selection of the Lower Basin flows. The monthly observed flows from the selected year along with the annual flow provided from the reconstruction are incorporated in a conditional probability function that ensures the disaggregated monthly flows sum to the original reconstructed flow. These steps are repeated for each annual flow in the Meko et al. reconstruction. A similar method used for the spatial disaggregation though the analogue year is also used to choose the representative year instead of picking from the K nearest observed flows.

Flows for the nine gages downstream of site 20 were taken from the observed natural flows (1906 to 2005) based on the analogue year that was chosen for the conditional probability function during the Upper Basin disaggregation. For example, if year 1954 was the analogue year chosen during the disaggregation of a given flow in the Upper Basin, then the associated monthly flows for each of the nine downstream sites are resampled from 1954 observed monthly natural flows. This method ensures the downstream sites are both temporally and spatially correlated with each other and with the upstream sites.

These disaggregated flows (1244 years of monthly flows at 29 sites) are chosen with the ISM generating 1244 traces each 53 years in length. As ISM sequentially block bootstraps the disaggregated streamflow data, the generated traces will consist of annual flow magnitudes and sequences that are present in the paleo reconstructed streamflows, with the exception of the sequences created as a result of the wrap.

N.2.3 Nonparametric Paleo Conditioning (NPC)

As previously mentioned, flow magnitudes vary significantly across multiple reconstructions for a particular site (Stockton and Jacoby 1976; Hildalgo et al. 2000; Hirschboeck and Meko 2005, and Woodhouse et al. 2006). However, the paleo-hydrologic state information (i.e., wet or dry), is similar across different reconstructions (Woodhouse et al. 2006). The nonparametric paleo-conditioning technique capitalizes on these observations by first extracting the paleo-hydrologic state information from the streamflow reconstruction and then generating flow magnitudes by conditionally choosing from the historical record (i.e., from historical flows from a wet or dry sequence corresponding to the type of sequence derived from the paleo record).

In essence, this technique combines the strengths of the DNF and Direct Paleo methods. The main drawbacks are that magnitudes not observed in the observed, gaged record can not be generated and the technique is complex and not easily understood by all stakeholders.

For example, to generate a trace, a Markov model fit to the paleo reconstruction is first used to generate a sequence of wet and dry spells over the trace that are representative of spell lengths seen in the paleo reconstruction. The observed record is split into four categories defined by the current and next year’s hydrologic state. These categories include being in a dry state one year and staying in a dry state the next year, or being in a dry state and moving to a wet state, or being in a wet state and moving to a dry state, or lastly being in a wet state and staying in a wet the next year. To choose a flow magnitude for the state sequence, first a flow from the observed record is randomly chosen and its state is determined. The next state is taken from the first value in the state sequence. With these two states the category, from which to choose a flow magnitude is defined. Within the appropriate category all the flows in the category are weighted such that the closest flow magnitude is weighted most and the farthest is weighted least. Then one of the weighted flows is randomly chosen and the flow for the next year is chosen to ensure preservation of the lag-1 correlation observed in the record flows. This chosen flow becomes the next flow and the next state value from the state sequence is used to choose the next flow magnitude. This process is repeated until the end of the state sequence for a given trace is reached. Prairie (2006) provides a detailed description of the conditional choosing technique and its mathematical basis.

For this study, the paleo hydrologic state information was derived from the sequence 1 paleo reconstruction and coupled with the conditional choosing technique to generate annual water year flows at Lees Ferry were generated. These flows are disaggregated, spatially and temporally, throughout the Colorado River Upper Basin with the nonparametric disaggregation method described in the Section N.2.2. The nine lower sites are resampled as described in Section N.2.2.

The traces generated for the Upper Basin sampling sites can produce monthly flows and sequences that were not seen before and reflect a blend of the hydrologic variability seen in the observed and reconstructed data. The downstream sites 21 to 29 contribute significantly less flow (eight percent of the total calendar year flow) than the upper sites; therefore, choosing from the direct observed natural flows does not adversely affect the ability to model unique and probable flows in the basin as a whole.

As a result of using the hydrologic state information from the paleo reconstruction data the flow sequences in the generated paleo conditioned hydrologies will reflect sequence properties (i.e., wet or dry) characteristic of the paleo reconstruction. The magnitudes of generated flow on a water year basis match the magnitudes in the observed record (1906 to 2005). The inability to generate flow magnitudes beyond those in the observed record can be a shortcoming of this technique although the increased variety of flow sequences is an advantage of this method when compared to some other stochastic hydrologic generation methods.

For these nonparametric paleo conditioned hydrologies, 125 traces, each 53 years in length, were generated for the 29 sites throughout the Colorado River Basin.

N.2.4 Comparison of the Inflow Scenarios

Basic statistics from the three inflow scenarios are shown in Figure N-1. Also presented are the two scenarios based on the Woodhouse et al. 2006 reconstructions analyzed in the Draft EIS and presented in Attachment A to this Appendix N. The statistics are computed from total calendar year flow at Lees Ferry Gaging Station on the Colorado River and include the mean, standard deviation, skew, lag-1 autocorrelation, maximum and minimum. The observed statistic (1906 to 2005) is shown as a blue triangle.

The statistics are shown as “box and whisker” plots that display the inter-quartile range as a box (where 25 percent to 75 percent of the values lie), with the median represented as a vertical line within the box. The five percent to 95 percent range of the values is also shown by the dashed lines typically extending outside the box (i.e., the “whiskers”). One measure of performance of a particular method is its ability to capture the observed statistic within the inter-quartile range. It is not always preferable to capture the observed statistic when considering climate variability. Modeling statistics other than what are exhibited by the observed data allows representation of scenarios that have not occurred in the gauged record but are plausible based on paleo reconstructions.

Each inflow scenario is presented in a row and the six statistics are presented in each column. The observed mean is reproduced well by the DNF and the Meko et al. and Woodhouse et al. NPC as expected. The Meko et al. and Woodhouse et al. Direct-Paleo (DP) scenarios underestimate the observed mean, as expected, because these paleo reconstructions have a lower mean (14.7 and 14.6 million acre-feet [maf], respectively) than the observed period (15.0 maf). The standard deviation which measures the spread of the flow magnitudes is similar to the observed standard deviation for all scenarios except the Meko et al. DP scenario, which has a reduced standard deviation. This most likely results from limited tree-ring data available before A.D. 1200 reducing the variability in the tree ring chronologies. The skew, which measures the overall shift of the flows, is shifted towards lower flows for the DP scenarios while the remaining scenarios exhibit a similar skew to the observed flows. The lag-1 autocorrelation is similar to the observed flow for all inflow scenarios. The observed maximum is not exceeded by the DP scenarios and only slightly exceeded by the Non-parametric Paleo Conditioning (NPC) scenarios. The observed minimum flow is not exceeded by the NPC scenarios while the DP scenarios result in lower minimums. The Meko et al. and Woodhouse et al. DP are able to generate much lower flows than observed, approximately two maf and 3.7 maf lower, respectively, five percent of the time. It was expected the DP would generate lower flows than observed as these are characteristic of Lees Ferry streamflow reconstructions. Paleo reconstructions have consistently shown that the recent period (1906 to 2005) has been a relatively wet period compared with results from multiple reconstructions completed for Lees Ferry. The DP scenarios demonstrate the impact these lower flow magnitudes in the paleo record, which are not seen in the recent observed period, may have on reservoir operations. Information from flow magnitudes is just one aspect of each scenarios statistical properties.

From the hydrologic perspective, the probabilities and durations of wet and dry periods is of interest and a further measure of variability. The probability of wet and dry periods of a given length for the DNF inflow and the two Meko et al., based alternative inflow scenarios are shown in Figure N-2 and Figure N-3 as histograms. Each bar in the histogram depicts the probability for the wet or dry period of a given length. A dry period was defined as consecutive years when the flow in each year is below the median (50th percentile) flow. Similarly, a wet period was defined as consecutive years when the flow in each year is above the median observed flow. In both cases, the length of the period was given by the number of consecutive years in each state.

The DNF inflow scenario contains wet and dry periods of maximum length of five and four years, respectively. The DP scenario based on Meko et al. has an increased variability of wet and dry periods where the maximum lengths are eight and 12 years, respectively. The NPC based on Meko et al. scenario displays the greatest variability with a maximum wet and dry length of 22 and 21 years, respectively.

Figure N-1
Boxplots of Basic Statistics for
Direct Natural Flow (DNF); Direct Paleo (DP) – Meko 2007; Direct Paleo - Woodhouse 2006
Nonparametric Paleo Conditioning(NPC) - Meko 2007; Nonparametric Paleo Conditioning - Woodhouse 2006

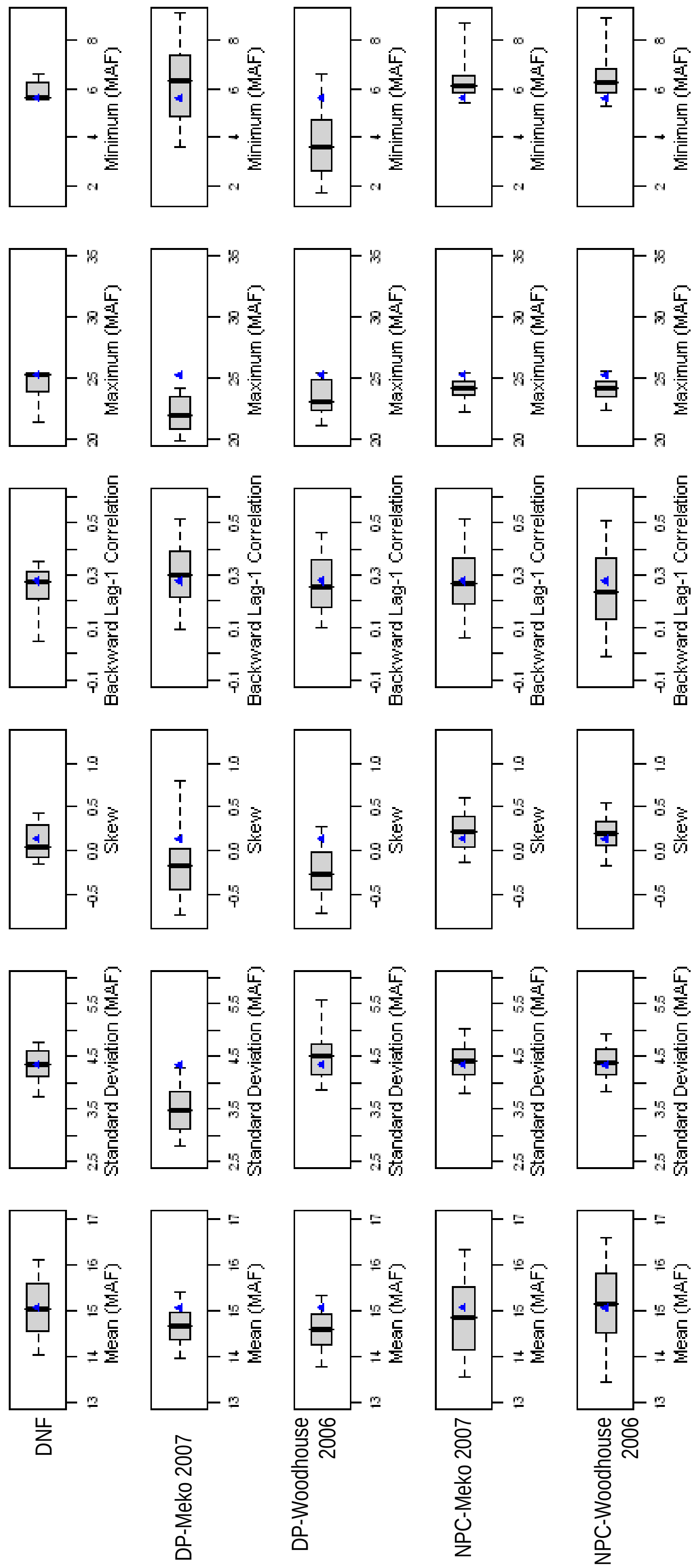


Figure N-2
Histograms of Dry Periods for the Inflow Scenarios
(a) Direct Natural Flow; (b) Direct Paleo – Meko 2007;
and (c) Nonparametric Paleo Conditioning – Meko 2007

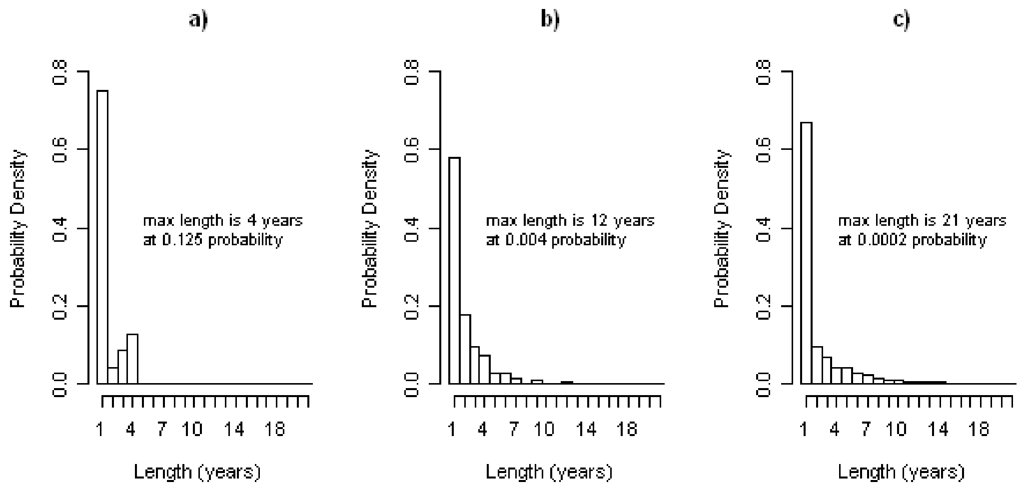


Figure N-3
Histograms of Wet Periods for the Inflow Scenarios
(a) Direct Natural Flow; (b) Direct Paleo – Meko 2007;
and (c) Nonparametric Paleo Conditioning – Meko 2007

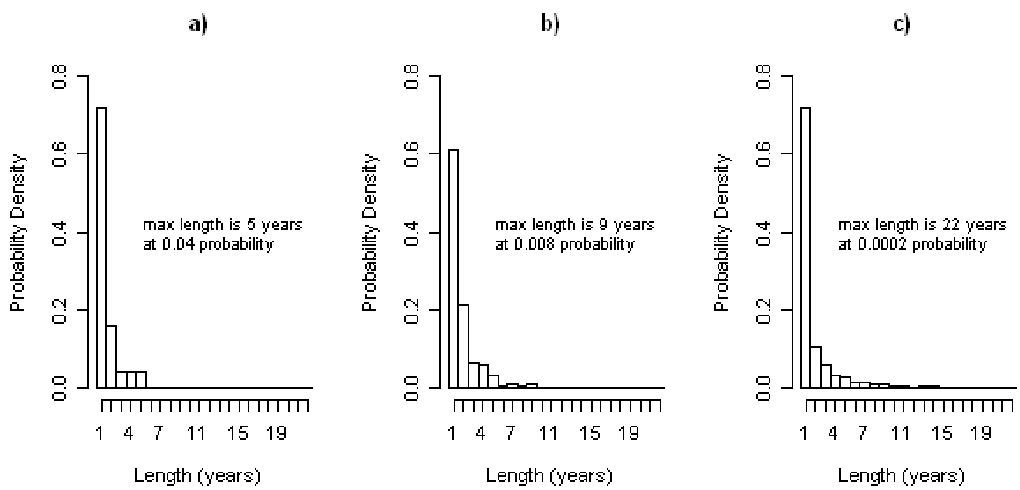


Table N-1 and Table N-2 further present the probability for all dry and wet spells, respectively, for the DNF inflow and the two Meko et al., based alternative inflow scenarios. Spell lengths range from one to 21 years for dry spells or one to 22 years for wet spells. The DNF is developed from the observed record for which the longest dry spell was four years with a 0.125 percent probability. The four-year dry spell has a 0.0697 percent probability with the DP scenario and a 0.0416 percent probability with the NPC scenario. The DP and NPC scenarios exhibit a reduced four-year dry spell as compared with DNF but display a probability of drought lengths beyond the four-year drought. The DP scenario has a 0.0820 percent probability of droughts five years or longer in length. The NPC scenario has a 0.1270 percent probability of droughts five years or longer in length.

Table N-1
Histograms of Dry Periods for the Inflow Scenarios
(a) Direct Natural Flow; (b) Direct Paleo – Meko 2007;
and (c) Nonparametric Paleo Conditioning – Meko 2007

Spell Length (years)	Probability (percent)	Probability (percent)	Probability (percent)
1	0.7500	0.5779	0.6704
2	0.0417	0.1762	0.0951
3	0.0833	0.0943	0.0658
4	0.1250	0.0697	0.0416
5	0.0000	0.0287	0.0388
6	0.0000	0.0287	0.0246
7	0.0000	0.0123	0.0208
8	0.0000	0.0000	0.0119
9	0.0000	0.0082	0.0079
10	0.0000	0.0000	0.0069
11	0.0000	0.0000	0.0044
12	0.0000	0.0041	0.0030
13	0.0000	0.0000	0.0028
14	0.0000	0.0000	0.0018
15	0.0000	0.0000	0.0012
16	0.0000	0.0000	0.0008
17	0.0000	0.0000	0.0010
18	0.0000	0.0000	0.0002
19	0.0000	0.0000	0.0006
20	0.0000	0.0000	0.0000
21	0.0000	0.0000	0.0002

Table N-2
Histograms of Wet Periods for the Inflow Scenarios
(a) Direct Natural Flow; (b) Direct Paleo – Meko 2007;
and (c) Nonparametric Paleo Conditioning – Meko 2007

Spell Length (years)	(a) Probability (percent)	(b) Probability (percent)	(c) Probability (percent)
1	0.7200	0.6122	0.7185
2	0.1600	0.2122	0.1028
3	0.0400	0.0612	0.0571
4	0.0400	0.0571	0.0324
5	0.0400	0.0327	0.0265
6	0.0000	0.0041	0.0148
7	0.0000	0.0082	0.0121
8	0.0000	0.0041	0.0103
9	0.0000	0.0082	0.0077
10	0.0000	0.0000	0.0038
11	0.0000	0.0000	0.0047
12	0.0000	0.0000	0.0014
13	0.0000	0.0000	0.0016
14	0.0000	0.0000	0.0018
15	0.0000	0.0000	0.0012
16	0.0000	0.0000	0.0010
17	0.0000	0.0000	0.0008
18	0.0000	0.0000	0.0006
19	0.0000	0.0000	0.0000
20	0.0000	0.0000	0.0004
21	0.0000	0.0000	0.0002

The longest wet spells for the DNF scenario are five years in length with a 0.04 percent probability. The DP and NPC again exhibit a slightly reduced five-year wet spell as compared with DNF but display a probability of wet spells beyond five years. The DP scenario has a 0.0245 percent probability of wet spells six years or longer and the NPC scenario has a 0.0627 percent probability of wet spells six years or longer in length.

These dry and wet spell lengths are beyond those exhibited in the observed natural flows and demonstrate the additional hydrologic variability beyond that seen in the recent gaged record that can been attributed to climate variability.

N.3 Results

This section describes the sensitivity of the No Action Alternative and Preferred Alternative to the hydrologic variability provided by the two alternative hydrologic inflow scenarios described in Section N.2. As described in Section 4.2, the modeling assumptions for the Preferred

Alternative are assumed to revert to the assumptions used for the No Action Alternative after 2026.

N.3.1 Percentile Elevations

Figure N-4 presents a comparison of the 90th, 50th, and 10th percentile plots of Lake Powell elevations obtained for DNF and the two alternative hydrologic inflow scenarios, under the No Action Alternative and the Preferred Alternative.

The 90th percentile range of the three hydrologic methods shows smaller variation between the scenarios, largely because Lake Powell is at or near its maximum reservoir capacity.

At the 50th percentile range, the No Action Alternative and Preferred Alternative show little difference except from 2016 to 2030 when the Preferred Alternative is elevated. The DNF and DP track closely throughout the run while the NPC begins lower than either DNF or DP until 2012 when it slightly exceeds both, then drops lower again until the end of the run in 2048.

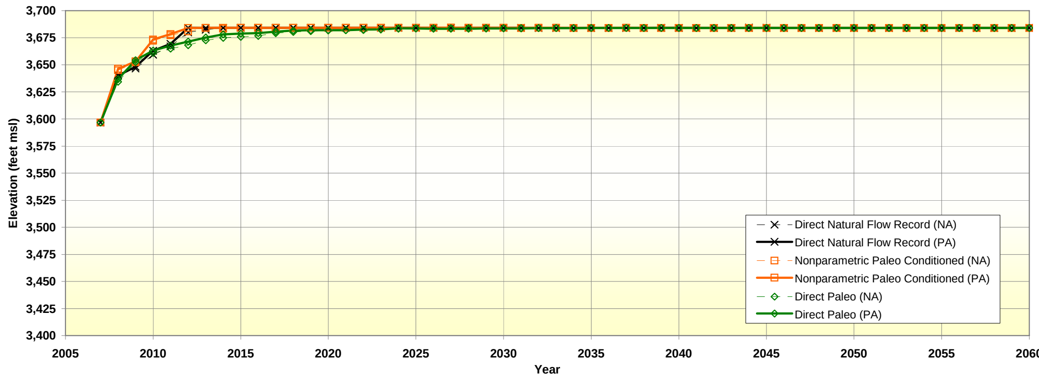
Variation between the various hydrologic inflow methods is highest at the 10th percentile range because Lake Powell is most sensitive to variations in inflow at lower elevations. The higher variability from year to year at the 10th percentile level for the NPC scenario is a result of the different resampling technique used. The DNF and DP hydrologic inflow scenarios are resampled with the ISM, which guarantees year to year hydrologic inflow scenario statistics that are nearly identical. The year to year variation seen in these scenarios results mostly from reservoir operations. The NPC hydrologic inflow scenario is generated with stochastic methods that do not generate identical hydrologic inflow scenario statistics on a year to year basis; although with increased sample size, these scenarios will produce an average year to year statistic which is similar but not identical. This property is present in most stochastic techniques other than ISM.

The No Action alternative produces lower reservoir elevations for all the hydrologic inflow scenarios in the early part of the run from 2009 to 2020. The NPC alternative shows a significant drop in reservoir elevation after 2030 that is not displayed by either the DNF or DP scenarios.

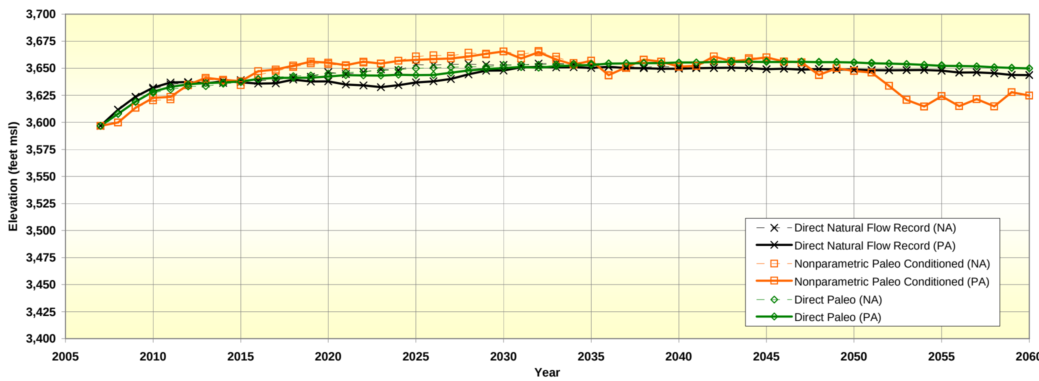
Because Lake Powell is able to make reduced releases at lower reservoir elevations, the Preferred Alternative has the effect of keeping Lake Powell higher (especially through 2017) compared to the No Action Alternative.

Figure N-4
Lake Powell End-of-December Elevations
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
90th, 50th and 10th Percentile Values

90th Percentile



50th Percentile



10th Percentile

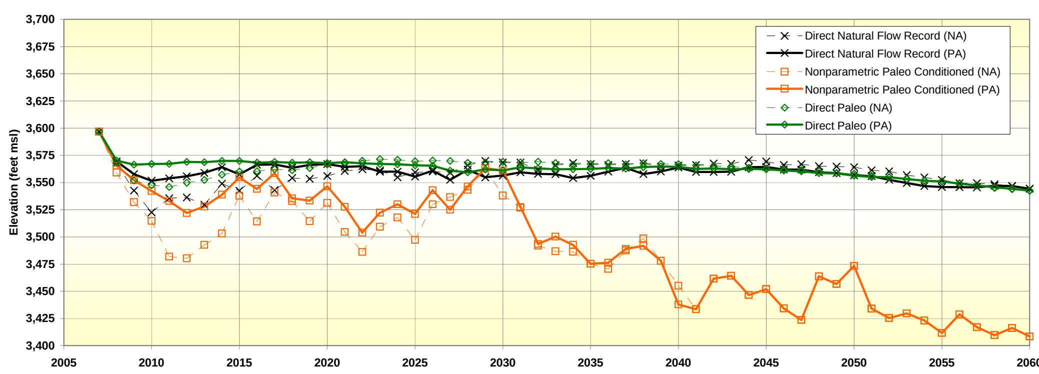
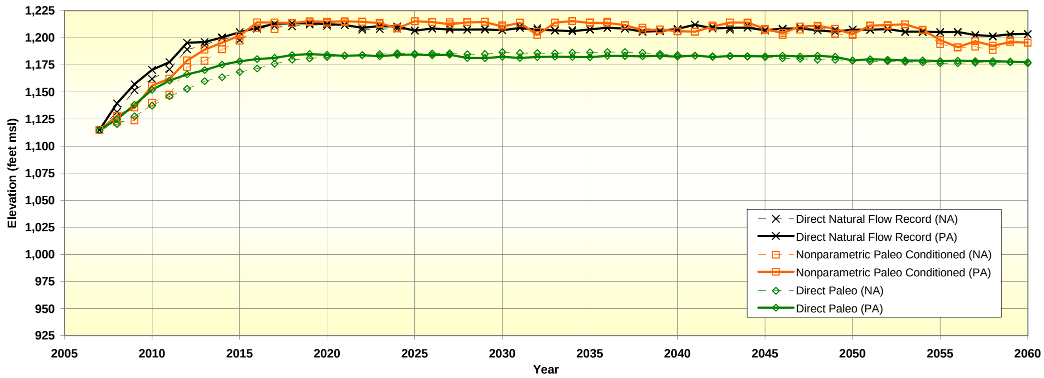


Figure N-5 presents a comparison of the 90th, 50th, and 10th percentile plots of Lake Mead elevations obtained for DNF and the two alternative hydrologic inflow scenarios, operated under the No Action Alternative and the Preferred Alternative. At the 90th and 50th percentiles, DP is generally consistently lower than DNF even though both utilized the same sampling technique because the DP hydrology set has a higher magnitude and droughts of longer duration. At the 90th and 50th percentiles, NPC is generally higher than DNF due to higher magnitude and longer duration wet cycles in the two data sets.

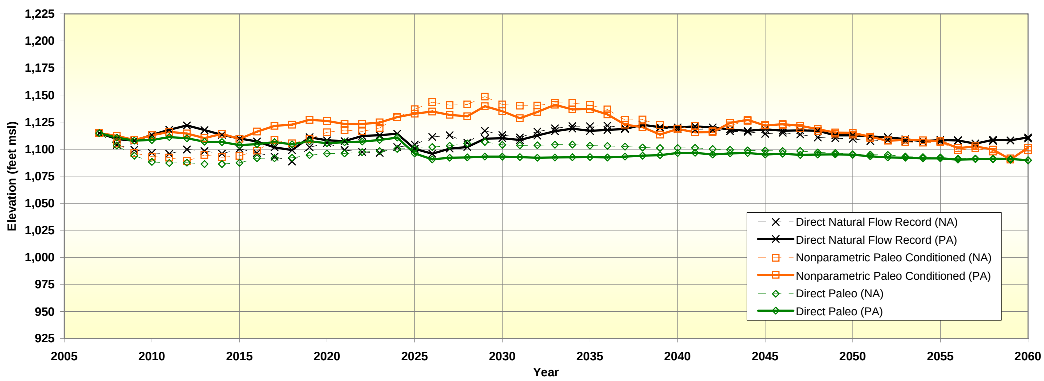
At the 90th percentile, the No Action Alternative is generally lower until 2020 when the two alternatives track similarly. At the 50th percentile, the No Action Alternative is again generally lower through the interim period. From 2027 to 2045, the No Action Alternative is higher than the Preferred Alternative after which the two alternatives track similarly. At the 10th percentile, the Preferred Alternative is the lowest compared to the No Action Alternative with the NPC hydrologic inflow scenario through about 2020. This behavior is due to the low inflows into Lake Powell under this scenario of which the effect can be seen at the Lake Powell 10th percentile in Figure N-4. In contrast to the NPC and DNF scenarios, under the DP scenario the Lake Powell elevation is generally higher under the Preferred Alternative than under the No Action Alternative during the interim period. Lake Powell elevation is highest at the 10th percentile under the DP scenario, and more significantly the Preferred Alternative is closest to elevation 3,575 feet msl. Above this elevation, Lake Powell must release 8.23 maf or for balancing (resulting in higher Lake Mead elevations) and below this elevation, Lake Powell reduces releases to 7.48 maf.

Figure N-5
Lake Mead End-of-December Elevations
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
90th, 50th and 10th Percentile Values

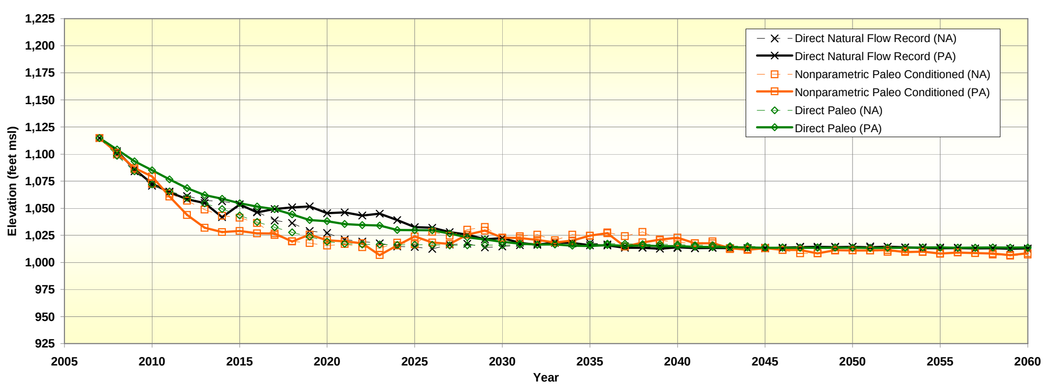
90th Percentile



50th Percentile



10th Percentile



N.3.2 Extreme Drought Single Trace Analysis

Figure N-6 presents the 25-year running mean from sequence 1 of the paleo reconstruction published by Meko et al. (2007). The lowest 25-year period in the paleo reconstruction extends from A.D. 1130 to 1154. During this period the mean flow is 84 percent of the mean observed natural flow from 1906 to 2005. The lowest 25-year period in the observed flow (1953 to 1977) is 87 percent of the observed mean.

Figure N-6
Annual Natural Flow at Lees Ferry
Meko et al. sequence 1 Reconstruction
25 Year Running Mean

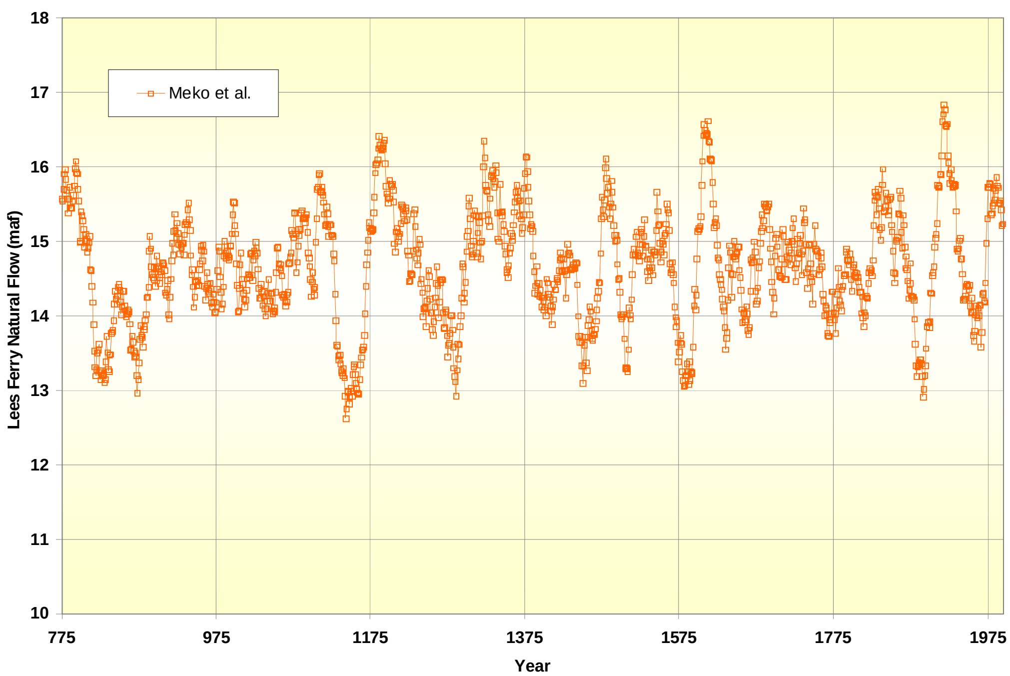


Figure N-7 presents the annual natural flow at Lees Ferry from trace 369 for DP. This trace is an identical input to both the No Action Alternative and the Preferred Alternative simulations. This trace is resampled directly from the Meko et al. paleo reconstruction and begins with the A.D. 1130 to 1154 lowest 25-year period thereby, including the flow sequence with the most extreme 25-year drought exhibited in the paleo reconstruction. This period falls within the timeframe of the Medieval Climate Anomaly, a period when many paleoclimate records have demonstrated severe hydrologic droughts in the western United States (Meko et al. 2007). During the first 25 years of trace 369, not all flows are below the mean observed flow (15.1 maf). Multiple years are above the mean observed flow, though the majority of years are below the mean in these first 25 years.

Figure N-7
Annual Natural Flow at Lees Ferry
Single trace using Meko et al. Reconstruction for
No Action Alternative (NA) and Preferred Alternative (PA)
Hydrology start year is 1130 from Meko et al. Reconstruction

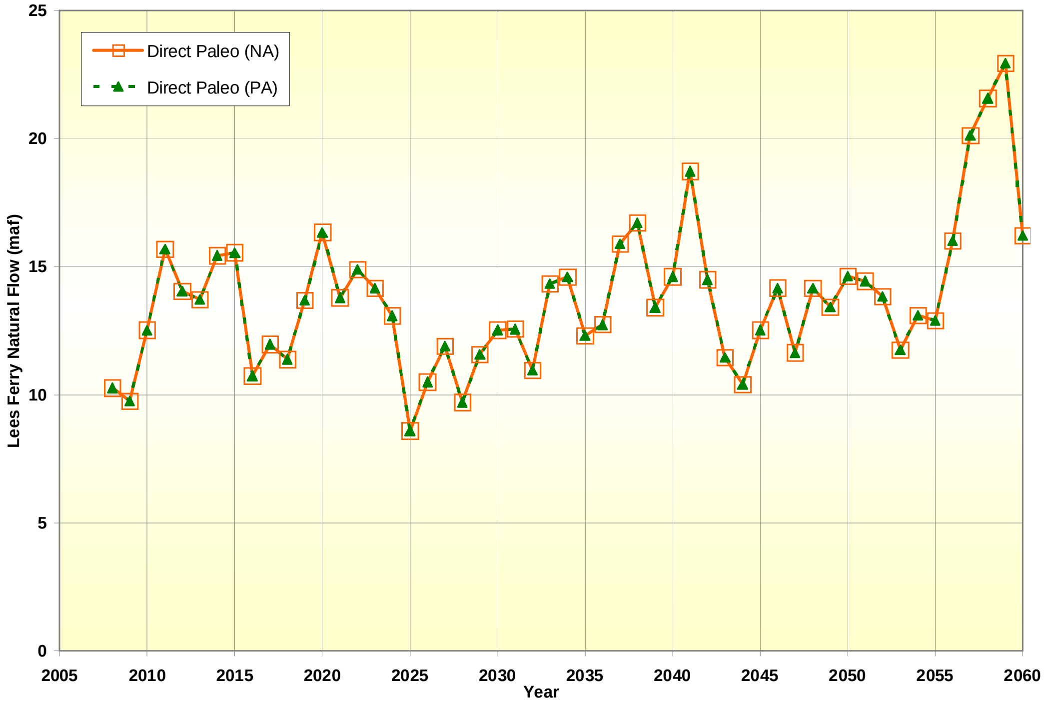
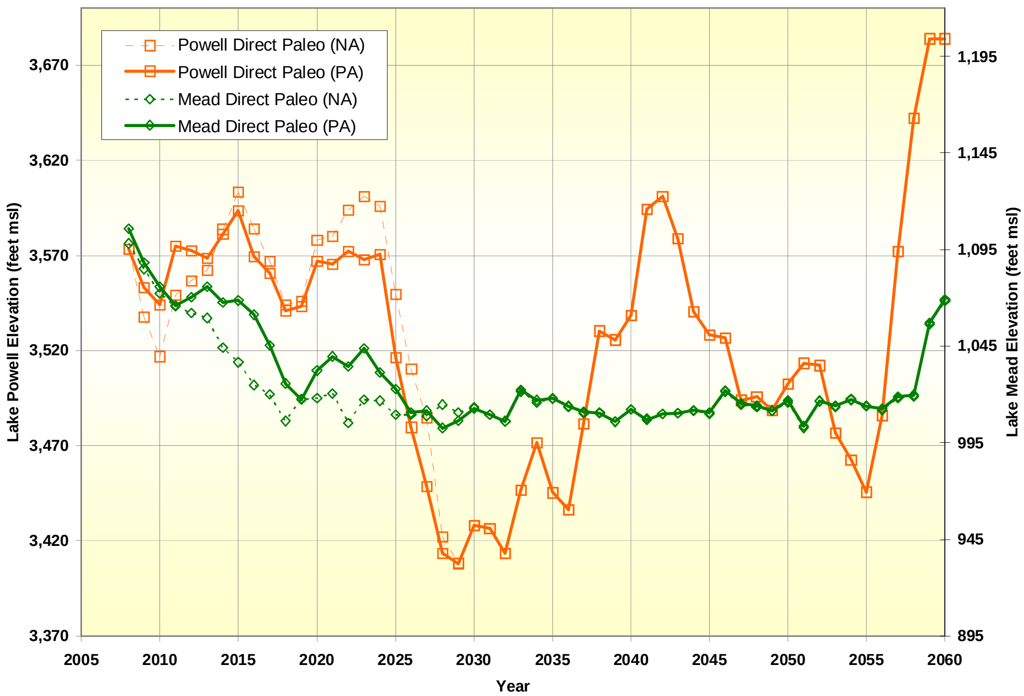


Figure N-8 presents end-of-December elevations of Lake Powell and Lake Mead resulting from trace 369 for DP.

Figure N-8
End-of-December Elevations
Comparison of Single Trace using Meko et al. Reconstruction for
No Action Alternative (NA) and Preferred Alternative (PA)
Hydrology Start Year is 1130 from Meko et al. Reconstruction



Given the current initial conditions a continuing drought further draws down Lake Mead though the Preferred Alternative maintains higher elevations at Lake Mead as a result of balancing releases from Lake Powell. Under the Preferred Alternative, Lake Powell is initially higher due to the ability to reduce releases below 8.23 maf. However, as Lake Mead's elevation is drawn down, Lake Powell provides water through balancing releases and is also eventually drawn down near the end of the interim period. During the higher Lake Powell reservoir elevations centered on 2042 and 2059 the natural flows were substantially increased, thereby building reservoir storage at Lake Powell.

Figure N-9 presents the annual natural flow at Lees Ferry from trace 50 for NPC. This trace is an identical input to both the No Action Alternative and the Preferred Alternative simulations. This trace is not directly resampled from the paleo reconstruction but uses the reconstruction to conditionally choose the observed natural flows generating dry spells not seen before but statistically plausible given the paleo reconstruction's spell length properties. The trace begins with the lowest 25-year period generated from the NPC hydrologic inflow scenarios. During this period the mean flow is 80 percent of the mean observed natural flow from 1906 to 2005. In this trace the natural flows exhibit increased variability of extreme low flows compared to the single trace presented in Figure N-7. In Figure N-7, the lowest annual flow is 8.6 maf while in Figure N-9, the lowest flow is 5.7 maf. The lower flows exhibited by the NPC trace allow further understanding of the impacts that periods of extreme low flows may have on reservoir operations.

Figure N-9
Annual Natural Flow at Lees Ferry
Single trace using Nonparametric Paleo Conditioning with
Meko et al. Reconstruction for No Action Alternative (NA) and Preferred Alternative (PA)

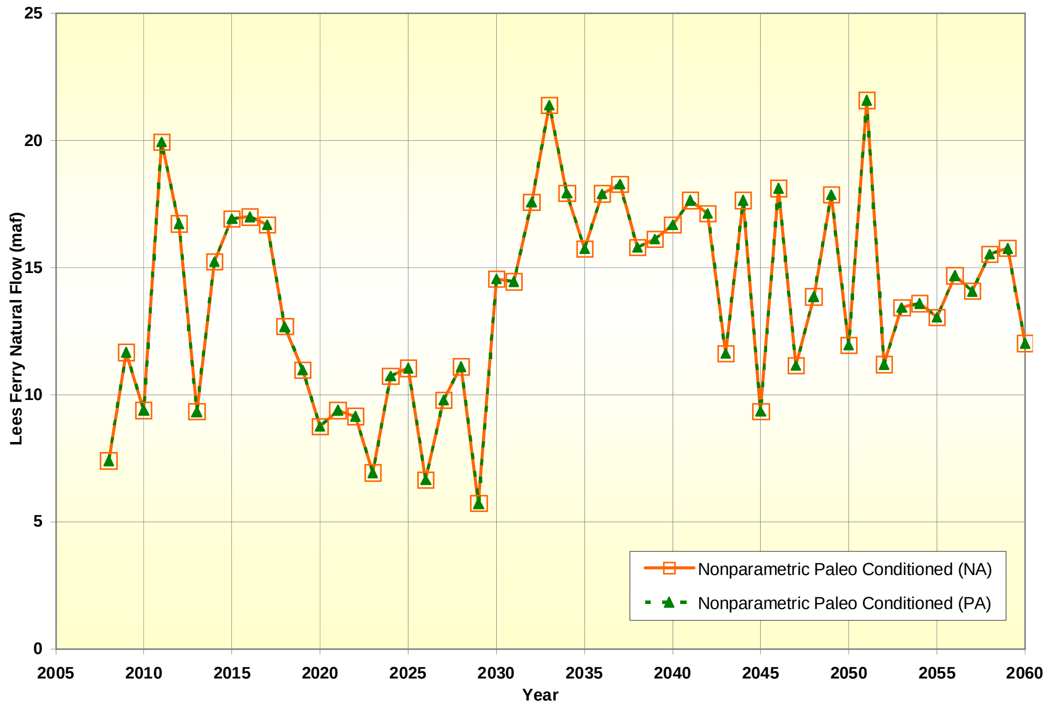
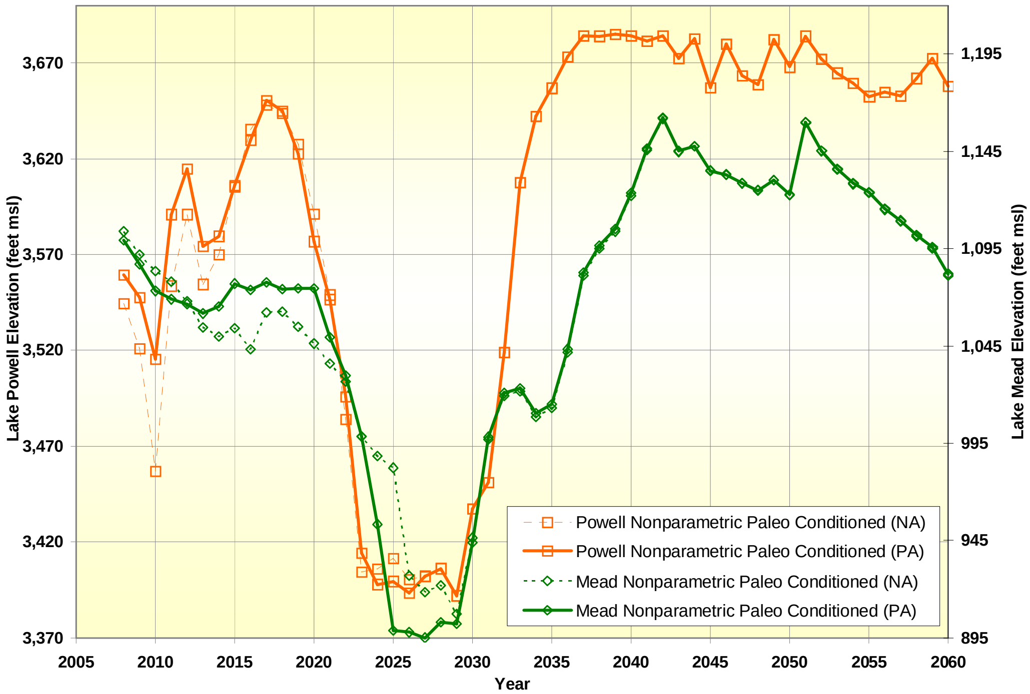


Figure N-10 presents end-of-December elevations of Lake Powell and Lake Mead from trace 50 for NPC.

Figure N-10
End-of-December Elevations
Comparison of Single Trace using Nonparametric Paleo Conditioning with
Meko et al. Reconstruction for No Action Alternative (NA) and Preferred Alternative (PA)



The initial natural flows shown in Figure N-10 are low but increase above the mean observed flow by 2011 increasing elevations at both Lake Powell and Lake Mead. Beginning in 2018, natural flows are below the mean observed flow and remain below until 2032. Under this sustained dry spell, Lake Mead is drawn down to dead pool (895 feet msl) by 2027 and Lake Powell is taken to 3,392 feet msl by 2029 under the Preferred Alternative. The increased drawdown seen under the Preferred Alternative is a result of the modeling assumption that includes a maximum shortage amount of 600 kaf[2] while the No Action Alternative includes absolute protection of Lake Mead at elevation 1,000 feet msl[3], which can result in shortages as large as 3,300 kaf which prevent the reservoirs from dropping to the elevations seen under the Preferred Alternative. When natural flows rebound above the mean observed flow again in 2032, both reservoirs recover.

N.3.3 Probability of Being Below Key Elevations

Figure N-11 presents a comparison of the likelihood of Lake Powell end-of-December elevations being at or below the minimum power pool (elevation 3,490 feet msl) for DNF and for the two alternative hydrologic inflow scenarios. DNF shows nearly no chance of

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[2] As noted in Section 2.7, the Preferred Alternative includes a provision for appropriate consultations regarding additional shortages when Lake Mead is below 1,025 feet msl. For modeling purposes, it was assumed that shortages of 600 kaf would continue to be applied for Lake Mead elevations below 1,025 feet msl.

[3] Modeling assumptions used in the Preferred Alternative allowed a maximum shortage of approximately 3,300 kaf, resulting in the inability to absolutely protect Lake Mead elevation 1,000 feet msl.

Lake Powell elevations falling below minimum power pool. NPC indicates the highest likelihood of occurrence at 26 percent, followed by the DP (five percent), and DNF (one percent). During the interim period, for all inflow scenarios, the probability of Lake Powell falling below elevation 3,490 feet msl is less under the Preferred Alternative due to the ability of Lake Powell to make reduced releases at lower reservoir elevations.

Figure N-11
Lake Powell End-of-December Elevations
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
Percent of Values Less Than or Equal to Elevation 3,490 feet msl

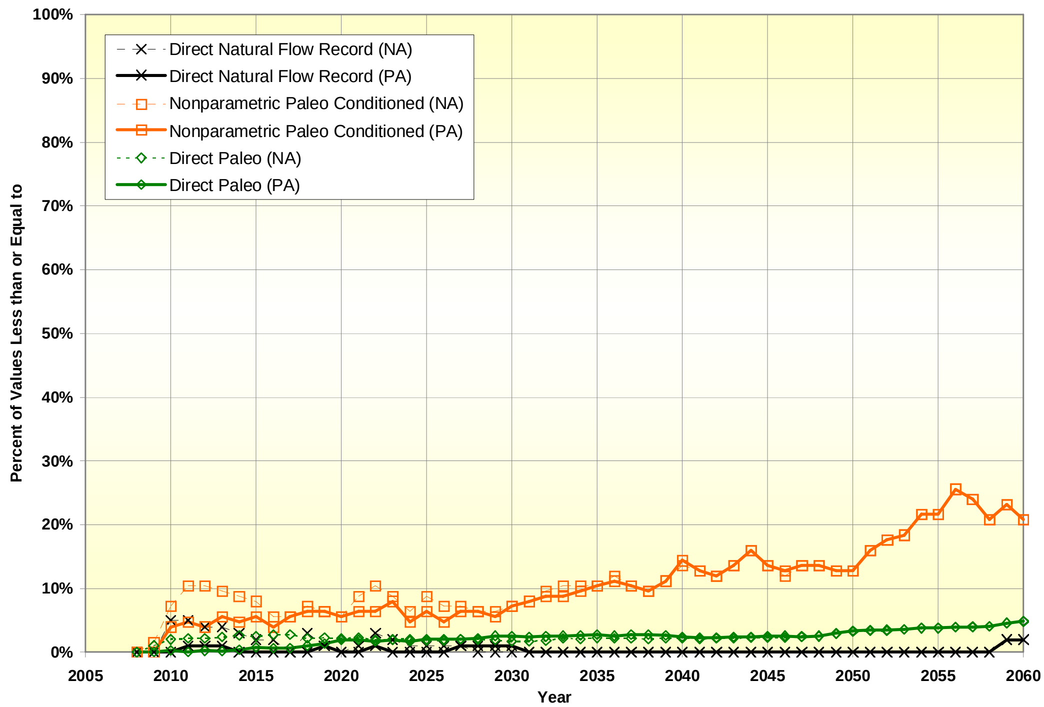


Figure N-12 presents a comparison of the likelihood of Lake Mead end-of-December elevations being at or below the minimum power pool (elevation 1,050 feet msl) for DNF and for the two alternative hydrologic inflow scenarios. NPC generally shows the highest chance of being below minimum power pool until 2017, when the No Action Alternative with DP and DNF indicate a higher likelihood. After 2028, the NPC generally indicates the lowest likelihood for most years.

The Preferred Alternative generally shows a lower likelihood for both the DNF and DP inflow scenarios until 2028 when these scenarios show the highest likelihood for most years.

Figure N-12
Lake Mead End-of-December Elevations
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
Percent of Values Less Than or Equal to Elevation 1,050 feet msl

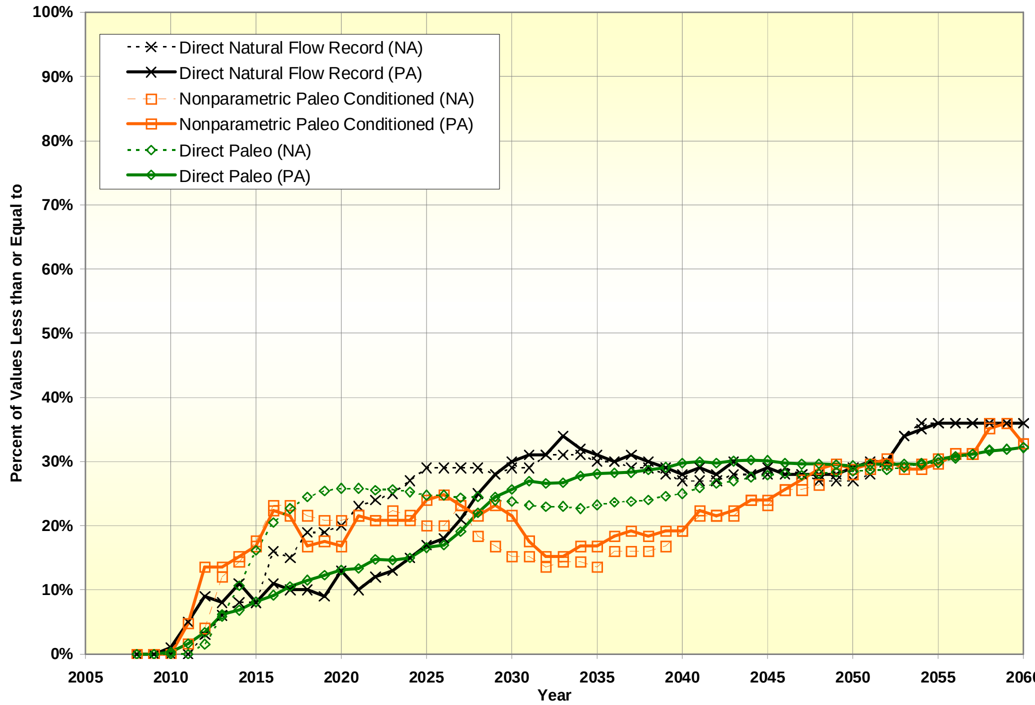


Figure N-13 presents a comparison of the likelihood of Lake Mead end-of-December elevations being at or below 1,025 feet msl for DNF and for the two alternative hydrologic inflow scenarios. NPC generally shows the highest likelihood of falling below elevation 1,025 feet msl until 2020, when the No Action Alternative with DP and DNF indicate a higher likelihood. After 2028, the NPC generally indicates the lowest likelihood until 2050, when NPC again shows the highest likelihood.

The Preferred Alternative generally shows a lower likelihood for both the DNF and DP hydrologic inflow scenarios until 2033, when these scenarios show slightly higher likelihood until 2050, when NPC generally shows a higher likelihood.

Figure N-13
Lake Mead End-of-December Elevations
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
Percent of Values Less than or Equal to Elevation 1,025 feet msl

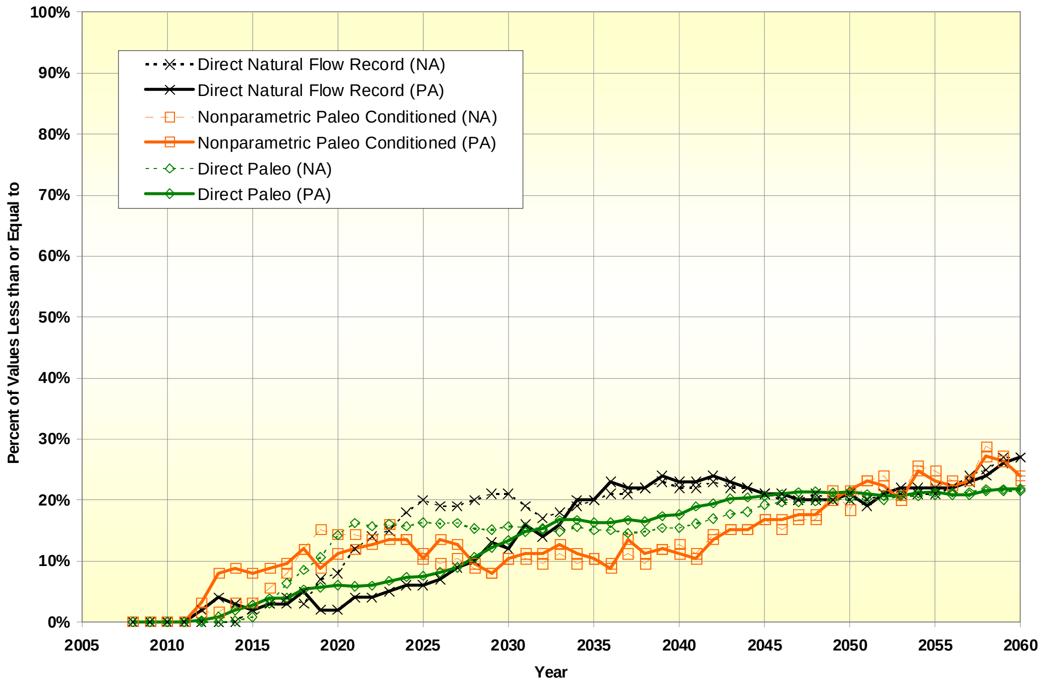
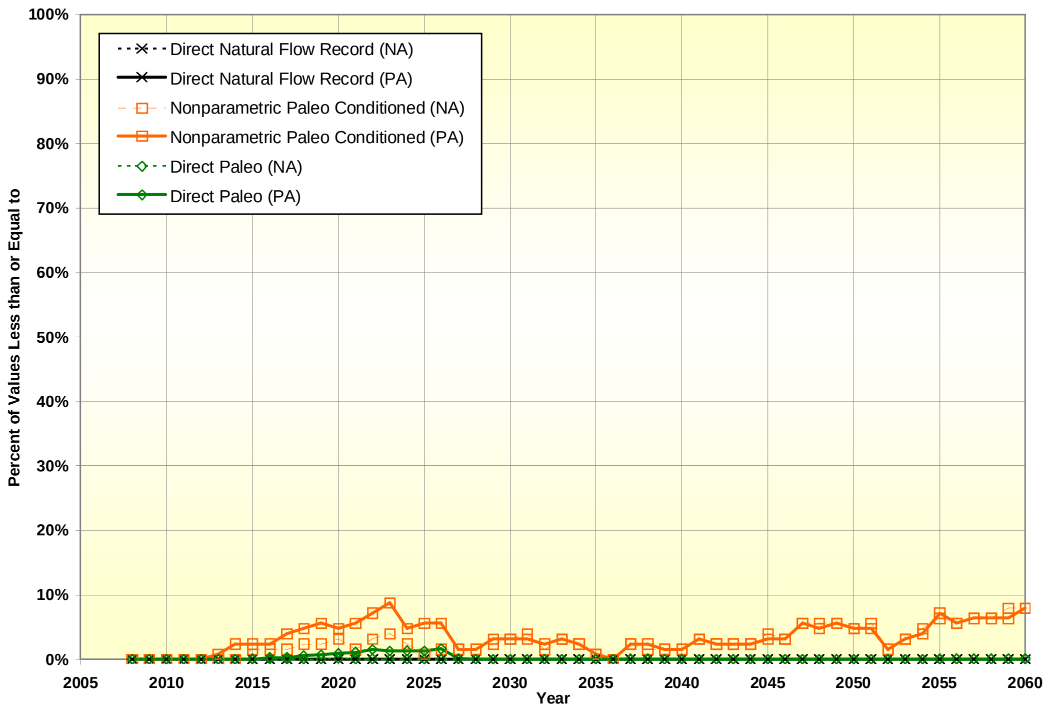


Figure N-14 presents a comparison of the likelihood of Lake Mead end-of-December elevations being at or below 1,000 feet msl (the elevation of Southern Nevada Water Authority's lower intake) for DNF and for the two alternative hydrologic inflow scenarios. DNF shows no chance of Lake Mead elevations being below 1,000 feet msl. NPC indicates the highest likelihood of occurrence at nine percent in 2023 under the Preferred Alternative, followed by the No Action Alternative (eight percent), and the DP Preferred Alternative (two percent).

Figure N-14
Lake Mead End-of-December Elevations
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
Percent of Values Less Than or Equal to Elevation 1,000 feet msl



N.3.4 Lower Basin Shortage

Figure N-15 shows the probability of shortage in the Lower Basin under the No Action Alternative and the Preferred Alternative obtained for DNF and the two alternative hydrologic inflow scenarios. The higher variability observed with the NPC method is a function of the resampling technique. The Preferred Alternative exhibits a lower probability of shortage until 2026 when the No Action Alternative has a generally lower probability. The highest probability of shortage for each alternative occurs after 2055 with the following approximate values: DNF, 69 percent; DP, 82 percent; and NPC, 78 percent.

Figure N-15
Lower Basin Shortages
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
Probability of Occurrence

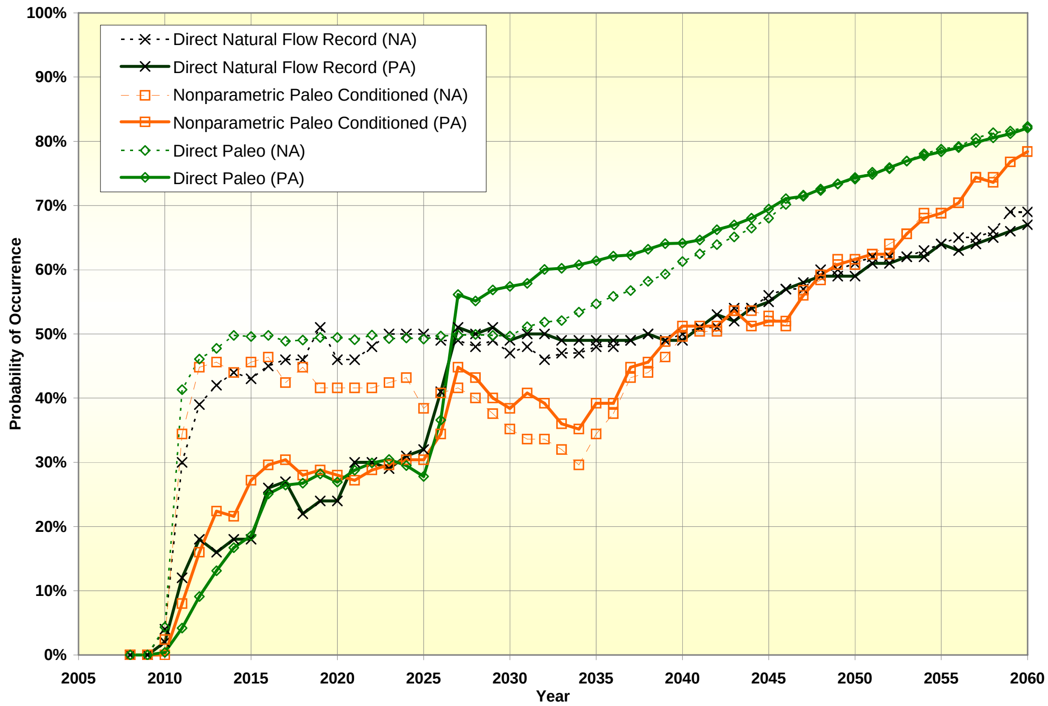


Figure N-16 shows the cumulative distribution of shortages over the interim period. Under the No Action Alternative, for all inflow scenarios, the magnitude of most shortages is about 500 kaf. Under the Preferred Alternative, for the DNF and DP scenarios, most shortages are about 400 kaf. With the NPC scenario, about fifty percent of the shortage amounts are 400 kaf while fifty percent are 500 kaf and above, up to 859 kaf. A shortage of 859 kaf under the Preferred Alternative indicates that Lake Mead elevation was below 1,000 feet msl for the entire year resulting in no delivery to SNWA. The No Action Alternative with both the DP and NPC scenarios reaches a maximum shortage of 3.3 maf, the maximum shortage using current modeling assumptions. With the DNF scenario, the maximum shortage in the No Action Alternative is much lower at about 1.9 maf.

Figure N-16
Cumulative Distribution of Lower Basin Shortages
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
2008 to 2026

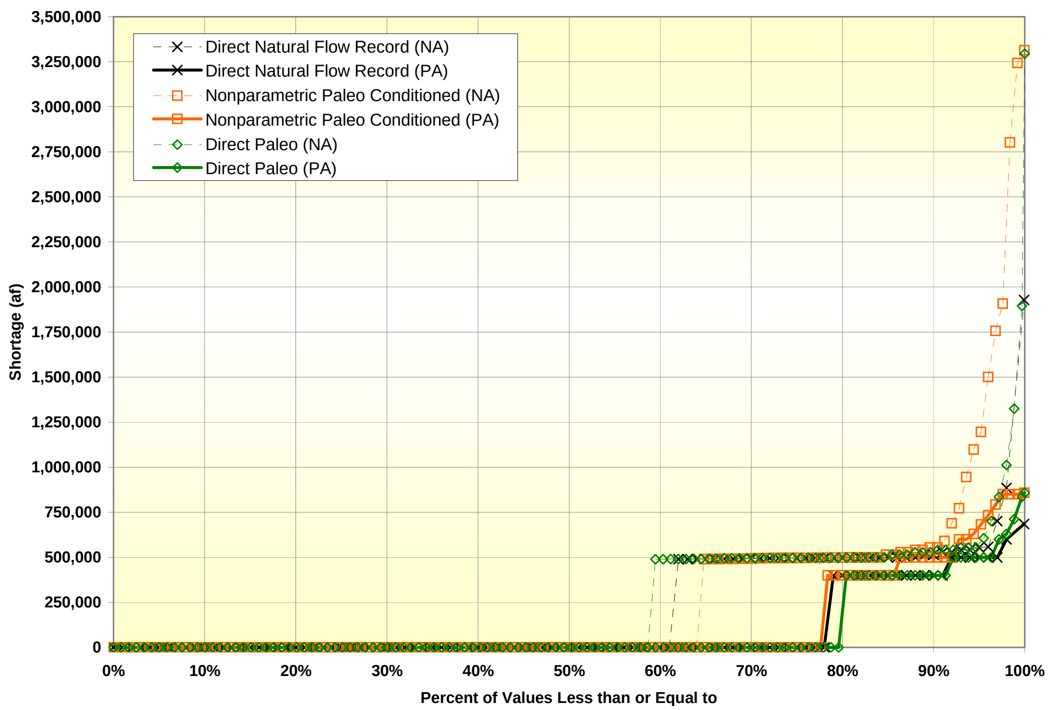
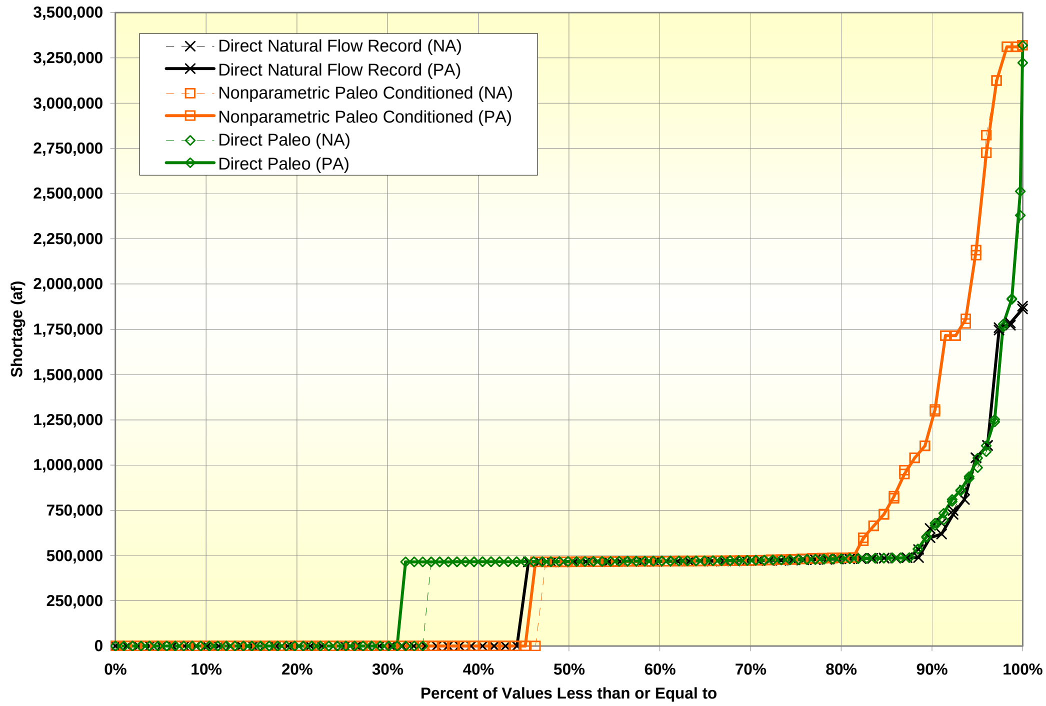


Figure N-17 shows the cumulative distribution of shortages from 2027 through 2060. During this period the shortage strategy for both the No Action Alternative and the Preferred Alternative is identical and includes absolute protection of Lake Mead elevation 1,000 feet msl. For all inflow scenarios most of the shortages are about 500 kaf, however shortages of this amount occur approximately fifteen percent more often with the DP inflow scenario. Shortages above 500 kaf occur about ten percent more often under the NPC scenario. Both the DP and NPC scenarios reach a maximum shortage of 3.3 maf, while the DNF scenario reaches a maximum shortage much lower at about 1.9 maf.

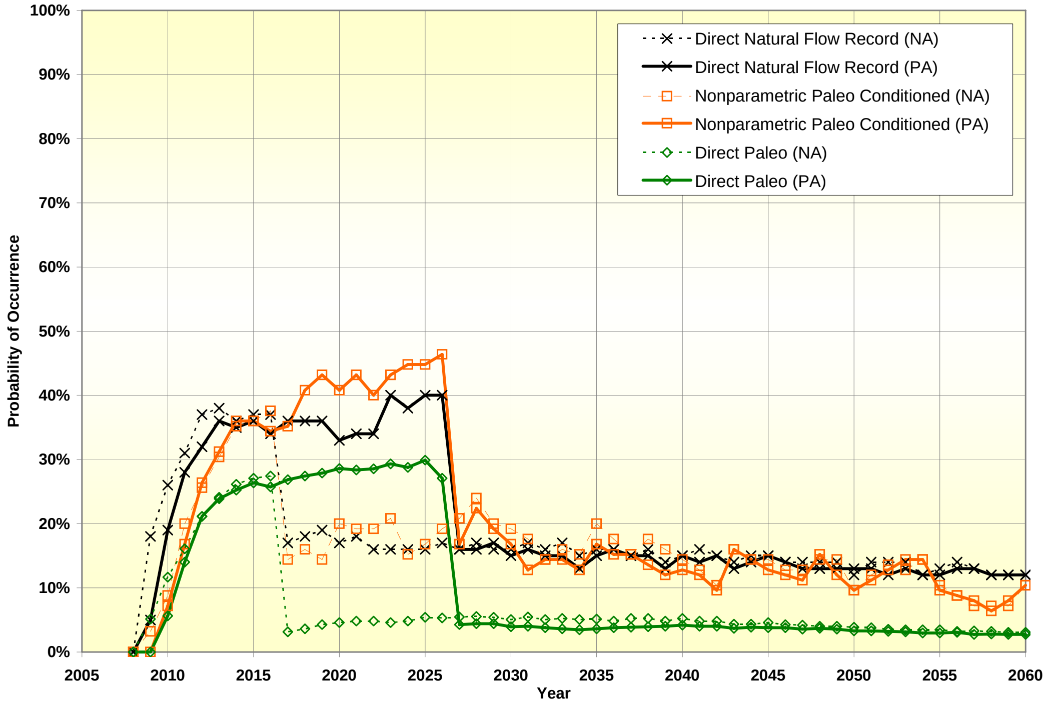
Figure N-17
Cumulative Distribution of Lower Basin Shortages
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
2027 to 2060



N.3.5 Lower Basin Surplus

Figure N-18 shows the probability of any surplus to the Lower Division states under the No Action Alternative and the Preferred Alternative obtained for DNF and the two alternative hydrologic inflow scenarios. This plot includes the probability of Flood Control surplus under which condition Mexico would also receive up to 1.7 mafy. The higher variability observed with the NPC is a function of the resampling technique. Under both alternatives, NPC has a higher probability of surplus than DNF from 2015 to 2030 due to the extended wet periods in the data set. The highest probability of surplus for each inflow scenario occurs around 2026 under the Preferred Alternative with the following approximate values: DP, 30 percent; DNF, 40 percent; and NPC, 46 percent. Beginning in 2017, under the No Action Alternative, only 70R and Flood Control surpluses occur, which reduces the probability of surplus to below 25 percent.

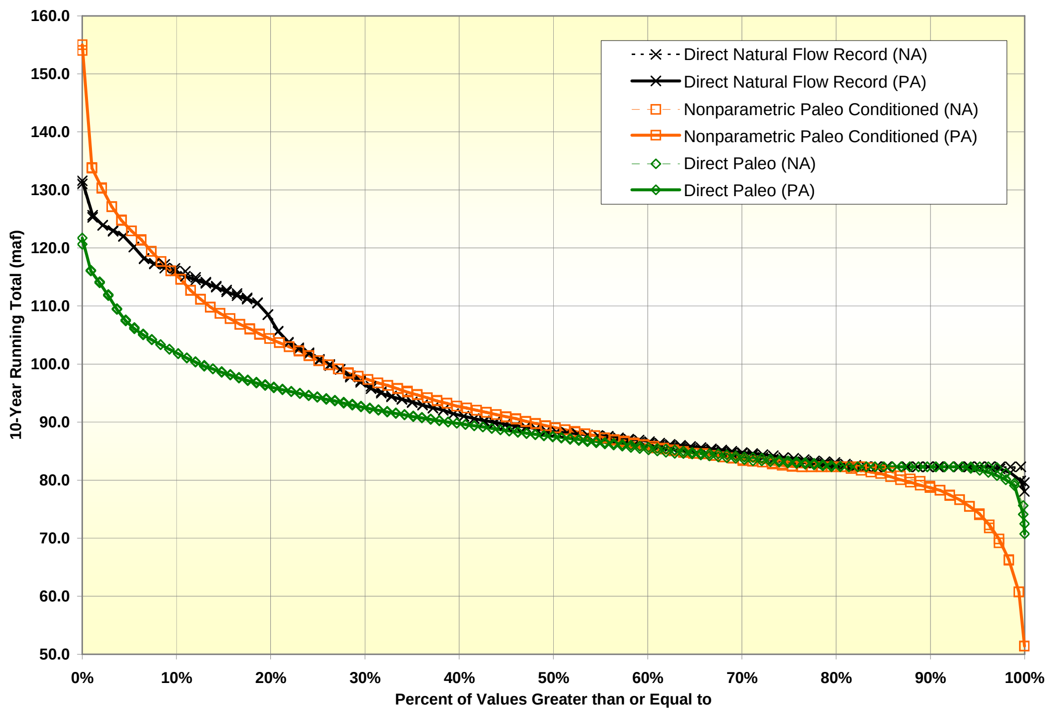
Figure N-18
Lower Basin Surplus Conditions
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
Probability of Occurrence



N.3.6 Releases from Glen Canyon Dam

Figure N-19 presents a comparison of 10-year running total of water-year release volumes from Glen Canyon Dam for DNF and the two alternative hydrologic scenarios. The largest differences in the frequency of release volumes are observed at the highest and lowest volumes, where the NPC hydrologic sequence shows the lowest low and highest high extreme values. DP shows the lowest high extreme values and has depressed high values as compared to the other two hydrologic inflow scenarios as a result of the reduced standard deviation discussed in Section 2.3 of this Final EIS.

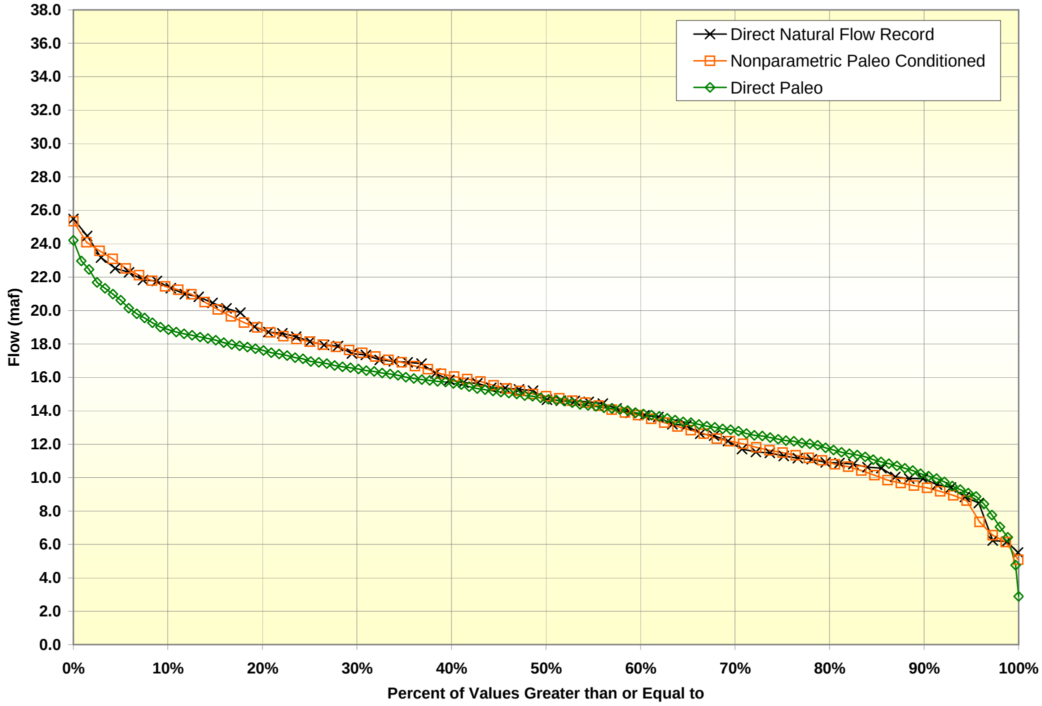
Figure N-19
Glen Canyon Dam 10-Year Running Total of Water Year Releases
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
No Action Alternative (NA) and Preferred Alternative (PA)
Water Years 2009 to 2060



N.3.7 Natural Flow at Lees Ferry

Figure N-20 presents a comparison of annual natural flow volumes past Lees Ferry Gaging Station for DNF and the two alternative hydrologic scenarios. The largest differences in the frequency of natural flow volumes are observed at the highest volumes, where the DP hydrologic sequence again shows depressed high flows. The DP hydrologic sequence also shows the lowest volume at 2.9 maf compared to the DNF and NPC scenarios at 5.5 maf and 5.1 maf, respectively.

Figure N-20
Annual Natural Flow at Lees Ferry Gaging Station
Comparison of Direct Natural Flow Record to Meko et al. Reconstruction
2008 to 2026



N.4 References

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Attachment A
(Appendix N from the Draft EIS dated February 2007)

Analysis of Hydrologic Variability Sensitivity

This attachment to Appendix N was first published as Appendix N in the Draft EIS. Although no substantial changes have been made, some minor errors were fixed. This attachment contains descriptions of the analyses performed to evaluate the potential effects of using alternative hydrologic inflow scenarios when performing modeling simulations in CRSS. This sensitivity analysis compares three accepted scientific methods for providing hydrologic variability. These alternative hydrologic inflow scenarios use hydrologic inflow data derived from Nonparametric Paleo Hydrologic State information, Parametric Stochastic Natural Flow Records, and Direct Paleo methods. The alternative hydrologic inflow scenarios are compared to the current method used by Reclamation which uses the Index Sequential Method (ISM) for stochastic streamflow reconstruction.

Table of Contents

List of Figures

List of Tables

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A.1 Introduction

This appendix was developed to explore the potential effects of using alternative hydrologic inflow scenarios when performing modeling simulations in CRSS. As explained previously in Section 4.2.4 of the Draft EIS hydrologic variability was incorporated in the hydrologic modeling using the Index Sequential Method (ISM) (USBR 1985; Ovarda, et al. 1997) on the 99-year natural flow record from 1906 to 2004. This sensitivity analysis will compare three other accepted scientific methods for providing hydrologic variability. The three methods used do not incorporate forecasts of future climate variability, but do provide a wider range of hydrologic variability than the application of ISM to the natural flow record, including longer wet and dry periods than seen in the observed record.

A.2 Development of Three Alternative Hydrologic Inflow Scenarios to Compare with the 1906 – 2004 Natural Flow Record using ISM

The CRSS model requires natural flow inputs at 29 sites throughout the Colorado River system. There are 20 sites above and including the Lees Ferry site on the Colorado River. Below the Lees Ferry site are an additional 9 sites. Generation of stochastic natural flows throughout the 29 sites is a critical step towards understanding the impact of natural streamflow variability on model results.

As stated before, Reclamation currently uses the ISM for stochastic streamflow generation. This stochastic method entails a sequential block bootstrap of the observed data, where the block size is determined by the simulation horizon. The ISM cycles through each year in the historic record generating 99 traces, assuming that the record wraps around at the end (i.e., 2004, 1906, 1907, etc.). Each trace will only consist of annual and monthly flow magnitudes and sequences that have occurred in the observed record, with the exception of new sequences being generated as a result of the wrap. This limits the ISM's ability to model a wide range of plausible future streamflows including flow magnitudes and sequences not seen in the observed record. Strengths of this method are it is easy to implement, understandable, and has been widely accepted by stakeholders on the Colorado River.

To address these drawbacks three alternative methods to generate stochastic natural flows were applied and three alternative hydrology scenarios were generated. These methods were chosen to sample a range of techniques available to generate stochastic flows. Each method has strengths and weaknesses that are described below along with the basic concept of the method.

Throughout this appendix the ISM technique as applied to the 1906 to 2004 natural flow record is referred to as Direct Natural Flow Record (DNF).

A.2.1 Nonparametric Paleo Conditioning (NPC)

This technique conditionally resamples historic data based on paleo hydrologic state information (i.e., wet or dry). Hydrologic state sequences are modeled based on the "Lees-B" paleo reconstruction (1490-1997) and flow magnitudes from the observed natural flows (1906-2004) are conditionally resampled generating annual water year flows at Lees Ferry on the Colorado River (Lee, et al. 2006). Prairie (2006) provides a detailed description of the conditional resampling technique.

The annual flows at Lees Ferry (site 20) are disaggregated, spatially and temporally, throughout the Upper Colorado River Basin using a nonparametric disaggregation method (Prairie, 2006; Prairie et al., 2006). The disaggregation scheme ensures that the flows generated throughout the Upper Colorado River basin are spatially and temporally consistent among the 20 locations that characterize natural flow.

Flows for the 9 gauges below site 20 are resampled from the observed natural flows (1906-2004) based on the analogue year resampled from the observed natural flows when conditionally generating monthly flows. For example, if year 1954 was the analogue year chosen during the disaggregation then the associated monthly flows for each of the 9 lower sites are resampled from 1954 observed monthly natural flows. This method ensures the lower sites are both temporally and spatially correlated with each other and the upper sites. The lower sites 21-29 contribute significantly less flow (eight percent of the total calendar year flow) than the upper sites; therefore, resampling the direct observed natural flows does not adversely affect the ability to model unique and probable flows in the basin as a whole.

For these nonparametric paleo conditioned hydrologies, 125 traces, each 53 years in length, were generated for the 29 sites throughout the Colorado River basin. The traces generated for the upper 20 sites will produce annual calendar year flow sequences that were not seen before. As a result of using the hydrologic state information from the paleo reconstruction data the flow sequences in the generated paleo conditioned hydrologies will reflect sequence properties (i.e., wet or dry) characteristic of the paleo reconstruction. The magnitudes of generated flow on a water year basis match the magnitudes in the observed record (1906-2004). The inability to generate flow magnitude beyond those in the observed record can be a shortcoming of this technique though the increased variety of flow sequences is an advantage of this method when compared to some other stochastic hydrologies.

A.2.2 Parametric Stochastic Natural Flow Record (PS)

This technique uses parametric stochastic methods to fit the observed natural flows (1906-2003) to an appropriate set of stochastic models for streamflow generation and disaggregation. A parameter fitting procedure, hence the name parametric methods, is applied to fit the observed natural flow to the appropriate parametric models. For this project the observed natural flows at two key sites (Lees Ferry and at Imperial Dam on the Colorado River) were fit to a contemporaneous autoregressive order 1 (CAR[1]) model (Salas, 1985). Annual flows at both sites were simultaneously generated producing 100 traces each 53 years in length. The generated flows where then spatially and temporally disaggregated to the 29 sites at a monthly time scale with appropriate parametric disaggregation techniques. Lee et al., 2006 provides a detailed description of the model selection and fitting procedure for the generation and disaggregation of flows. Scheme 2 from Lee et al., (2006) was found to best preserve both the monthly and annual statistical properties of the observed natural flow and was selected for generation of the parametric hydrologies applied in this study.

Note these parametric hydrologies were developed with natural flows only including up to 2003 while the preceding two stochastic methods used observed natural flows though 2004. At the time these parametric hydrologies were developed the 2004 data was not yet available. A Kolmogorov-Smirnov test (KS-test) was performed for each site to determine if the data distribution has significantly changed between these two datasets. This test found no significant differences at any sites at a 95 percent significance level. Therefore, there should be no reason the parametric hydrologies cannot be compared along side the other two alternative hydrologies.

The parametric techniques can generate both flow magnitudes and sequence not seen in the observed record but statistically similar to the observed record A drawback of the parametric methods are they have the ability to generate values must larger or smaller than those in the observed record and can be difficult to justify. They also have difficulty representing non-Gaussian data distribution features.

A.2.3 Direct Paleo (DP)

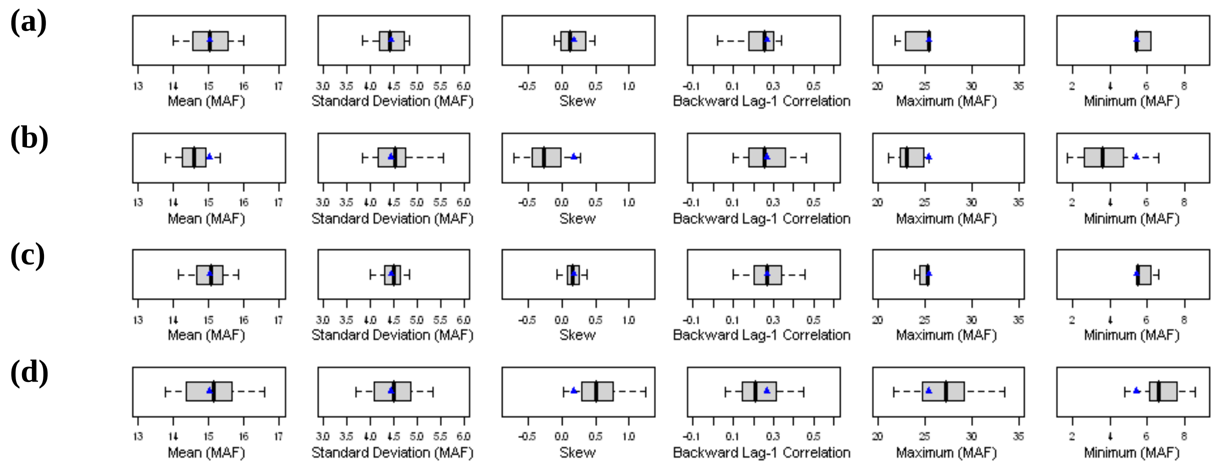
This technique uses the “Lees-B” paleo-reconstruction from Woodhouse et al. (2006). This paleo-reconstruction provides annual water year flows from 1490-1997 on the Colorado River at Lees Ferry. The annual water year flows are disaggregated, spatially and temporally, throughout the Upper Colorado River Basin with the nonparametric disaggregation method (Prairie et al., 2006); the same disaggregation method described in the Section A.2.1 Nonparametric Paleo Conditioned. The nine lower sites are resampled as described in Section A.2.1.

These disaggregated flows (508 years of monthly flows at 29 sites) are resampled with the ISM generating 508 traces each 53 years in length. As ISM sequentially block bootstraps the disaggregated streamflow data, the generated traces will consist of annual flow magnitudes and sequences that are present in the paleo reconstructed streamflows, with the exception of the sequences created as a result of the wrap.

A.2.4 Comparison of Three Alternative Inflow Scenarios

Basic statistics from the DNF inflow and the three alternative inflow scenarios are shown in Figure Att. A-1. The statistics are computed from total calendar year flow at Lees Ferry on the Colorado River. These statistics include the mean, standard deviation, skew, lag-1 autocorrelation, maximum and minimum. The observed statistic (1906-2004) is shown as a blue triangle. While the statistics based on the inflow scenario are shown as boxplots. The boxplots display the interquartile range (IQR), where 25 percent to 75 percent of the values lie, with the median represented as a vertical line within the IQR. The whiskers extend to the five percent to 95 percent range of the values. Performance is generally judged as appropriate when the observed statistics is captured within the IQR.

Figure Att. A-1
Boxplots of Basic Statistics for
(a) Direct Natural Flow Record, (b) Nonparametric Paleo Conditioned,
(c) Parametric Stochastic Natural Flow Record, and (d) Direct Paleo



Each inflow scenario is presented in a row and the six statistics are presented in each column. The observed mean is reproduced well by the first three scenarios (DNF, NPC and PS) as expected. The DP scenario underestimates the observed mean, as expected, because this paleo reconstruction has a lower mean (14.6 million acre-feet [maf]) than the observed period (15.0 maf). The standard deviation is well reproduced by all scenarios. The skew is over estimated by the PS, a difficult statistic for parametric techniques to capture, while the DP underestimates the skew. The lag-1 autocorrelation is captured by all inflow scenarios. The observed maximum is not exceeded by the DNF or DP scenarios and only slightly exceeded by the NPC but the PS scenario is able to reproduce much higher flows than observed, approximately 8.0 maf higher five percent of the time. The observed minimum flow is not exceeded by the ISM or NPC, while the PS generates a few lower values. The DP is able to generate much lower flows than observed, approximately 3.7 maf lower five percent of the time. It was expected the DP would generate lower flows than observed as these are characteristic of Lees Ferry streamflow reconstructions.

A.3 Results

This section is separated into two parts. Section A.3.1 examines the effects of the alternative hydrologic inflow scenarios by holding constant the alternative and varying the hydrologic inflow sequences. Section A.3.2 examines the performance of each alternative under the alternative hydrologic inflow scenarios by holding constant the inflow scenario while varying the alternative.

A.3.1 Effects of Alternative Hydrology on No Action Alternative

This section describes the sensitivity of the No Action Alternative to the hydrologic variability provided by the three alternative hydrologic inflow scenarios described in the previous sections. This will be done through comparing the No Action Alternative, simulated using ISM and the 99-year natural flow record (DNF) to the No Action Alternative simulated with three alternative hydrologic inflow scenarios.

A.3.1.1Percentile Elevations

Figure N-19 presents a comparison of the 90th, 50th, and 10th percentile lines of Lake Powell elevations obtained for DNF and the three alternative hydrologic inflow scenarios, operated under the No Action Alternative.

The 90th percentile range of the four hydrologic methods shows smaller variation between the scenarios, largely because Lake Powell is at or near its maximum reservoir capacity.

At the 50th percentile range the DP hydrologic inflow scenario consistently produces the lowest elevations, while the NPC and the PS hydrologic inflow scenarios generally produce higher median elevations than DNF.

Variation between the various hydrologic inflow methods is highest at the 10th percentile range. The higher variability from year to year at the 10th percentile level for the NPC and the PS hydrologic inflow scenarios is a result of sample size. The DNF and DP hydrologic inflow scenarios are resampled with the ISM, which guarantees year to year hydrologic inflow scenario statistics that are identical. The year to year variation seen in these scenarios only results from reservoir operations. The NPC and PS hydrologic inflow scenarios are generated with stochastic methods that do not generate identical hydrologic inflow scenario statistics on a year to year basis; although with increased sample size, these scenarios will produce an average year to year statistic which is similar but not identical. This property is present in most stochastic techniques other than ISM.

Figure Att. A-2
Lake Powell End-of-July Elevations
Comparison of Direct Natural Flow Record to Three Alternative Hydrologic Sequences
No Action Alternative
90th, 50th and 10th Percentile Values

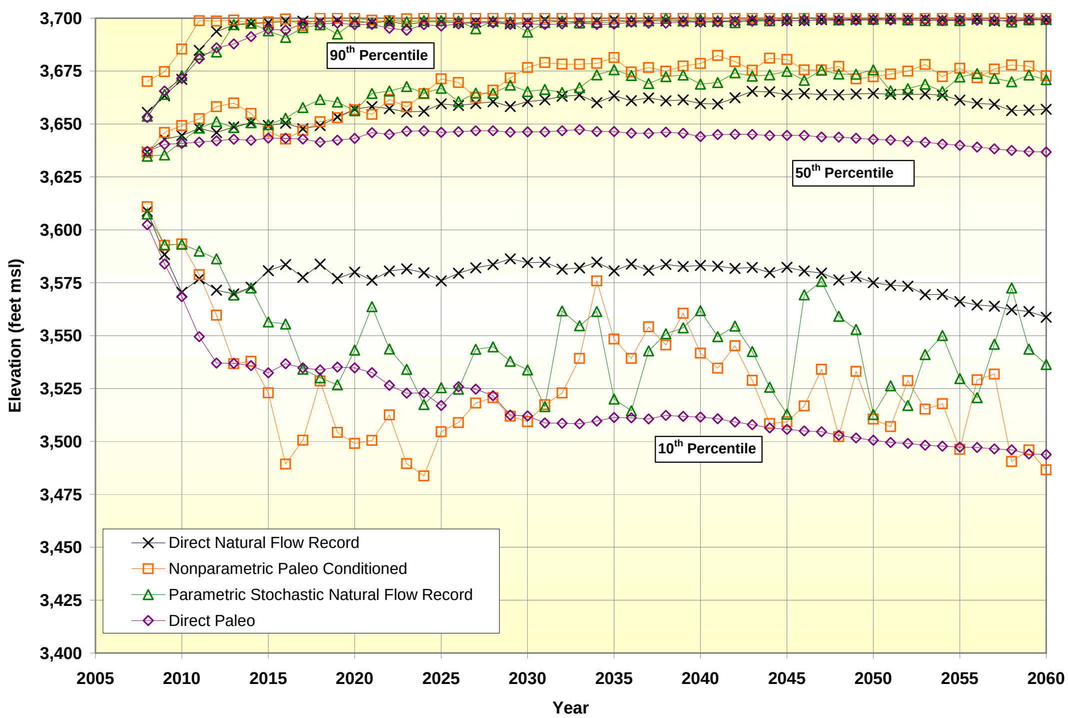
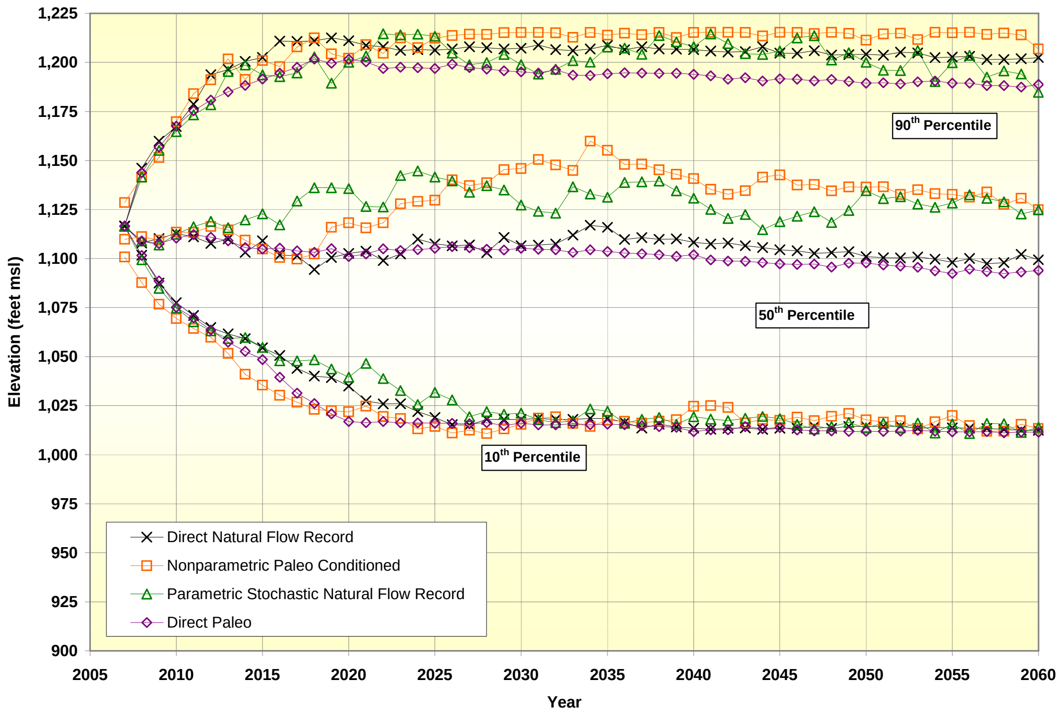


Figure Att. A-3 presents a comparison of the 90th, 50th, and 10th percentile lines of Lake Mead elevations obtained for DNF and the three alternative hydrologic inflow scenarios, operated under the No Action Alternative. At each percentile, DP is consistently lower than DNF even though both utilized the same sampling technique because the DP hydrology set has a higher magnitude and droughts of longer duration. At the 90th and 50th percentile, NPC and PS are generally higher than DNF due to higher magnitude and longer duration wet cycles in the two data sets.

Figure Att. A-3
Lake Mead End-of-December Elevations
Comparison of Direct Natural Flow Record to Three Alternative Hydrologic Sequences
No Action Alternative
90th, 50th and 10th Percentile Values



A.3.1.2 Probability of Being Below Key Elevations

Figure Att. A-4 presents a comparison of the likelihood of Lake Powell end-of-July elevations being at or below the minimum power pool for DNF and for the three alternative hydrologic inflow scenarios. DNF shows nearly no chance of Lake Powell elevations falling below minimum power pool. NPC indicates the highest likelihood of occurrence at 14 percent, followed by the DP (nine percent), PS (nine percent), and DNF (one percent).

Figure Att. A-4
Lake Powell End-of-July Elevations
Comparison of Direct Natural Flow Record to Three Alternative Hydrologic Sequences
No Action Alternative
Percent of Values Less Than or Equal to 3,490 feet msl

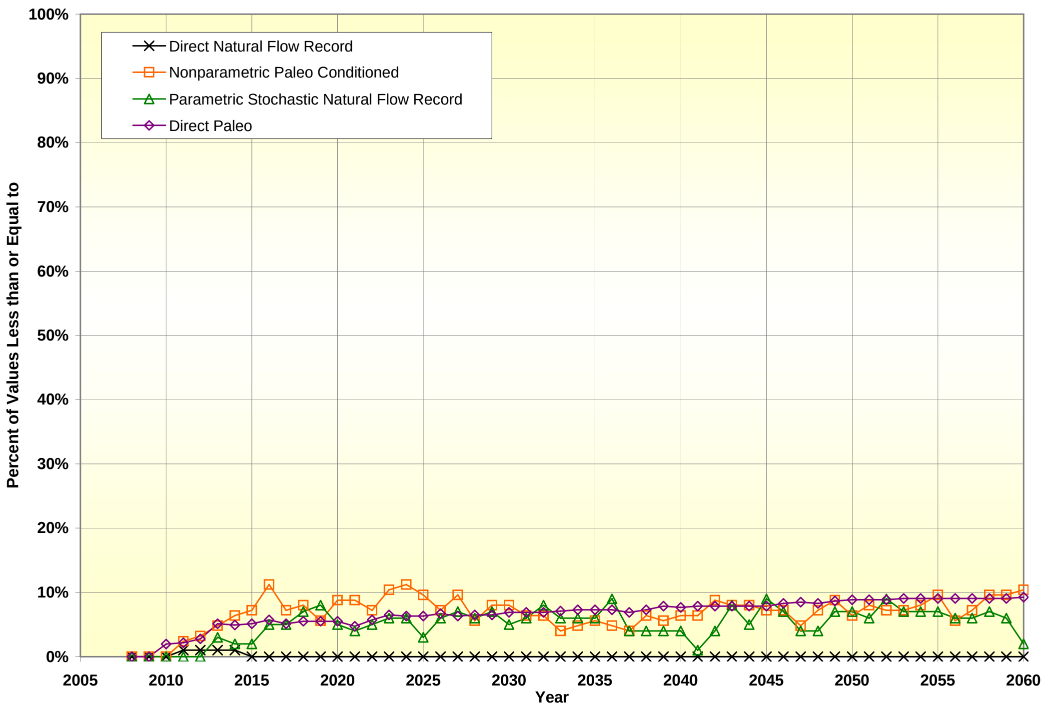


Figure Att. A-5 presents a comparison of the likelihood of Lake Mead end-of-December elevations being at or below the minimum power pool for DNF and for the three alternative hydrologic inflow scenarios. PS shows the lowest chance for all years of Lake Mead elevations falling below minimum power pool. DP and DNF indicate the highest likelihood for most years.

Figure Att. A-5
Lake Mead End-of-December Elevations
Comparison of Direct Natural Flow Record to Three Alternative Hydrologic Sequences
No Action Alternative
Percent of Values Less Than or Equal to 1,050 feet msl

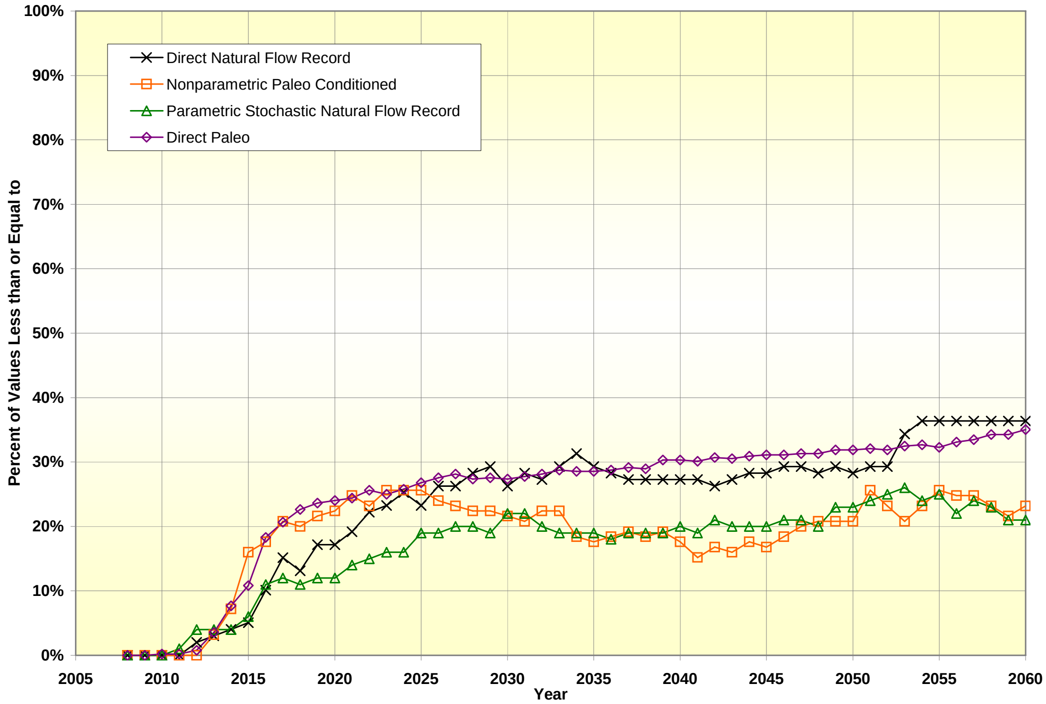
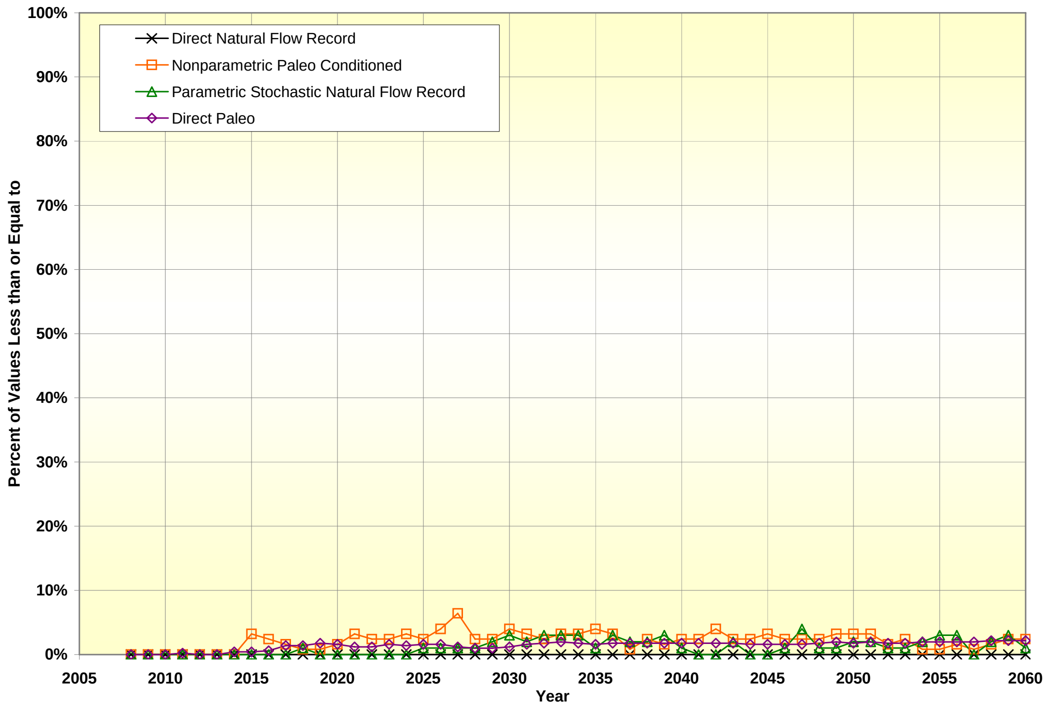


Figure Att. A-6 presents a comparison of the likelihood of Lake Mead end-of-December elevations being at or below 1,000 feet msl for DNF and for the three alternative hydrologic inflow scenarios. DNF shows no chance of Lake Mead elevations falling below 1,000 feet msl. NPC indicates the highest likelihood of occurrence at six percent in 2022, followed by the PS (four percent), and DP (one percent).

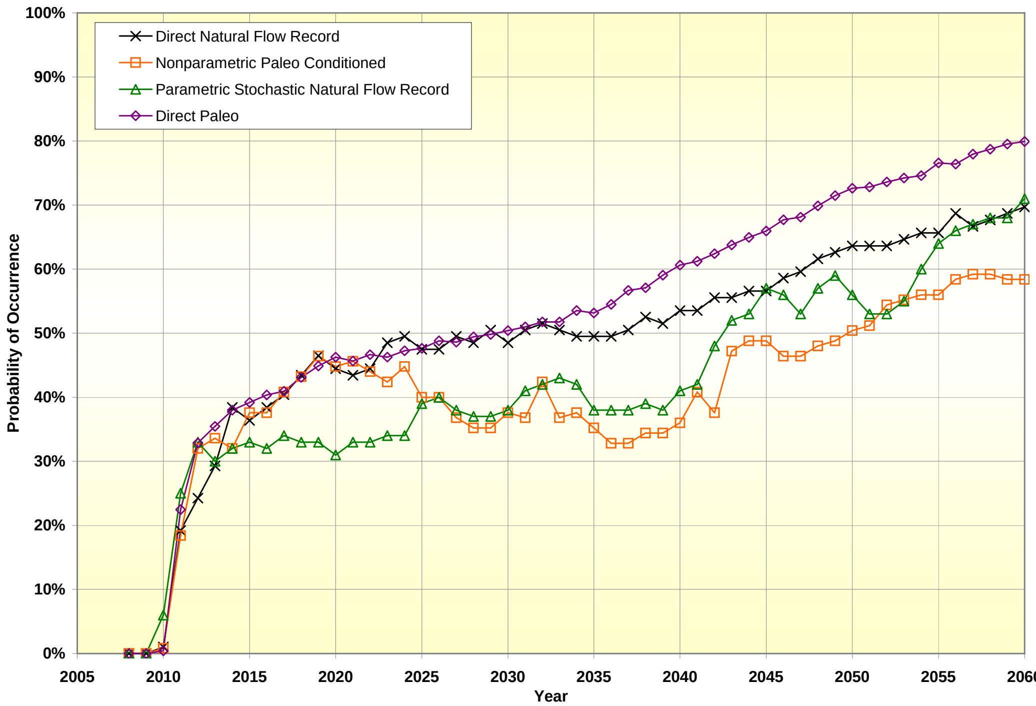
Figure Att. A-6
Lake Mead End-of-December Elevations
Comparison of Direct Natural Flow Record to Three Alternative Hydrologic Sequences
No Action Alternative
Percent of Values Less Than or Equal to 1,000 feet msl



A.3.1.3 Lower Basin Shortage

Figure Att. A-7 shows the probability of shortage to the Lower Basin and Mexico under the No Action Alternative obtained for DNF and the three alternative hydrologic inflow scenarios. The higher variability observed with the NPC and PS methods are a function of sample size, as described under Section A.3.1.1. NPC and PS have a lower probability of shortage than DNF for most of the period of analysis due to the extended wet periods in both data sets. The highest probability of shortage for each alternative occurs after 2055 with the following approximate values: DNF, 69 percent; DP, 80 percent; NPC, 62 percent; and PS, 71 percent.

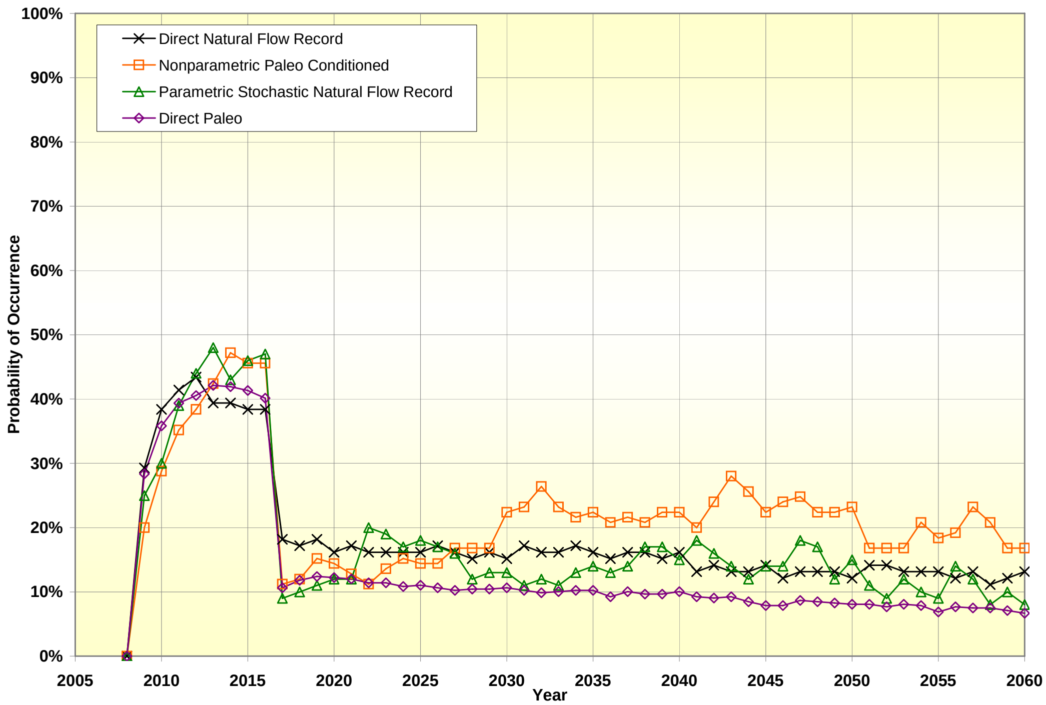
Figure Att. A-7
Lower Basin Shortage
Comparison of Direct Natural Flow Record to Three Alternative Hydrologic Sequences
No Action Alternative
Probability of Occurrence



A.3.1.4 Lower Basin Surplus

Figure Att. A-8 shows the probability of any surplus to the Lower Division states under the No Action Alternative obtained for DNF and the three alternative hydrologic inflow scenarios. Note: this plot includes the probability of Flood Control surplus where Mexico would also receive surplus water. The higher variability observed with the NPC and PS methods are a function of sample size. NPC and PS have a higher probability of surplus than DNF for most of the period of analysis due to the extended wet periods in both data sets. The highest probability of surplus for each alternative occurs before 2017 with the following approximate values: DNF, 44 percent; DP, 42 percent; NPC, 44 percent; and PS, 48 percent. Beginning in 2017, under the No Action Alternative, only 70R and Flood Control surpluses occur, which reduces the probability of surplus to below 25 percent.

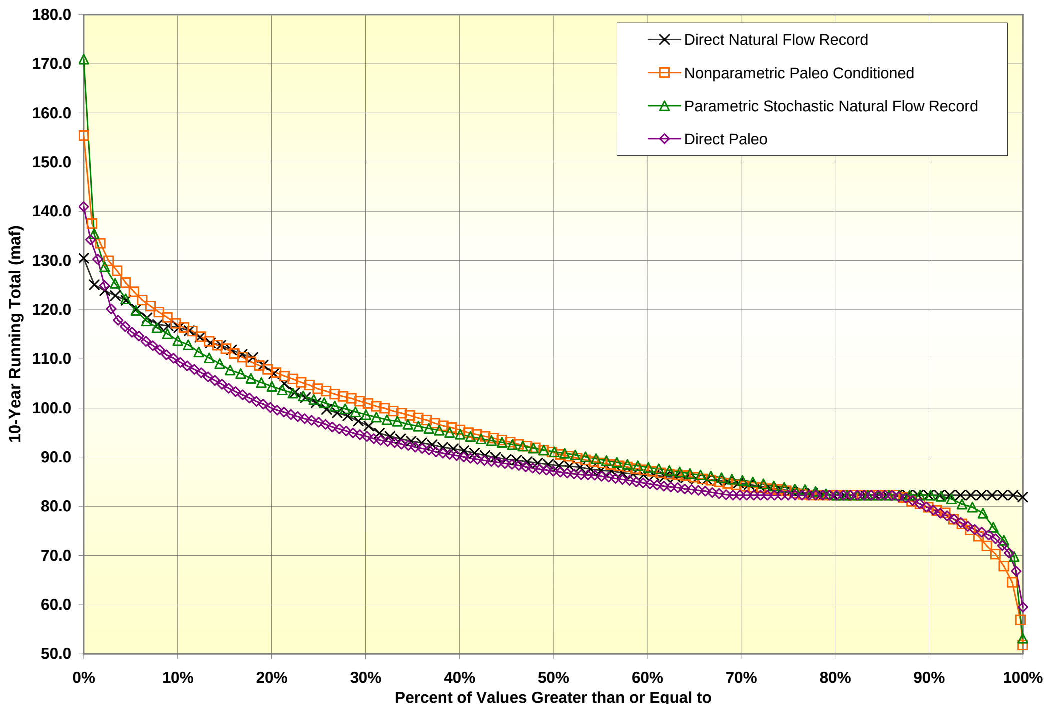
Figure Att. A-8
Lower Basin Surplus
Comparison of Direct Natural Flow Record to Three Alternative Hydrologic Sequences
No Action Alternative
Probability of Occurrence



A.3.1.5 Releases from Glen Canyon Dam

Figure Att. A-9 presents a comparison of 10-year release volumes from Glen Canyon Dam for DNF and the three alternative hydrologic scenarios. The largest differences in the frequency of flow volumes are observed at the highest and lowest volumes, where the NPC hydrologic sequence shows the lowest low extreme values and DNF shows the lowest high extreme values. The PS hydrologic sequence "fills the gaps" in the data resulting in the smoothest curve and the highest extreme value.

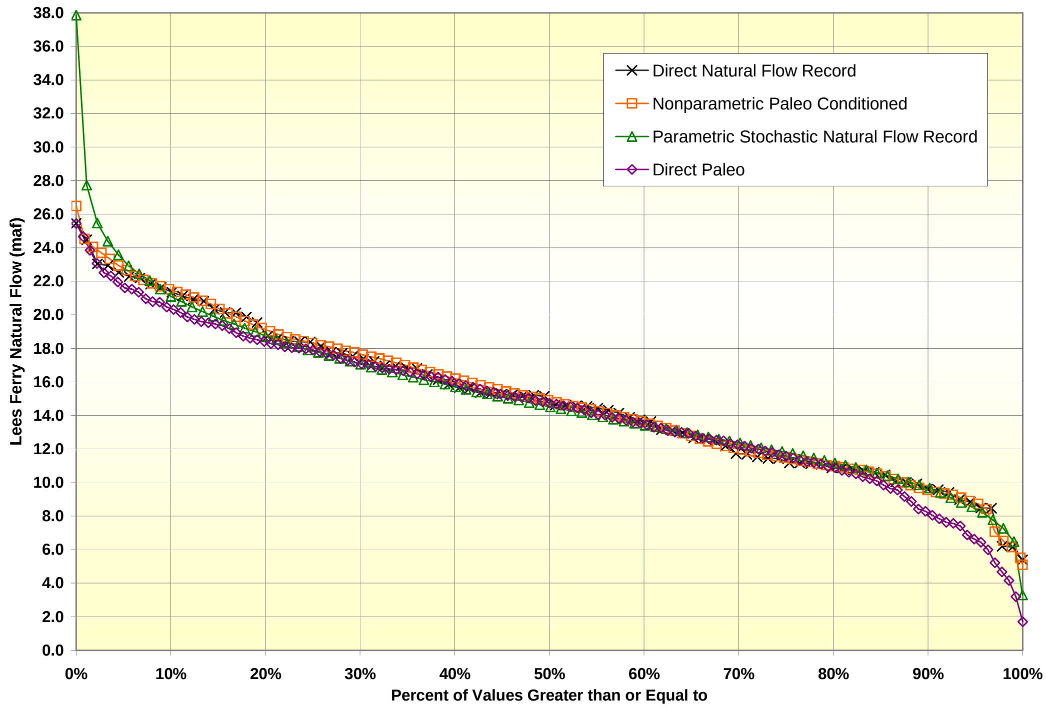
Figure Att. A-9
Glen Canyon Dam 10-Year Release Volume
Comparison of Direct Natural Flow Record to Three Alternative Hydrologic Sequences
No Action Alternative
Percent of Values Greater than or Equal to (Years 2008 to 2060)



A.3.1.6 Natural Flow at Lees Ferry

Figure Att. A-10 presents a comparison of annual natural flow volumes past Lees Ferry for DNF and the three alternative hydrologic scenarios. The largest differences in the frequency of flow volumes are observed at the highest and lowest volumes, where the DP hydrologic sequence shows the lowest extreme values. The PS hydrologic sequence "fills the gaps" in the data resulting in the smoothest curve and the highest extreme value. The maximum flows produced under the PS scenario are much higher than the maximum flows by any other method in this analysis.

Figure Att. A-10
Annual Natural Flow at Lees Ferry
Comparison of Direct Natural Flow Record to Three Alternative Hydrologic Sequences
No Action Alternative
Percent of Values Greater than or Equal to for Years 2008-2060



A.3.2 Effects of Alternative Hydrology on Action Alternatives

This section describes the sensitivity of the No Action and action alternatives to the hydrologic variability provided by the three alternative hydrologic inflow scenarios described in Section A.2. Below are the reservoir percentile figures and tables under DNF for reference and comparison (Figures Att. A-11 through Att. A-12 and Tables Att. A-1 through Att. A-2).

Figure Att. A-11
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Direct Natural Flow Record Inflow Hydrology
90th, 50th and 10th Percentile Values

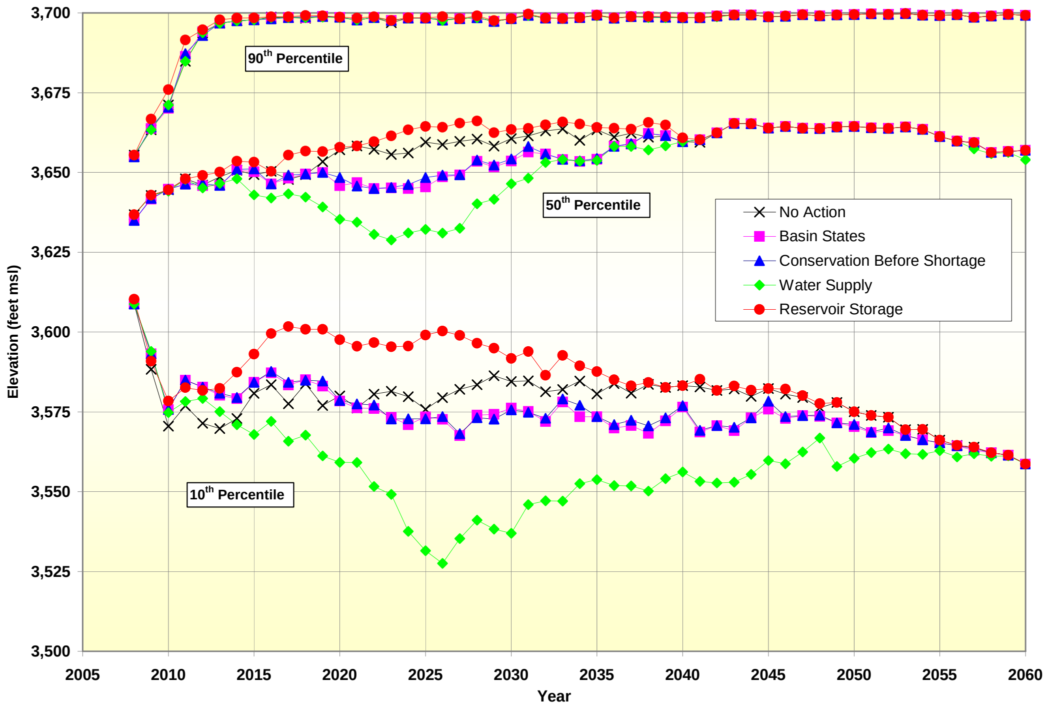


Table Att. A-1
Lake Powell End-of-July Elevations (feet msl)
Comparison of Action Alternatives to No Action Alternative
Direct Natural Flow Record
90th, 50th and 10th Percentile Values

Alternative	Year 2026			Year 2060		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
No Action	3,697.90	3,658.75	3,579.43	3,699.27	3,656.99	3,558.63
Basin States	3,697.71	3,648.61	3,572.63	3,699.27	3,656.99	3,558.63
Conservation Before Shortage	3,697.74	3,649.20	3,573.50	3,699.27	3,656.99	3,558.63
Water Supply	3,697.64	3,631.02	3,527.55	3,699.27	3,654.00	3,558.63
Reservoir Storage	3,698.85	3,664.17	3,600.29	3,699.27	3,656.99	3,558.63

Figure Att. A-12
Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative
Direct Natural Flow Record Inflow Hydrology
90th, 50th and 10th Percentile Values

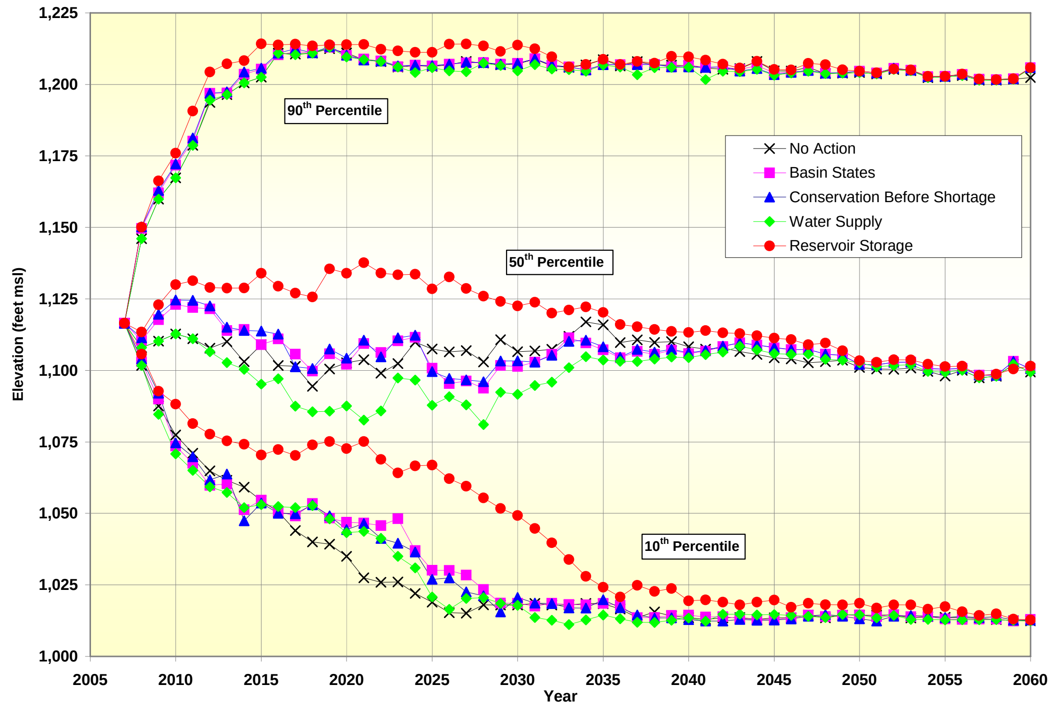


Table Att. A-2
Lake Mead End-of-December Elevations (feet msl)
Comparison of Action Alternatives to No Action Alternative
Direct Natural Flow Record
90th, 50th and 10th Percentile Values

Alternative	Year 2026			Year 2060		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
No Action	1,206.87	1,106.50	1,015.31	1,202.39	1,099.41	1,012.44
Basin States	1,207.05	1,095.39	1,030.07	1,205.79	1,100.55	1,012.95
Conservation Before Shortage	1,207.05	1,097.22	1,027.39	1,205.79	1,100.55	1,012.70
Water Supply	1,204.72	1,090.78	1,016.47	1,205.59	1,099.41	1,012.42
Reservoir Storage	1,214.05	1,132.64	1,062.16	1,205.80	1,101.47	1,012.75

A.3.3 Nonparametric Paleo Conditioned – Reservoir Levels

Figure Att. A-13 and Table Att. A-3 presents a comparison of the 90th, 50th, and 10th percentile lines obtained for the No Action and action alternatives under the NPC hydrologic inflow scenario. The NPC inflow hydrology method is explained in detail in Section A.2.1.

Median Lake Powell elevations as depicted on the 50th percentile lines are consistently lower under the Water Supply Alternative than the No Action Alternative until year 2038, with a maximum difference of 32 feet in year 2026.

At the 10th percentile, elevations under the Water Supply Alternative drop below elevations under the No Action Alternative in year 2016, reaching a maximum difference of 39 feet below the No Action Alternative in year 2020. Elevations at the 10th percentile under the Basin States, Conservation Before Shortage and Reservoir Storage alternatives remain above No Action Alternative elevations for most years before year 2033, and thereafter the differences are minimal.

Figure Att. A-13
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Nonparametric Paleo Conditioned Inflow Hydrology
90th, 50th and 10th Percentile Values

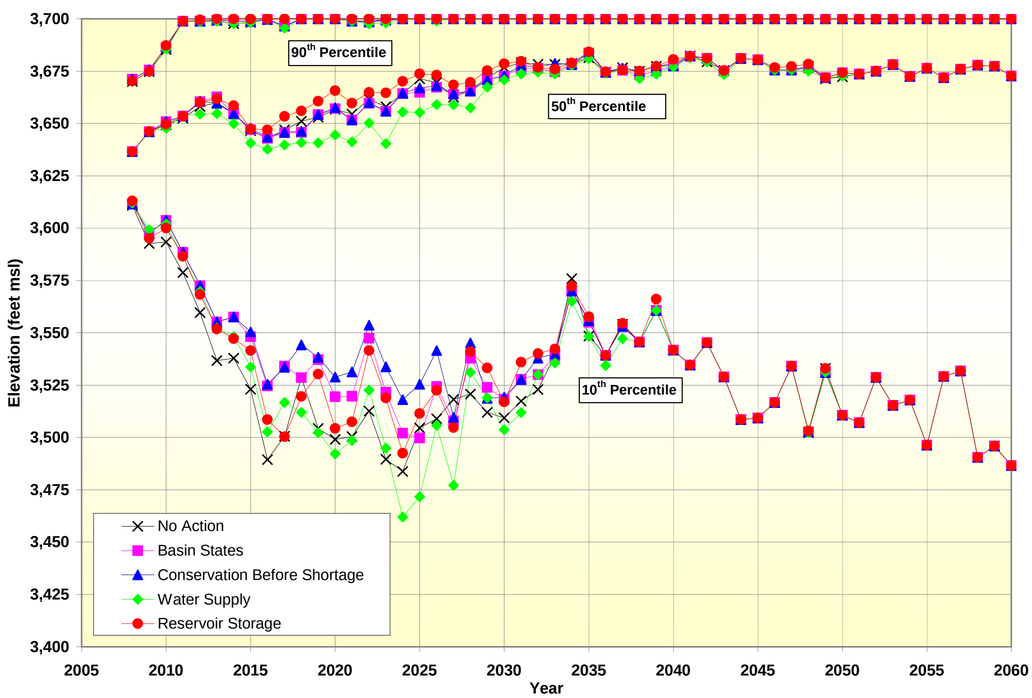


Table Att. A-3
Lake Powell End-of-July Elevations (feet msl)
Comparison of Action Alternatives to No Action Alternative
Nonparametric Paleo Conditioned
90th, 50th, and 10th Percentile Values

Alternative	Year 2026			Year 2060		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
No Action	3,700.00	3,669.57	3,508.94	3,700.00	3,672.76	3,486.56
Basin States	3,700.00	3,667.27	3,524.31	3,700.00	3,672.76	3,486.56
Conservation Before Shortage	3,700.00	3,668.01	3,541.49	3,700.00	3,672.76	3,486.56
Water Supply	3,699.06	3,659.05	3,505.77	3,700.00	3,672.76	3,486.56
Reservoir Storage	3,700.00	3,673.14	3,522.48	3,700.00	3,672.76	3,486.56

Figure Att. A-14 and Table Att. A-4 present a comparison of the 90th, 50th, and 10th percentile elevations at Lake Mead. The relationship between alternatives is maintained under NPC hydrologic sequences at Lake Mead 50th and 90th percentiles as both percentiles lie in the same elevation range as under DNF. Because the 10th percentile is lower in the reservoir (ranging from 25 to 100 feet through 2026), whether or not an alternative includes the absolute protection of 1,000 feet msl is important. For example, the Conservation Before Shortage and Basin States alternatives are very similar at the 10th percentile under DNF. The absolute protection of 1,000 feet msl as part of the Conservation Before Shortage Alternative and not the Basin States Alternative results in keeping Lake Mead higher at the 10th percentile. The Water Supply, Basin States and Conservation Before Shortage alternatives are lower than the No Action Alternative at the 10th percentile due to reduced releases from Lake Powell. Using the NPC inflow hydrology the Water Supply Alternative reaches the lowest 10th percentile values compared to the other action alternatives.

Figure Att. A-14
Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative
Nonparametric Paleo Conditioned Inflow Hydrology
90th, 50th and 10th Percentile Values

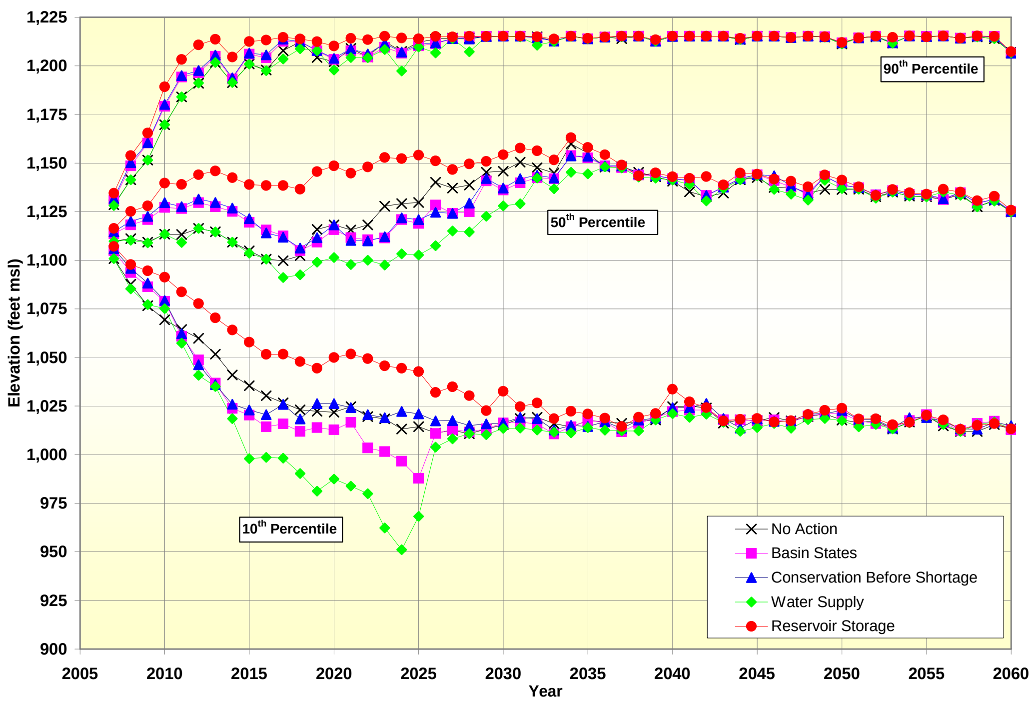


Table Att. A-4
Lake Mead End-of-December Elevations (feet msl)
Comparison of Action Alternatives to No Action Alternative
Nonparametric Paleo Conditioned
90th, 50th, and 10th Percentile Values

Alternative	Year 2026 90th Percentile	Year 2026 50th Percentile	Year 2026 10th Percentile	Year 2060 90th Percentile	Year 2060 50th Percentile	Year 2060 10th Percentile
No Action	1,212.28	1,129.74	1,014.41	1,214.02	1,130.74	1,015.44
Basin States	1,210.33	1,118.96	987.85	1,215.22	1,131.33	1,017.20
Conservation Before Shortage	1,211.10	1,120.93	1,021.01	1,215.02	1,131.33	1,016.76
Water Supply	1,209.71	1,102.77	968.18	1,214.02	1,130.50	1,016.86
Reservoir Storage	1,213.95	1,154.10	1,042.77	1,215.22	1,132.93	1,015.93

A.3.3.1 Parametric Stochastic – Reservoir Levels

Figure Att. A-15 and Table Att. A-5 present a comparison of the 90th, 50th, and 10th percentile lines obtained for the No Action and the action alternatives under the PS hydrologic inflow scenario. The PS inflow hydrology method is explained in detail in Section A.2.2.

Median Lake Powell elevations as depicted on the 50th percentile lines are consistently lower under the Water Supply Alternative than the No Action Alternative until year 2036, with a maximum difference of eight feet in year 2029.

At the 10th percentile, elevations under the Water Supply Alternative drop below elevations under the No Action Alternative in year 2011, reaching a maximum difference of 46 feet below the No Action Alternative in year 2028. Following year 2035, these differences are minimal. Elevations at the 10th percentile under the Basin States, Conservation Before Shortage and Reservoir Storage alternatives remain above the No Action Alternative elevation until year 2030.

Figure Att. A-15
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Parametric Stochastic Natural Flow Record Inflow Hydrology
90th, 50th and 10th Percentile Values

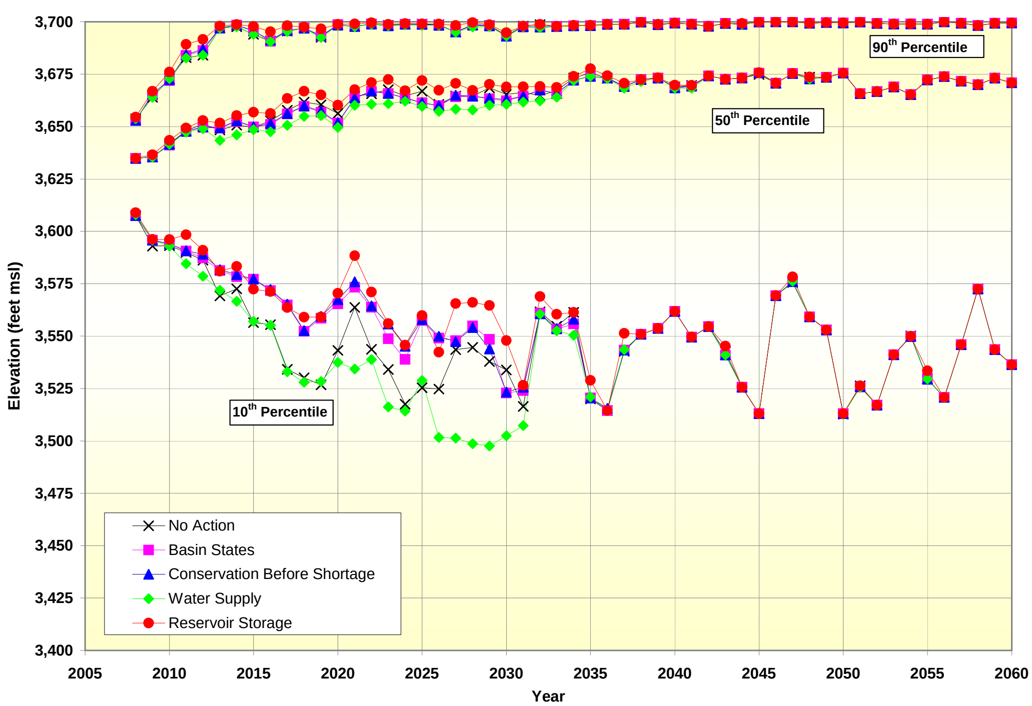


Table Att. A-5
Lake Powell End-of-July Elevations (feet msl)
Comparison of Action Alternatives to No Action Alternative
Parametric Stochastic Natural Flow Record
90th, 50th and 10th Percentile Values

Alternative	Year 2026			Year 2060		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
No Action	3,698.61	3,660.60	3,524.76	3,699.46	3,670.91	3,536.35
Basin States	3,698.34	3,659.99	3,549.06	3,699.46	3,670.91	3,536.35
Conservation Before Shortage	3,698.36	3,659.99	3,549.93	3,699.46	3,670.91	3,536.35
Water Supply	3,698.36	3,657.22	3,501.62	3,699.46	3,670.91	3,536.35
Reservoir Storage	3,698.90	3,667.34	3,542.31	3,699.46	3,670.91	3,536.35

Figure Att. A-16 and Table Att. A-6 present a comparison of the 90th, 50th, and 10th percentile elevations at Lake Mead. As with the NPC hydrologic sequences, the relationship between alternatives is maintained at Lake Mead 50th and 90th percentiles. The 50th percentile is about 25 feet higher in the reservoir compared to DNF. The 10th percentile is lower in the reservoir (about 15 feet) than with DNF but not as low as with NPC. Whether or not an alternative includes the absolute protection of 1,000 feet msl is not as dominate here as with NPC as seen by the smaller difference between the Conservation Before Shortage and Basin States alternatives. The Water Supply Alternative drops lower than under DNF due to the possible more extreme droughts resulting in lower Lake Powell inflow. The position of the Reservoir Storage Alternative remains almost unchanged compared to DNF at the 10th percentile.

Figure Att. A-16
Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative
Parametric Stochastic Natural Flow Record Inflow Hydrology
90th, 50th and 10th Percentile Values

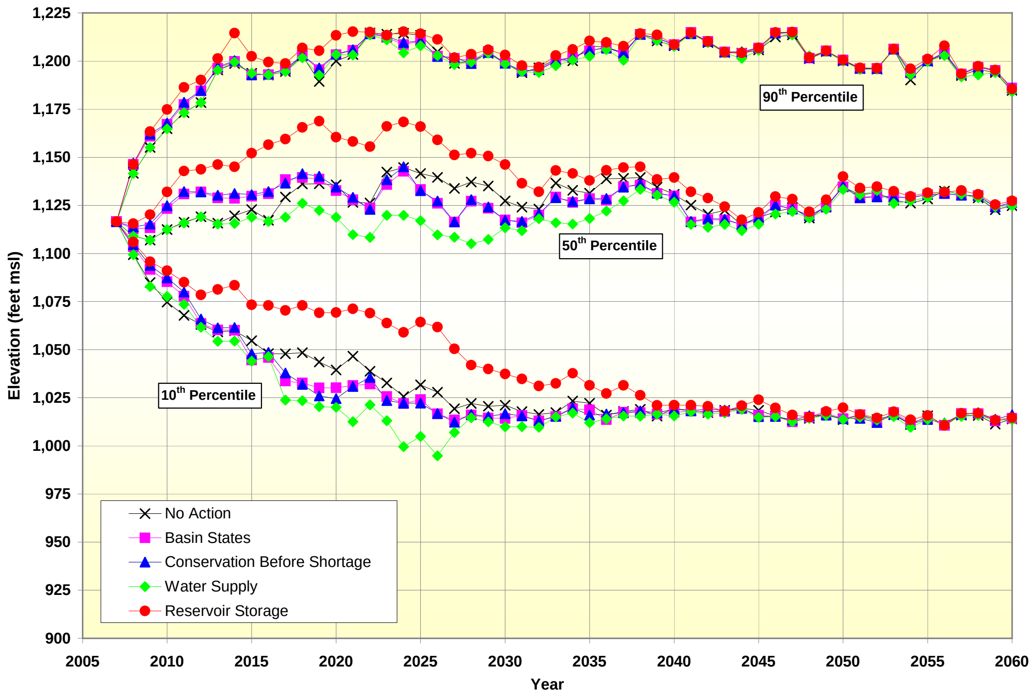


Table Att. A-6
Lake Mead End-of-December Elevations (feet msl)
Comparison of Action Alternatives to No Action Alternative
Parametric Stochastic Natural Flow Record
90th, 50th and 10th Percentile Values

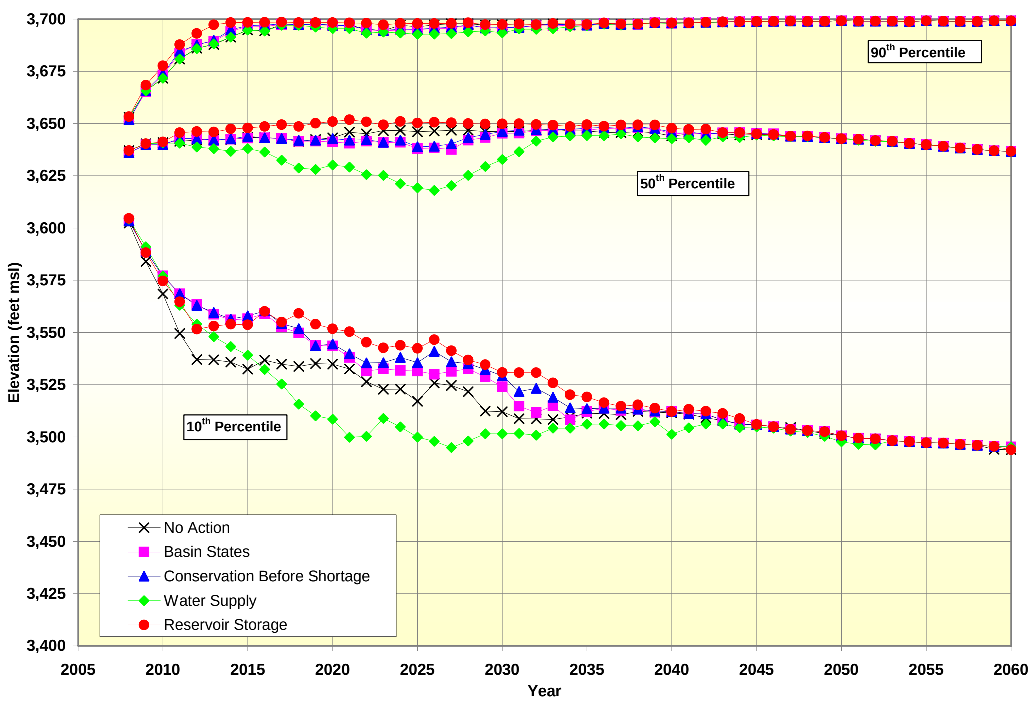
Alternative	Year 2026			Year 2060		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
No Action	1,204.76	1,139.61	1,027.90	1,184.74	1,124.79	1,013.93
Basin States	1,202.49	1,126.05	1,016.66	1,185.98	1,126.46	1,014.31
Conservation Before Shortage	1,202.39	1,127.21	1,016.83	1,186.02	1,126.46	1,016.18
Water Supply	1,202.79	1,109.70	994.88	1,184.05	1,124.78	1,013.58
Reservoir Storage	1,211.22	1,158.98	1,061.76	1,185.53	1,127.35	1,014.59

A.3.3.2 Direct Paleo – Reservoir Levels

Figure Att. A-17 and Table Att. A-7 present a comparison of the 90th, 50th, and 10th percentile lines obtained for the No Action and action alternatives under the DP hydrologic inflow scenario. The DP inflow hydrology method is explained in detail in Section 2.3

The median Lake Powell elevation for all five scenarios generally declines over the period of analysis, due to increasing Upper Basin depletions. Figure Att. A-7 also illustrates that median Lake Powell elevations as depicted on the 50th percentile lines are consistently lower under the Water Supply Alternative until year 2047, with a maximum difference of 33 feet in year 2026. These differences are insignificant by year 2047.

Figure Att. A-17
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Direct Paleo Inflow Hydrology
90th, 50th and 10th Percentile Values



At the 10th percentile, elevations under the Water Supply Alternative drop below those of the No Action Alternative in year 2016, reaching a maximum difference of 33 feet below the No Action Alternative in year 2021. Elevations at the 10th percentile from the Basin States, Conservation Before Shortage and Reservoir Storage alternatives remain above No Action Alternative elevations until 2038.

Table Att. A-7
Lake Powell End-of-July Elevations (feet msl)
Comparison of Action Alternatives to No Action Alternative
Direct Paleo
90th, 50th and 10th Percentile Values

Alternative	Year 2026			Year 2060		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
No Action	3,697.24	3,646.33	3,525.79	3,699.17	3,636.71	3,493.86
Basin States	3,695.52	3,638.28	3,529.95	3,699.17	3,636.71	3,495.25
Conservation Before Shortage	3,695.62	3,639.13	3,540.96	3,699.17	3,636.71	3,495.25
Water Supply	3,692.83	3,617.99	3,497.83	3,699.17	3,636.71	3,495.25
Reservoir Storage	3,697.89	3,650.61	3,546.57	3,699.17	3,636.71	3,493.86

Figure Att. A-18 and Table Att. A-8 present a comparison of the 90th, 50th, and 10th percentile elevations at Lake Mead. The position of these percentiles is most similar to DNF with DP. All relationships are preserved with the exception of the Water Supply Alternative and No Action Alternative at the 10th percentile. The Basin States and Conservation Before Shortage Alternatives remain below the No Action Alternative from 2012 to 2019 as Lake Powell makes reduced releases. The same is true for the Water Supply Alternative. This alternative drops almost 40 feet lower in 2026 at the 10th percentile compared to DNF. Lake Powell is unable to provide balancing releases that benefit Lake Mead due to lower inflow sequences.

Figure Att. A-18
Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative
Direct Paleo Inflow Hydrology
90th, 50th and 10th Percentile Values

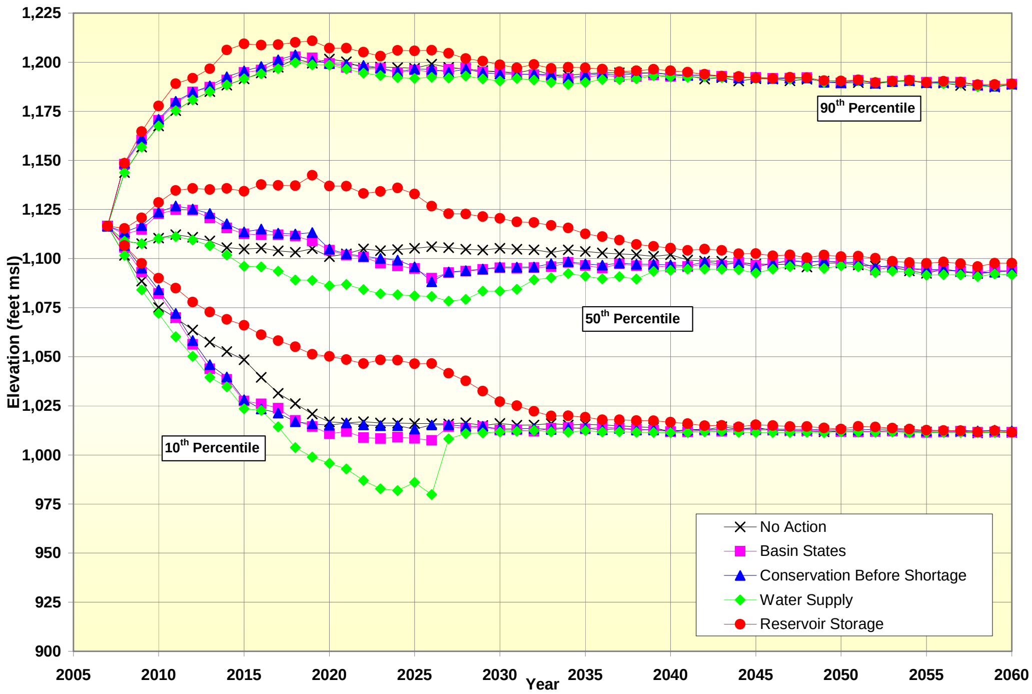


Table Att. A-8
Lake Mead End-of-December Elevations (feet msl)
Comparison of Action Alternatives to No Action Alternative
Direct Paleo
90th, 50th and 10th Percentile Values

Alternative	Year 2026 90th Percentile	Year 2026 50th Percentile	Year 2026 10th Percentile	Year 2060 90th Percentile	Year 2060 50th Percentile	Year 2060 10th Percentile
No Action	1,199.04	1,106.10	1,015.94	1,188.70	1,093.89	1,011.47
Basin States	1,195.10	1,090.03	1,007.41	1,188.89	1,093.63	1,011.59
Conservation Before Shortage	1,196.39	1,088.23	1,015.23	1,188.89	1,093.88	1,012.23
Water Supply	1,192.33	1,080.72	979.86	1,188.52	1,091.73	1,011.54
Reservoir Storage	1,206.10	1,126.68	1,046.47	1,188.91	1,097.71	1,011.61

A.3.3.3 All Inflow Scenarios – Shortage Magnitude and Frequency

Tables Att. A-9 and Att. A-10 compare the probabilities of shortages occurring between 0 and 500 kaf, 500 and 750 kaf, 750 and 1.0 maf, 1.0 and 1.5 maf, 1.5 and 2.0 maf, 2.0 and 2.5 maf and above 2.5 maf for the years 2010, 2017, 2026 and 2060. The upper range of the shortage increment is inclusive. These years and shortage ranges are compared for all alternatives and inflow scenarios.

2010. The earliest occurrence of shortage, for all alternatives and inflow scenarios, is 2010. Most of these occurrences are under the Reservoir Storage Alternative due to the highest trigger elevation of the alternatives at 1,100 feet msl. The probability of these occurrences is within 4 percent except for DNF which is the highest.

2017. In 2017, about halfway through the interim period, the majority of the shortages are less than 1.0 maf. Deeper shortages occur with NPC under all alternatives. With NPC there is a 5 percent occurrence of a 1.2 maf shortage under the Reservoir Storage Alternative which never occurs under DNF. The 15 percent chance of a shortage under the Water Supply Alternative with NPC indicates that Lake Mead is lowest under this hydrology as there is no reduction in demand unless Lake Mead is below 1,000 feet msl.

2026. In 2026, the last year of the interim period, the majority of the shortages still fall below 1.0 maf. However, with all inflow scenarios, a larger portion of the shortages are distributed at deeper levels. Under DP and NPC there are more shortages above 750 kaf than below in the Reservoir Storage Alternative.

2060. In 2060 the majority of the shortages are 500 kaf or below. All alternatives have reverted to the No Action Alternative and are all under the same shortage strategy. The distribution of shortage above 500 kaf is similar across all alternatives and inflow scenarios. This indicates that by 2060 the effects of the alternatives have washed out. Lake Mead is receiving a steady release from Lake Powell and therefore does not fluctuate as much as during the interim period.

Table Att. A-9
Distribution and Probability of Involuntary Lower Basin Shortage (percent)
Comparison of Action Alternatives to No Action Alternative for All Alternative Hydrologic Sequences

Shortage (kaf)	Sequence	NA	BS	CBS	WS	RS	NA	BS	CBS	WS	RS
		2010					2017				
0 to 500	ISM	0	2	0	0	0	39	25	0	0	0
	NPC	0	0	0	0	0	30	20	2	15	0
	PS	0	0	0	0	0	25	15	0	7	0
	DP	0	1	0	0	0	34	22	3	9	0
500 to 750	ISM	1	0	0	0	24	0	2	0	0	22
	NPC	1	0	0	0	10	0	5	0	0	15
	PS	6	0	0	0	18	3	3	1	0	14
	DP	0	0	0	0	14	2	5	1	0	14
750 to 1,000	ISM	0	0	0	0	0	1	0	1	0	11
	NPC	0	0	0	0	0	1	7	1	0	14
	PS	0	0	0	0	0	1	3	1	0	11
	DP	0	0	0	0	0	0	5	1	0	19
1,000 to 1,500	ISM	0	0	0	0	0	0	0	0	0	0
	NPC	0	0	0	0	0	6	0	2	0	5
	PS	0	0	0	0	0	2	0	0	0	0
	DP	0	0	0	0	0	2	0	0	0	2
1,500 to 2,000	ISM	0	0	0	0	0	0	0	0	0	0
	NPC	0	0	0	0	0	2	0	2	0	0
	PS	0	0	0	0	0	3	0	0	0	0
	DP	0	0	0	0	0	2	0	1	0	0
2,000 to 2,500	ISM	0	0	0	0	0	0	0	0	0	0
	NPC	0	0	0	0	0	0	0	2	0	0
	PS	0	0	0	0	0	0	0	2	0	0
	DP	0	0	0	0	0	0	0	1	0	0
2,500 +	ISM	0	0	0	0	0	0	0	0	0	0
	NPC	0	0	0	0	0	2	0	3	0	0
	PS	0	0	0	0	0	0	0	0	0	0
	DP	0	0	0	0	0	1	0	1	0	0

Table Att. A-10
Distribution and Probability of Involuntary Lower Basin Shortage (percent)
Comparison of Action Alternatives to No Action Alternative for All Alternative Hydrologic Sequences

Shortage (kaf)	Sequence	NA	BS	CBS	WS	RS	NA	BS	CBS	WS	RS
		2026					2060				
0 to 500	ISM	39	28	2	9	0	55	53	49	53	54
	NPC	24	19	1	22	0	40	41	40	41	40
	PS	33	22	2	12	0	55	56	55	55	56
	DP	36	22	4	17	0	60	60	59	59	60
500 to 750	ISM	2	7	2	0	19	5	5	8	5	5
	NPC	6	4	2	0	8	3	3	3	3	3
	PS	2	7	0	0	16	3	2	2	3	3
	DP	3	8	2	0	13	4	4	5	4	5
750 to 1,000	ISM	4	0	3	0	18	3	2	2	3	1
	NPC	2	11	0	0	16	4	2	3	3	3
	PS	1	4	5	0	11	2	3	4	2	1
	DP	2	9	2	0	20	3	3	3	3	2
1,000 to 1,500	ISM	0	0	0	0	0	3	3	4	3	4
	NPC	2	0	1	0	6	3	3	4	3	3
	PS	2	0	1	0	3	5	3	3	4	3
	DP	2	0	0	0	3	4	4	5	4	5
1,500 to 2,000	ISM	2	0	1	0	0	4	4	3	4	3
	NPC	1	0	1	0	0	4	5	4	4	4
	PS	1	0	1	0	0	3	3	3	3	4
	DP	3	0	2	0	0	4	5	5	5	4
2,000 to 2,500	ISM	0	0	0	0	0	0	0	0	0	0
	NPC	0	0	4	0	0	1	1	1	1	2
	PS	0	0	0	0	0	2	2	2	1	1
	DP	1	0	3	0	0	2	1	1	1	1
2,500 +	ISM	0	0	0	0	0	0	0	0	0	0
	NPC	6	0	2	0	0	3	3	3	3	3
	PS	1	0	1	0	0	1	1	1	2	1
	DP	2	0	1	0	0	3	3	3	3	3

Appendix O

Analysis of Power and Energy Impacts to Glen Canyon Dam, Shortage Criteria EIS

This appendix contains a copy of a report prepared by the Western Area Power Administration entitled *Analysis of Power and Energy Impacts to Glen Canyon Dam, Shortage Criteria EIS*. The report describes the methodology and analysis conducted for energy resources at the Glen Canyon Powerplant. The analysis in Section 4.11 of this Final EIS uses information derived from this analysis of generation capacity and its associated economic value.

Analysis of Power and Energy Impacts to Glen Canyon Dam, Shortage Criteria EIS

July 30, 2007, Update for FEIS

S. Clayton Palmer, Sam Loftin, and Thomas Veselka
Western Area Power Administration
Colorado River Storage Project Management Center
and Argonne National Laboratory

Prepared for the Bureau of Reclamation

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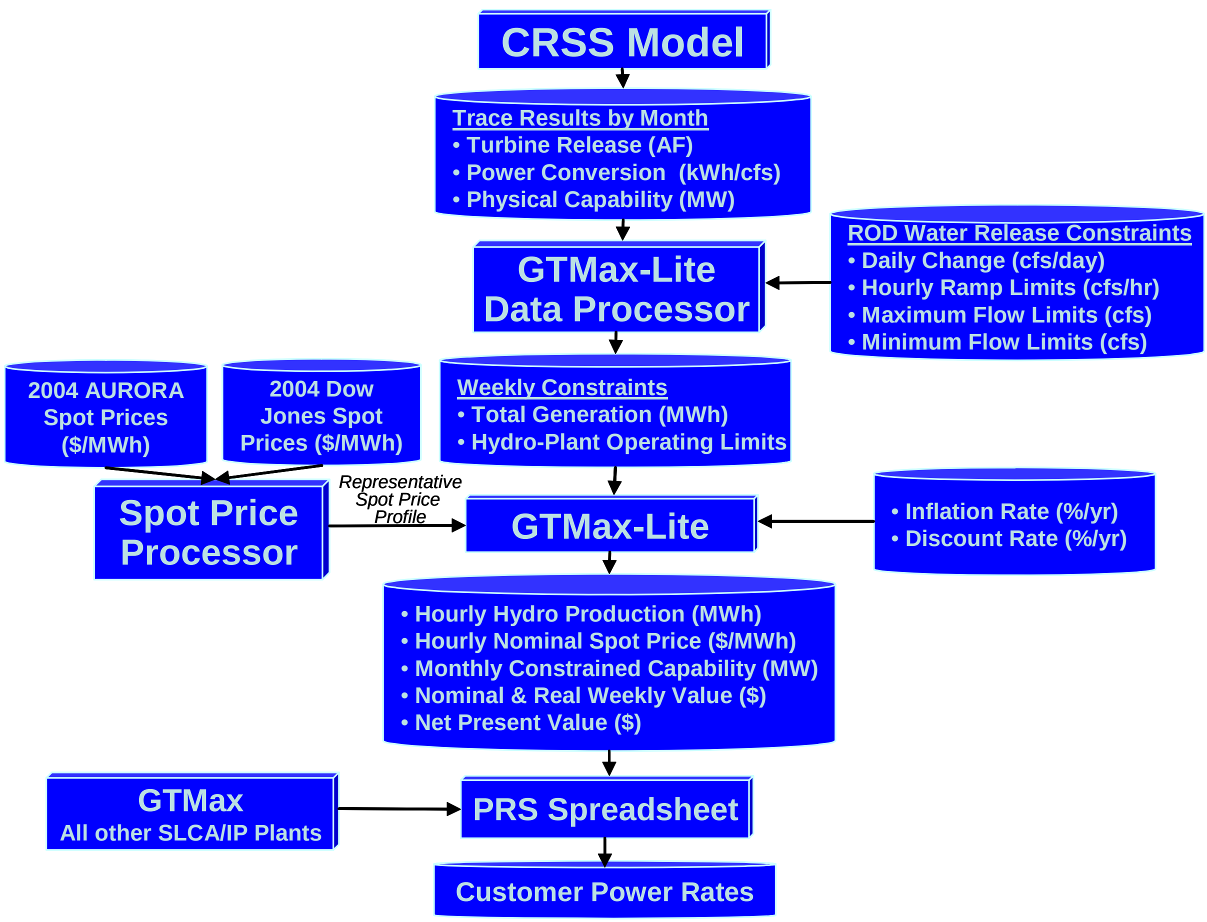
Methodology Overview

The methodology used by the Western Area Power Administration (Western) to estimate the economics of Shortage Criteria Environmental Impact Statement (EIS) alternatives is a multi-step procedure of data processing and computer simulations. A flow diagram depicting the major components of this procedure and component interactions is displayed in Figure 1. The procedure uses monthly results produced by the Colorado River Simulation System (CRSS) for each of the six EIS alternatives. This includes monthly values of turbine-water releases, power conversion factors, and the physical production capability of the Glen Canyon Dam (GCD) hydropower plant. The CRSS model also simulates operations for other Colorado River System Project (CRSP) reservoirs. However, EIS alternatives only impact the Glen Canyon Dam and are therefore the focus of this analysis.

Figure 1
Diagram Depicting Major Modeling Components and Processes



CRSS results along with operating constraints mandated by the Glen Canyon Dam EIS Record of Decision (ROD) are input into an Excel spreadsheet that prepares input data for a customized variation of the Generation and Transmission Maximization (GTMax) model. To distinguish this customized version from the original model, it is referred to as GTMax-Lite in this document. The Data Processor spreadsheet uses power conversion factors to translate CRSS releases and ROD constraints from water units into a power equivalent. For example, monthly turbine water releases specified in terms of acre-feet (AF) in CRSS output tables are converted into an equivalent electricity production in units of Mega-Watt-hours (MWh). The spreadsheet also selects a subset of CRSS results and calculates statistics that are analyzed in more detail by other processes.

Physical monthly operating limits for capacity and energy along with ROD operational constraints are used by the GTMax-Lite model to simulate hourly Glen Canyon Dam power plant generation levels. The model determines the hourly operation schedule over a 1-week period (i.e., 168 hours) that maximizes the economic value of the hydropower resource. The operation schedule produced by the model is within the physical limitations of the power plant and it complies with all environmental and institutional regulations.

The GTMax-Lite model uses a projection of market prices as a measure of the future economic value of hydropower generation. These prices heavily influence the generation schedule produced by the model when it optimizes the hydropower plant resource. Future hourly price signals are estimated over the study period by a second Excel spreadsheet referred to as the Spot Price Processor. It uses 2004 hourly spot market price patterns produced by the AURORA model (Electric Power Information Solutions, Inc. 2005), an estimate of historical 2004 market prices for the Palo-Verde market hub as reported in the Dow-Jones index, and a nominal inflation rate.

GTMax results include an estimate of the economic value of Glen Canyon power plant capacity and energy production over the simulation period. It also includes an estimate of the hydropower plant maximum production capability taking into account ROD operational constraints. This measure of capacity is mostly, but not always, substantially less than the physical capability of the plant based only on hydrological head; that is, the physical capability estimated by CRSS.

Western customer power rates are calculated using a power repayment study (PRS) spreadsheet-based computer program that contains both general and specific repayment rules associated with a particular hydropower project. This spreadsheet uses GTMax-Lite results for Glen Canyon and from the full-scale GTMax model for all other Salt Lake City Area Integrated Project (SLCA/IP) plants.

A more detailed explanation of the methodology used for the Shortage Criteria EIS is provided in the following sections. This includes both data processing algorithms and the GTMax-Lite simulation model. Detailed explanations of other models, such as CRSS that feed into the process, but are not run by Western, are provided elsewhere.

CRSS Model

The CRSS model mimics operational decisions that are made for CRSP reservoirs. Since EIS alternatives have unique criteria, each simulation contains alternative-specific operating rules that affect monthly and annual water releases. Monthly release patterns affect the economic value of the hydropower resource since the value of power is highly sensitive to seasonal and hourly variations in market prices. Typically market prices are the highest in the summer and winter seasons. Therefore, from a power generation-centric viewpoint, water releases would ideally be concentrated during these two seasons. However, from a broader perspective power benefits must be weighted against other operational objectives such as flood control, irrigation, municipal and industrial water supplies, recreation, and the environment.

Shortage Criteria alternatives also affect reservoir forebay elevations and the amount of water that bypass turbines. The forebay elevation determines the hydraulic head and is the primary factor that influences the amount of power that is produced per volume of water released through the turbines. High forebay elevations typically translate into more power production per AF of turbine water releases as compared to lower forebay elevations. However, maintaining full or nearly full reservoirs increases the risk of releasing water through bypass tubes and spillways. Sudden unexpected inflows under a full reservoir condition may require reservoir releases that exceed maximum turbine flow rates. Maintaining lower reservoir levels, on the other hand, will reduce the risk of non-turbine water releases during flood conditions, but it will also increase the risk of lowering the forebay elevation below turbine inlet tubes during droughts. When this occurs, both power production and the plant capacity is zero. Operating rules must therefore balance the risks associated with either having too much or not enough water stored in Lake Powell.

Balancing risks in a basin with large variations of water inflows, such as the Colorado, require a full-spectrum examination of hydrological conditions. Therefore, the CRSS model produces numerous simulation results for each month. These results represent a range of plausible futures from which probability distributions of future hydropower conditions are constructed. Distributions are influenced by initial reservoir conditions such that distributions are relatively narrow for near-term projections. This represents a relatively low level of uncertainty about the future. However, as the projection period extends further into the future, the distribution widens as uncertainty grows.

CRSS results include scenario-specific estimates of monthly energy production and physical capability for 100 possible futures throughout the analysis period which extends from the beginning of January 2008 through the end of December 2060. For the Shortage Criteria EIS, forecasts are made by simulating reservoir operations with 100 different sequences of inflows. Each sequence is based on a chronological inflow pattern that has occurred in the past, and is referred to as a trace. Refer to for the text of the EIS for a detailed explanation of CRSS reservoir operating rules and traces.

Hydrological Conditions Studied

Ideally detailed simulations of hourly operations at the Glen Canyon Dam hydropower plant would be performed for each of the 100 traces over the 53-year analysis period. However, it is computationally impractical. Therefore, a simplified approach was used to measure differences among alternatives. This involves analyzing only selected points from the monthly distributions produced by CRSS. The Data Processor spreadsheet computes statistics and extracts pertinent information from the CRSS output.

Western chose five hydrological conditions to study to ensure a representative look at the differences between the alternatives. The five conditions are: Mean, Median, 90 percent Exceedence, 10 percent Exceedence, and Trace 94, and are explained below.

- **Mean:** An average value of the 100 CRSS traces was computed for each month of the study period, for each alternative.
- **Median:** The 50th percentile value of the 100 CRSS traces was computed for each month of the study period, for each alternative.
- **90 percent Exceedence:** The 10th percentile value of the 100 CRSS traces was computed for each month of the study period. 90 percent exceedence is often referred to as 10th percentile in Western and Reclamation hydrological studies; the two terms are synonymous.
- **10 percent Exceedence:** The 90th percentile value of the 100 CRSS traces was computed for each month of the study period. 10 percent exceedence is often referred to as 90th percentile in Western and Reclamation hydrological studies; the two terms are synonymous.
- **Trace 94:** Individual traces of the CRSS output were examined. Trace 94 was selected by Western as representing especially poor conditions for generation at GCD, with periods of no generation due to low Lake Powell reservoir elevations (below 3490’). Trace 94 was selected to examine the difference in performance of the six alternatives under conditions of complete loss of GCD generation for an extended period of time. Trace 94 also allows for examination of a time-connected series of potential GCD operations, showing drops and recoveries of Lake Powell elevation over time. The other four hydrological conditions studied are not time-connected in the same manner that a single trace is.

Mean, median, 90 percent exceedence, and 10 percent exceedence values for capability and energy are computed separately. Furthermore, capability statistics are based only on hydrologic head as computed by CRSS. However, under current operating constraints imposed on Glen Canyon, sustainable capability is a function of both the physical powerplant capability and the monthly water release volume (refer to the next section for more details). Although it may be more accurate to compute capacity statistics using both the hydrologic head and monthly water releases, this process would have been very computationally intensive with only a marginal increase in precision. As a simplification, statistical values for physical capability and energy are first calculated and then sustainable capacity is estimated by the GTMax-Lite model using these statistical values.

Glen Canyon Dam Record of Decision

The economics of Shortage Criteria Alternatives is not only a function of monthly water release volumes, but also of physical and institutional limitations on daily and hourly operations. Of particular importance is the Glen Canyon Dam Record of Decision (ROD) that affirmed the selection of the Modified Low Fluctuating Flow Alternative as the preferred operating alternative. The Bureau of Reclamation (Reclamation) issued the operating criteria for Glen Canyon Dam early in 1997. The 1997 Operating Criteria expanded on the operational rules contained in the Glen Canyon Dam Operation EIS and ROD. It also provided Western and Reclamation staff with guidance on the operation of the dam and the Salt Lake City Area Integrated Projects (SLCA/IP) power system.

The ROD imposed a limit on the maximum allowable release from Glen Canyon Dam to 25,000 cubic feet of water per second (cfs) and included exceptions to the maximum release for Beach/Habitat Building Flows and Habitat Maintenance Flows such as occurred in March 1996. Exceptions were also made to avoid spills or flood flow releases during high runoff years. During high hydropower conditions when the total monthly water release volume is greater than a constant 25,000 cfs release rate throughout the month, the maximum release rate is relaxed. However, releases are restricted to a flat-flow operating regime.

Releases must also be at least 8,000 cfs between the daytime hours of 7:00 a.m. to 7:00 p.m., and 5,000 cfs or more at night. The ROD also set limits on the allowable release fluctuations in any continuous 24-hour period. The amounts vary depending on the volume of water scheduled to be released in a given month. For example, the allowable daily change is 5,000 cfs/24 hours for months in which scheduled water releases through the dam are less than 600 thousand acre feet (TAF). Fluctuations will be held at 6,000 cfs/24 hours for months of scheduled releases between 600 and 800 TAF, and at 8,000 cfs/24 hours for months of scheduled releases greater than 800 TAF/month. Finally, the ROD limits the rate at which the generators may ramp up or down during a 1-hour time period. The maximum power plant ramp rates are set at 4,000 cfs per hour increasing and 1,500 cfs per hour decreasing.

GTMax-Lite Data Processor

The Data Processor spreadsheet prepares input data for the GTMax-Lite model by translating CRSS and ROD information from water units into equivalent power and energy units. Equations that are used by the spreadsheet are summarized in Table 1. For example, the processor multiplies a power conversion factor by the ROD allowable maximum flow rate to compute the maximum power plant output. Power factors are approximated by CRSS for each trace in all study months. The maximum output level computed by the data processor is not always achieved since the maximum daily change restriction and hourly up and down ramp rate limits further constrain operations.

Table 1
Equations for Converting ROD Operating Criteria and CRSS Output

CRSS/ROD Criteria	Power Equivalent for GTMax-Lite Input
Monthly Water Release	$E_w^{pow} = \frac{TR_m^{wat} \times CF_m^{w-p}}{1000} \times \frac{7}{ND_m} \;\; \forall \; m \mid m = 1, \ldots, NM$
Maximum Release	$C_w^{pow} = \mathrm{Max}\left(C_m^{CRSS}, \frac{MR_m^{wat} \times CF_m^{w-p}}{1000} \times 0.082644 \right) \;\; \forall \; m \mid m = 1, \ldots, NM$
Maximum Daily Change	$DC_w^{pow} = \frac{DC_m^{wat} \times CF_m^{w-p}}{1000} \times 0.082644 \;\; \forall \; m \mid m = 1, \ldots, NM$
Hourly Up-Ramp Rate Limit	$HU_w^{pow} = \frac{HU_m^{wat} \times CF_m^{w-p}}{1000} \times 0.082644 \;\; \forall \; m \mid m = 1, \ldots, NM$
Hourly Down-Ramp Rate Limit	$HD_w^{pow} = \frac{HD_m^{wat} \times CF_m^{w-p}}{1000} \times 0.082644 \;\; \forall \; m \mid m = 1, \ldots, NM$
Minimum Daytime Release	$DM_w^{pow} = \frac{DM_m^{wat} \times CF_m^{w-p}}{1000} \times 0.082644 \;\; \forall \; m \mid m = 1, \ldots, NM$
Minimum Nighttime Release	$MN_w^{pow} = \frac{MN_m^{wat} \times CF_m^{w-p}}{1000} \times 0.082644 \;\; \forall \; m \mid m = 1, \ldots, NM$

where,

m = Simulation month index

w = Simulation week index with one representative week per month

ND_m = Number of simulation days in month m

NM = Number of simulation months; $636 = 12 \times 53$

E_w^{pow} = Weekly generation (MWh) during week w

TR_m^{wat} = Total water volume (AF) released during month m

C_w^{pow} = Weekly capability (MW) during week w

C_m^{CRSS} = CRSS physical capability (MW) during month m

MR_m^{wat} = Maximum release rate (cfs) during month m; dependent on TR_w^{wat}

DC_w^{pow} = Maximum daily change (MW/day) during week w

DC_m^{wat} = Maximum daily change (cfs/day) during month m; dependent on TR_w^{wat}

HU_w^{pow} = Maximum hourly power increase (MW/h) during week w

HU_m^{wat} = Maximum hourly up-ramp rate (cfs/hr) during month m

HD_w^{pow} = Maximum hourly power decrease (MW/h) during week w

HD_m^{wat} = Maximum hourly down-ramp rate (cfs/hr) during month m

MD_w^{pow} = Minimum daytime hourly generation (MWh) during week w

MD_m^{wat} = Minimum daytime release rate (cfs) during month *m*

MN_w^{pow} = Minimum nighttime hourly generation (MWh) during week *w*

MN_m^{wat} = Minimum nighttime release rate (cfs) during month *m*

It should be noted that the monthly water releases in table are scaled to represent the amount of water that is released in a typical week. GTMax-Lite model is executed for only 1 week per study period month. Total generation during this "typical" week is based on CRSS monthly water release volumes times a scaling factor. This factor is equal to the number of days in the week divided by the number of days in a simulated month. For example, the scaling factor for January equals 7 divided by 31. The inverse of this factor is used to obtain monthly values by scaling-up weekly results.

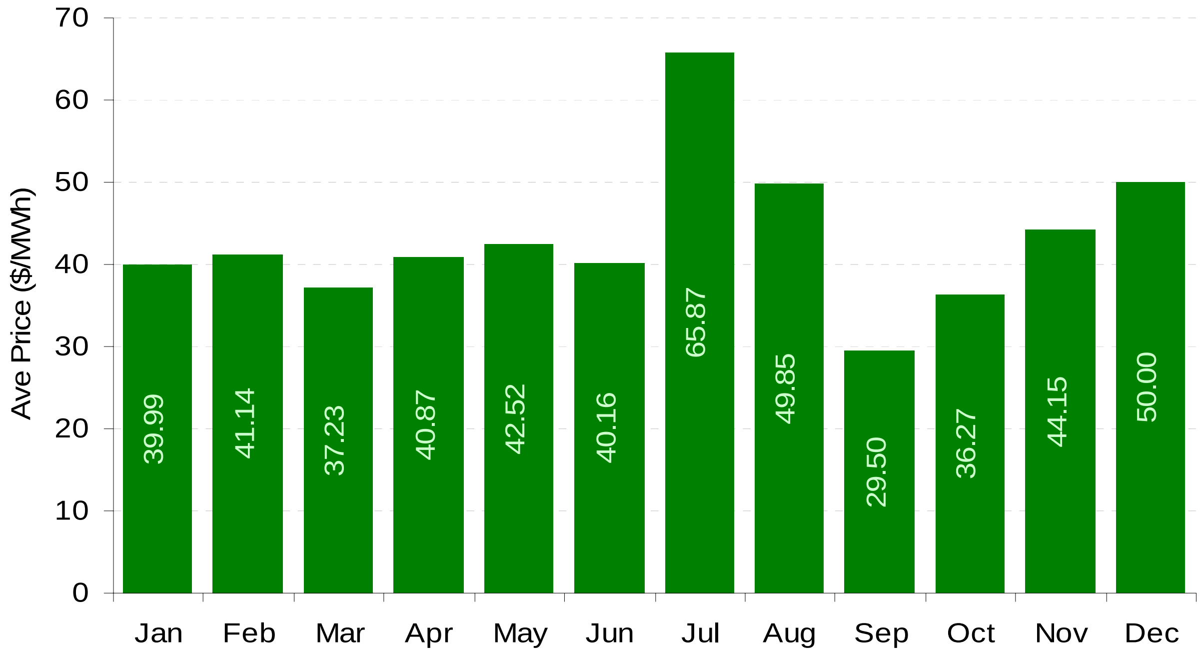
Market Prices

Representative energy and capacity prices are essential for an economic evaluation of Shortage Criteria alternatives. Pricing assumptions tend to be controversial because there are many sources of information, and because the price assumed can make a large difference in the resulting valuation of energy and capacity. Some analysts prefer using historical energy and capacity prices because they can be tied to a specific set of purchase transactions. Others prefer to use estimates of future costs under the assumption that historical costs do not necessarily predict future prices. Prices for historical or future energy can be obtained fairly easily from a variety of sources. However, prices for capacity are more difficult to obtain since they are more closely identified to a particular utility or power generation facility and usually are considered proprietary information by the facility owner.

Western coordinated analysis of energy prices with Reclamation to ensure that both agencies were using the same data. The two agencies agree upon a method that combined two types of energy prices. These data include a historical price index for the Palo-Verde market hub contained in a Dow Jones, Inc. database and hourly market price patterns produced by the AURORA model. Both the historical and modeled data are for the year 2004. Prices for 2005 were rejected from consideration due to the anomalies caused by fuel supply disruptions resulting from hurricane damage that occurred in the summer and autumn.

A review of hourly 2004 Dow Jones price data identified numerous anomalies such as atypically high prices on several Sundays over the course of the year. There were also long and frequent periods of missing data. Although the Dow Jones month average prices, shown in Figure 2, are representative and would suffice for Reclamation's monthly energy modeling, the quality of the hourly price data was inadequate for Western's hourly modeling. To eliminate the hourly energy price problems, Reclamation provided Western with AURORA model simulated market prices for 2004. The Aurora model results had hourly and weekly prices that represented typical weekly price profiles, but average price levels were significantly less than historical levels. To match the Dow Jones index prices, the AURORA hourly model output was scaled such that the average monthly values matched the Dow Jones monthly average values. A more detailed description of the scaling process is provided in the next section.

Figure 2
Average Market Prices for 2004 Based on the Dow Jones Index



Some of the anomalies associated the Dow Jones, Inc. price index may be a reflection of the energy market that is currently functioning in the WECC and small number of reported transactions that is used to calculate the index. For any given hour the Dow index is the weighted average price for all reported bilateral exchanges. A bilateral exchange is a private transaction between two parties at a negotiated price. It should also be noted that only a small percentage of bilateral contracts are reported to the Dow Jones. Although monthly average prices follow a typical pattern, the extent to which the Dow Jones prices reflect the broader WECC electricity market is not known. This method of price discovery differs from a market price that is determined through a central clearinghouse whereby individual buyers and sellers do not directly communicate with each other. Instead a price is determined by the intersection of supply and demand bid curves.

AURORA model simulations used in this analysis were developed for and used in the Northwest Power and Conservation Council's Fifth Northwest Electric Power and Conservation Plan (NWPCC 2005). The Northwest Power and Conservation Council is primarily interested in Northwestern electricity markets. Relatively less attention is devoted to characterizing market conditions in other parts of the WECC region. Consequently, the Palo Verde forecast described in this analysis primarily reflects the default data supplied with the AURORA model.

Market Price Processor

The GTMax-Lite model uses a projection of market prices as a measure of the future economic value of hydropower generation. This assumption implies that market prices reflect the marginal economic cost of serving the last megawatts-hour (MWh) of load in the system (i.e., system lambda). Furthermore, Glen Canyon power injections into the grid are minuscule relative to the entire power system in which it operates. Therefore, its operations do not influence the marginal value of energy. Given the size and complexity of the Western Electricity Coordinating Council (WECC) power grid and the markets that it functions in, these assumptions are reasonable. It should also be noted that the relative economic differences among alternatives are of importance, rather than the absolute economic value of a specific alternative.

The Spot Price Processor prepares typical energy price profiles for GTMax based on the AURORA model results. Instead of using each hourly price, typical spot price patterns were computed for three different day types in each month. These include Sunday, weekday, and Saturday. A daily price pattern is obtained by computing an average hourly price for each similar hour. For example, the weekday price at 1 a.m. is the average of AURORA prices at 1 a.m. for all days in a month that are between Monday and Friday, inclusive. Each day of the month is then assigned hourly prices depending on the month and type of day. For example, every weekday in January is assigned the average price pattern for January weekdays.

The final step of the process scales monthly prices to match the simple (i.e., unweighted) mean of hourly Palo-Verde prices contained in the Dow Jones database. These monthly average prices follow a typical seasonal pattern for the Southwestern United States. Prices are the highest during the summer months reflecting an elevated demand for air conditioning. On the other hand, prices during the spring and autumn seasons are relatively low. Winter prices are somewhat higher than these shoulder seasons as loads are elevated by more lighting and heating demands. Prices are inflated to approximate hourly prices for future years. For this analysis, the annual inflation rate is assumed to be 2.2 percent.

The use of typical (i.e., average) hourly price profiles to estimate Glen Canyon power plant generation patterns is more realistic than estimating generation patterns based on individual hourly prices. This is in part due to the recognition that power marketers have excellent foresight regarding overall daily price patterns over the upcoming week, but the magnitude and individual hourly variations from the typical pattern cannot be accurately predicted. In contrast, the GTMax model has perfect foresight and if provided with the detailed price profile it will react to each individual "perfectly predicted" price. When GTMax is provided with the typical or average pattern, it produces a generation pattern that more closely emulates actual energy scheduling practices.

Market prices have a profound influence on generation schedules prepared by power marketers as well as those produced by optimization models. Figures 3 and 4 show hourly used by GTMax for a winter month, December, and for a summer month, July. The hourly price pattern for weekdays in December follows a typical winter profile with two separate daily peaks. The first peak occurs in the morning followed by a midday price slump. Prices rise again in the evening reaching a high between 6 p.m. to 8 p.m. The lowest prices hours are in the middle of the night, bottoming out at 2 a.m. to 4 a.m. Prices are somewhat lower during the weekends, especially on Sunday. Also weekend hourly price patterns deviate somewhat from weekday price profiles.

While winter prices exhibit a two-hump price pattern, prices during the summer months peak only once during the day – typically in the late afternoon between 4 p.m. to 6 p.m. during the hottest part of the day. Similar to the wintertime, prices are at a minimum in the middle of the night.

GTMax-Lite Model

Western and Argonne National Laboratory simulated Glen Canyon hydropower plant operations on an hourly time step the with the GTMax-Lite modeling software. GTMax-Lite is similar to the full version of the GTMax model except it only contains those features that are required to perform an economic evaluation of Shortage Criteria alternatives. Model run time and data transfers are significantly shorter, while a level of simulation accuracy equivalent to the full version is retained.

The GTMax-Lite objective function is to produce an hourly generation schedule over a one (1) week time period that maximizes the economic value of the hydropower resource. Market prices input into the model convey the economic value of hydropower generation. These prices heavily influence the generation schedule produced by the model when optimizing the hydropower plant resource. To the extent possible the GTMax-Lite model uses its limited energy resource to first generate electricity during on-peak hours when it has the highest economic value. Any remaining energy is scheduled during lower-priced hours.

Glen Canyon power plant operations are subject to a set of constraints. These include a physical operating capability and a limit on the total weekly electricity production. As described in previous sections, these constraints are consistent with CRSS model results. In addition to physical operating constraints, the GTMax-Lite model also complies with the ROD Criteria. Table 2 contains the GTMax-Lite mathematical formulations consisting of an objections function and a set of operating constraints.

Figure 3
December AURORA Prices Scaled to the Dow Jones Monthly Average

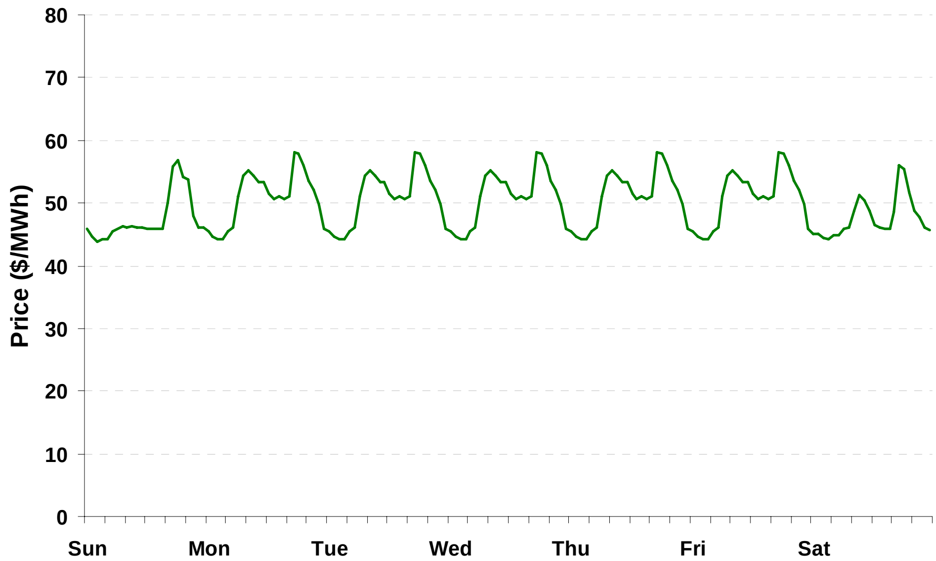


Figure 4
July AURORA Prices Scaled to the Dow Jones Monthly Average

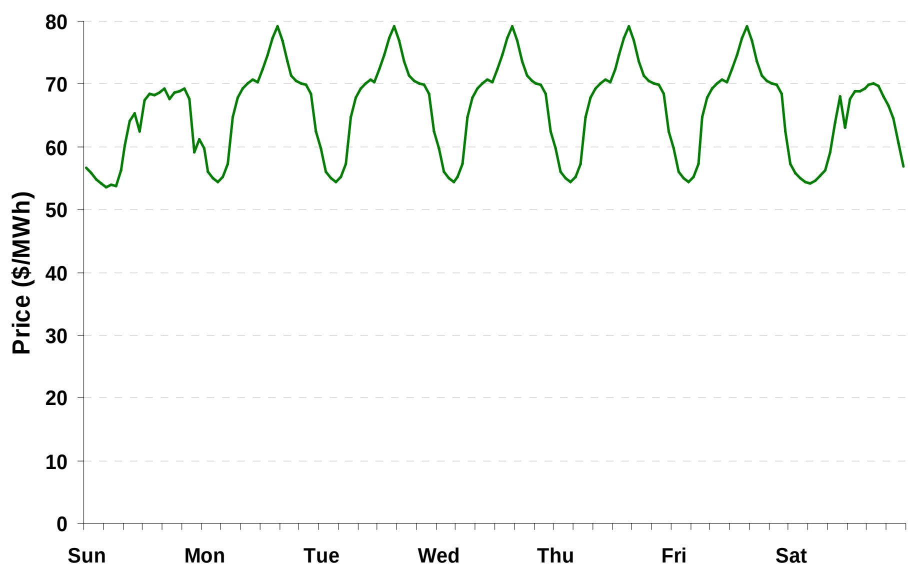


Table 2
GTMax-Lite Equations

Description	GTMax-Lite Equation
Objective Function	$Maximize: \quad SP_h \times Gen_h \quad \forall\ h \mid h = 1,...,168$
Maximum Hourly Generation	$Gen_h \le C_w^{pow} \quad \forall\ h \mid h = 1,...168$
Weekly Generation	$WGen_w = \sum_{h=1}^{168} Gen_h$
Maximum Daily Change	$DC_w^{pow} \ge Gen_{j+k-wrap} - Gen_j \quad \forall\ j \mid j = 1,...,168$ and for each $j,\ k = 1,...,23$ $when\ j + k > 168,\ wrap = j + k - 168\ else\ wrap = 0$
Hourly Up-Ramp Rate Limit	$HU_w^{pow} \ge Gen_h - Gen_{h-1+Wrap} \quad \forall\ h \mid h = 1,...168$ when $h > 1$ $wrap = 0$ else $wrap = 168$
Hourly Down-Ramp Rate Limit	$HD_w^{pow} \ge Gen_{h-1+wrap} - Gen_h \quad \forall\ h \mid h = 1,...168$ when $h > 1$ $wrap = 0$ else $wrap = 168$
Minimum Daytime Release	$MD_w^{pow} \le Gen_h \quad \forall\ h \mid h = 1,...,7,20,...,31,44,...,55,68,...,79,92,...,103,116,...,127,140,...,151,164,...168$
Minimum Nighttime Release	$MN_w^{pow} \le Gen_h \quad \forall\ h \mid h = 8,...,19,32,...,43,56,...,67,80,...,91,104,...,115,128,...,139,152,...,163$
Daily Generation	$DGen_d = \sum_{i=1}^{24} Gen_{(d-1)\times 24+i} \quad \forall d \mid d = 1,...,7$
Minimum Daily Generation for Weekend Days	$DGen_d \ge DGen_2 \times DMin_d \quad \forall d \mid d = 1,7$
Identical Weekday Total Generation Levels	$DGen_2 = DGen_d \quad \forall d \mid d = 3,4,5$

where,

$h =$ Simulation hour index

$d =$ Simulation day index where 1=Sun, 2= Mon, etc.

$wrap =$ index parameter to address temporal boundary conditions

$Gen_h =$ Average generation level (MWh) during hour h

$SP_h =$ Spot market price index ($/MWh) for hour h

$WGen_w =$ Total generation (MWh) during week w

$DGen_d =$ Total generation (MWh) during day d

$DMin_d =$ Minimum daily generation fraction for day d (see Table X)

In practice, hydropower plant operations do not always strictly follow an economic optimization regime as suggested by mathematical models. This occurs because models are a simplification of reality and typically only include those elements that can be described in the form of in mathematical equations. In GTMax-Lite, equations are used to model the power plant based on an economic maximization function subject to physical and legal operating limits. However, marketers must often include other important factors which result in operations that often deviate from the simplified mathematical optimal. Some of these factors include individual risk tolerance levels and intricacies associated with bilateral contracts, block spot purchase patterns, grid limitations, and power exchanges and interchanges. Other factors not included in GTMax-Lite are general agreements that have been made with affected parties, but that are not contained in a legally binding decree.

Despite its limitations, the GTMax-Lite model usually simulates daily and hourly generation patterns that are similar to actual operations. However, compared typical operations, the GTMax-Lite model will at times schedule less power during the weekend when market prices are low, shifting more power to higher-priced weekdays. Although operations comply with ROD constraints, the GTMax-Lite schedule may have some detrimental implications for the environment. Therefore, additional constraints that specify a minimum allocation of daily generation among the days of the weeks are incorporated into the GTMax-Lite mathematical formulation.

Daily minimums are specified as the ratio of daily generation during a weekend day relative to the average daily generation during a weekday. For example, a value of 0.9 assigned to Saturday requires that the total generation during that day must be at least 90 percent of a weekday's generation. Values assigned to the daily generation restrictions are based on historical operations and vary by month as shown in Table 3. Minimum daily generation levels are often not binding in the model and water releases scheduled by GTMax-Lite on Saturday and Sunday frequently are more than the minimum.

Table 3
Daily Generation Fractions for Weekend Days

Month	Sunday	Saturday
January	0.86349	0.88511
February	0.86861	0.94269
March	0.90666	0.94367
April	0.91358	0.98481
May	0.93182	0.95657
June	0.86247	0.89126
July	0.94368	0.96479
August	0.92117	0.94085
September	0.95205	0.96890
October	0.97621	0.97621
November	0.94810	0.98237
December	0.90623	0.96419

Glen Canyon power plant operations simulated by GTMax-Lite under median hydrological conditions for a typical week in the wintertime, 2nd week in December, 2010, are depicted in Figure 5. To maximize the economic value of the hydropower resource, the model generates as much power as possible during hours when market prices are the highest. Generation tends to drop as the spot price decreases; for example, during the midday price valley. Generation during on-peak hours are constrained by the ROD daily change, reaching a peak of about 610 megawatts (MW). That is substantially less than (approximately half) the median capability of 1,205 megawatts (MW) estimated by CRSS based on the Powell Reservoir forebay elevation.

Simulated operations during the summertime also tend to follow prices. As shown in Figure 6, Glen Canyon generation exhibits a one-hump pattern that has a shape similar to the market price profile. Simulated operations are for July 2010 under median conditions. Comparable to the wintertime, peak generation levels are constrained to slightly more than 600 megawatts (MW) despite a hydrological head that is capable of supporting generation levels of approximately 1,232 MW.

Figure 5
Glen Canyon Power Plant Operations under Median Winter Conditions

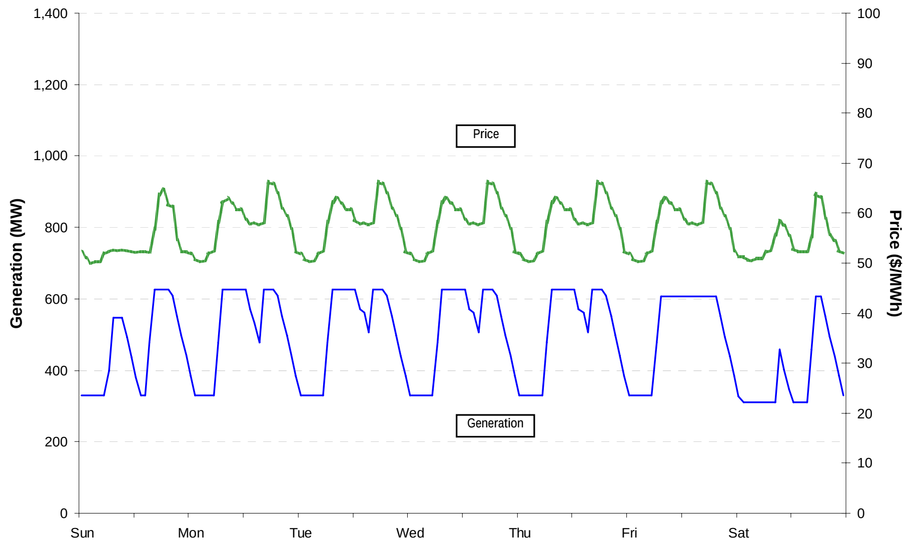
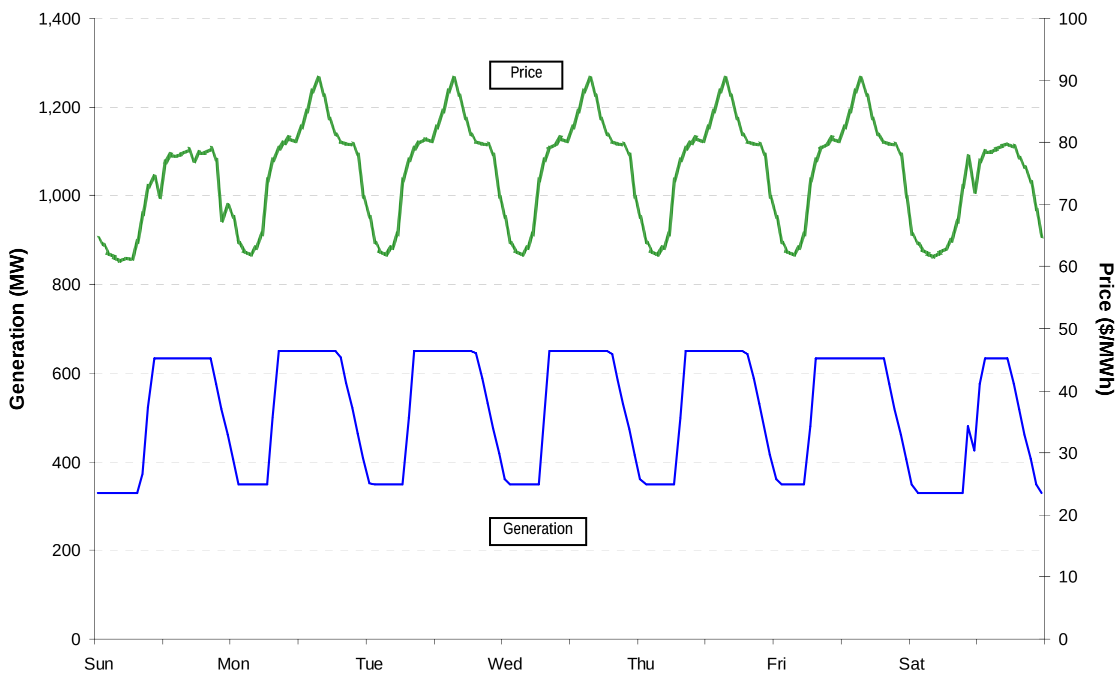
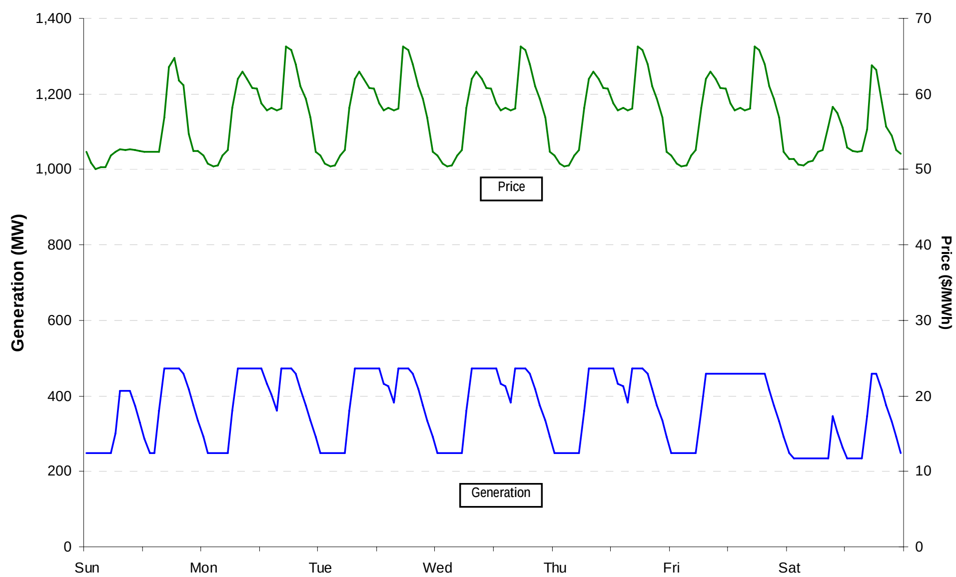


Figure 6
Glen Canyon Power Plant Operations under Median Summer Conditions



Under dry hydrological conditions, the maximum generation levels simulated by GTMax-Lite drop even further. Figure 7 shows that on-peak production levels are less than 475 MW. Under the driest conditions, forebay elevations dip below turbine water inlet tubes resulting in zero monthly electricity generation and zero power plant capacity.

Figure 7
Glen Canyon Power Plant Operations under Dry Winter Conditions



Economic Calculations

The economic value of the Glen Canyon Dam energy is computed by multiplying power plant generation estimated by GTMax-Lite by the market price. Since the model only simulates operations for one representative week in each month, economic values are scaled. This scaling factor equals the number of days in a projection month divided by 7. A net present value (NPV) of the monthly economic values over the study period was calculated by discounting monthly values at an annual rate of 4.875 percent. When discounting, it was assumed that the stream of hourly economic benefits in a month occurred mid-month as a single lump-sum value.

Differences in annual energy and capacity generation were calculated between the No Action Alternative and each Action Alternative. The annual capacity difference in terms of megawatts was assigned a value using a capacity price of $6.32/kilowatt-month. That price represents the market value of generation in 2007 dollars. For valuing capacity, Western obtained a cost of constructing a new combined cycle natural gas power plant. Capacity was valued at the replacement cost identified by some SLCA/IP customer utilities who have recently constructed facilities which provide load following capacity. These customer data were collected in order to get information regarding the construction cost per megawatt of a recently built facility that provides electrical services similar to the GCD power plant.

This value is higher than the average cost of capacity from existing facilities on the system, but was selected for two reasons. (1) Over the 53-year study period, available capacity from existing sources will not be adequate to serve growing loads. New capacity will have to be built. (2) Renewable resource requirements in states such as California could cause new capacity costs to escalate at a rate faster than the 2.2 percent assumed in this analysis.

The two Western offices performing analyses coordinated capacity values, so the same capacity values were used for GCD and for the Lower Basin power plants.

Capacity values were converted to a present value using the same method as for energy, and were then added to the energy present value to obtain a total value of the difference in generation between the No Action alternative and each Action alternative. Reclamation did not value capacity differences in their analysis.

Results of Western's Analysis

Western Area Power Administration's financial analysis of the alternatives concentrated on the effect each alternative has on energy generation and capacity generation at Glen Canyon Dam (GCD). The effects are measured by the difference in generation in gigawatthours (GWh) of energy and megawatts (MW) of capacity between the No Action alternative and each of the Action alternatives, for the five representative hydrological conditions outlined above. The analysis includes the economic effect of changes to capacity and energy calculated by applying energy and capacity costs to the changes in generation. Finally, a net present value calculation was performed to develop a single value to compare each Action alternative to No Action. The sections below break down the results of the analysis into each of the aspects studied.

Glen Canyon Dam Energy Generation

The energy generation at GCD for each alternative was summed over the 53-year study (2008-2060) period and is displayed in Table 4 below in GWh. (One GWh is equal to 1 million kilowatt hours.) The difference in generation of the Action alternatives as compared to No Action is shown in Table 5. Table 6 has those same differences as percentages.

Table 4
Energy Generation

Alternatives	Mean (GWh)	Median (GWh)	90% Exceed. (GWh)	Trace 94 (GWh)	10% Exceed. (GWh)
No Action	4,247.88	3,748.42	3,130.88	4,300.57	6,312.73
Basin States	4,244.28	3,799.64	3,038.20	4,419.71	6,274.71
Conservation Before Shortage	4,244.89	3,798.99	3,037.97	4,420.09	6,276.28
Water Supply	4,138.76	3,783.26	2,904.22	4,366.65	6,214.02
Reservoir Storage	4,281.05	3,768.78	3,134.48	4,320.29	6,374.22
Preferred Alternative	4,251.34	3,794.67	3,055.75	4,420.69	6,286.12

Table 5
Change in Energy Generation

Alternatives	Mean (GWh)	Median (GWh)	90% Exceed. (GWh)	Trace 94 (GWh)	10% Exceed. (GWh)
No Action	0.00	0.00	0.00	0.00	0.00
Basin States	(3.61)	51.21	(92.68)	119.14	(38.02)
Conservation Before Shortage	(2.99)	50.57	(92.91)	119.52	(36.45)
Water Supply	(109.12)	34.83	(226.66)	66.08	(98.71)
Reservoir Storage	33.17	20.36	3.60	19.71	61.49
Preferred Alternative	3.46	46.25	(75.13)	120.12	(26.61)

Table 6
Percent Change in Energy Generation

Alternatives	Mean (percent)	Median (percent)	90% Exceed. (percent)	Trace 94 (percent)	10% Exceed. (percent)
No Action	0.00%	0.00%	0.00%	0.00%	0.00%
Basin States	-0.06%	0.97%	-2.11%	2.06%	-0.44%
Conservation Before Shortage	-0.05%	0.96%	-2.12%	2.06%	-0.42%
Water Supply	-1.84%	0.66%	-5.17%	1.14%	-1.13%
Reservoir Storage	0.56%	0.39%	0.08%	0.34%	0.71%
Preferred Alternative	0.06%	0.88%	-1.71%	2.07%	-0.31%

Glen Canyon Dam Capacity Generation

Generation of capacity at GCD was calculated and averaged over the same study period as shown in Table 7. The numbers in the table represent the average peak capacity output of GCD in megawatts, and is much lower than the power plant capability based on lake elevation. Table 8 displays the difference between each alternative and the No Action alternative. Table 9 has those same differences as percentages.

Table 7
Average Capacity Generation

Alternatives	Mean (Megawatts)	Median (Megawatts)	90% Exceed. (Megawatts)	Trace 94 (Megawatts)	10% Exceed. (Megawatts)
No Action	606.21	546.21	450.85	598.68	838.76
Basin States	605.33	552.25	435.73	616.66	837.98
Conservation Before Shortage	605.43	552.31	435.84	616.57	838.03
Water Supply	589.72	549.92	416.94	608.19	829.11
Reservoir Storage	611.02	549.08	448.30	600.51	845.51
Preferred Alternative	606.40	551.71	438.44	616.30	839.00

Table 8
Change in Capacity Generation

Alternatives	Mean (Megawatts)	Median (Megawatts)	90% Exceed. (Megawatts)	Trace 94 (Megawatts)	10% Exceed. (Megawatts)
No Action	0.00	0.00	0.00	0.00	0.00
Basin States	(0.88)	6.04	(15.12)	17.97	(0.79)
Conservation Before Shortage	(0.79)	6.09	(15.01)	17.88	(0.74)
Water Supply	(16.50)	3.71	(33.91)	9.51	(9.65)
Reservoir Storage	4.81	2.87	(2.55)	1.83	6.75
Preferred Alternative	0.18	5.49	(12.41)	17.62	0.24

Table 9
Percent Change in Capacity Generation

Alternatives	Mean (percent)	Median (percent)	90% Exceed. (percent)	Trace 94 (percent)	10% Exceed. (percent)
No Action	0.00%	0.00%	0.00%	0.00%	0.00%
Basin States	-0.01%	0.11%	-0.34%	0.31%	-0.01%
Conservation Before Shortage	-0.01%	0.12%	-0.34%	0.31%	-0.01%
Water Supply	-0.28%	0.07%	-0.77%	0.16%	-0.11%
Reservoir Storage	0.08%	0.05%	-0.06%	0.03%	0.08%
Preferred Alternative	0.00%	0.10%	-0.28%	0.30%	0.00%

Present Value of Energy

The NPV of energy generation at GCD was calculated for each Alternative at each hydrological condition. Each of the Action alternatives was compared to the No Action alternative to determine the difference in NPV of energy generation in GWh over the study period. Table 10 shows the NPV of each alternative studied. Table 11 displays the difference between each of the Action alternatives and the No Action alternative. Table 12 has those same differences as percentages.

Table 10
Present Value of Energy

Alternatives	Mean ($ million)	Median ($ million)	90% Exceed. ($ million)	Trace 94 ($ million)	10% Exceed. ($ million)
No Action	$5,939.86	$5,252.65	$4,386.68	$5,795.48	$8,714.88
Basin States	$5,940.86	$5,358.48	$4,215.65	$6,060.69	$8,653.00
Conservation Before Shortage	$5,941.74	$5,356.91	$4,215.84	$6,063.47	$8,655.34
Water Supply	$5,806.84	$5,347.08	$4,040.81	$5,969.16	$8,583.61
Reservoir Storage	$5,992.13	$5,286.84	$4,362.82	$5,844.29	$8,806.41
Preferred Alternative	$5,950.84	$5,345.64	$4,242.91	$6,062.95	$8,669.97

Table 11
Change in Present Value of Energy

Alternatives	Mean ($ million)	Median ($ million)	90% Exceed. ($ million)	Trace 94 ($ million)	10% Exceed. ($ million)
No Action	$0.00	$0.00	$0.00	$0.00	$0.00
Basin States	$1.01	$105.83	($171.03)	$265.22	($61.88)
Conservation Before Shortage	$1.88	$104.26	($170.84)	$267.99	($59.54)
Water Supply	($133.02)	$94.43	($345.87)	$173.68	($131.27)
Reservoir Storage	$52.27	$34.18	($23.86)	$48.81	$91.53
Preferred Alternative	$10.99	$92.99	($143.77)	$267.48	($44.91)

Table 12
Percent Change in Present Value of Energy

Alternatives	Mean (percent)	Median (percent)	90% Exceed. (percent)	Trace 94 (percent)	10% Exceed. (percent)
No Action	0.00%	0.00%	0.00%	0.00%	0.00%
Basin States	0.02%	2.01%	-3.90%	4.58%	-0.71%
Conservation Before Shortage	0.03%	1.98%	-3.89%	4.62%	-0.68%
Water Supply	-2.24%	1.80%	-7.88%	3.00%	-1.51%
Reservoir Storage	0.88%	0.65%	-0.54%	0.84%	1.05%
Preferred Alternative	0.18%	1.77%	-3.28%	4.62%	-0.52%

Present Value of Capacity and Energy and Capacity Combined

Tables 14 and 15 display the combined change in NPV of energy and capacity shown in Table 13 below in dollars and percent, respectively. Tables 16 and 17 display the change in capacity as compared to the values displayed in Table 10 above, respectively.

Table 13
Present Value of Energy and Capacity

Alternatives	Mean ($ million)	Median ($ million)	90% Exceed. ($ million)	Trace 94 ($ million)	10% Exceed. ($ million)
No Action	$7,350.02	$6,522.54	$5,435.79	$7,136.61	$10,663.23
Basin States	$7,351.72	$6,649.12	$5,223.01	$7,464.80	$10,602.68
Conservation Before Shortage	$7,352.88	$6,647.62	$5,223.62	$7,467.32	$10,605.33
Water Supply	$7,184.30	$6,634.62	$5,009.62	$7,344.81	$10,511.84
Reservoir Storage	$7,414.74	$6,564.24	$5,400.48	$7,192.02	$10,771.63
Preferred Alternative	$7,364.28	$6,633.98	$5,257.20	$7,465.98	$10,622.62

Table 14
Change in Present Value of Energy and Capacity

Alternatives	Mean ($ million)	Median ($ million)	90% Exceed. (($ million)	Trace 94 ($ million)	10% Exceed. ($ million)
No Action	$0.00	$0.00	$0.00	$0.00	$0.00
Basin States	$1.70	$126.57	($212.78)	$328.19	($60.55)
Conservation Before Shortage	$2.86	$125.07	($212.17)	$330.72	($57.90)
Water Supply	($165.72)	$112.08	($426.17)	$208.20	($151.39)
Reservoir Storage	$64.72	$41.70	($35.31)	$55.42	$108.40
Preferred Alternative	$14.26	$111.43	($178.60)	$329.37	($40.61)

Table 15
Percent Change in Present Value of Energy and Capacity

Alternatives	Mean (percent)	Median (percent)	90% Exceed. (percent)	Trace 94 (percent)	10% Exceed. (percent)
No Action	0.00%	0.00%	0.00%	0.00%	0.00%
Basin States	0.02%	1.94%	-3.91%	4.60%	-0.57%
Conservation Before Shortage	0.04%	1.92%	-3.90%	4.63%	-0.54%
Water Supply	-2.25%	1.72%	-7.84%	2.92%	-1.42%
Reservoir Storage	0.88%	0.64%	-0.65%	0.78%	1.02%
Preferred Alternative	0.19%	1.71%	-3.29%	4.62%	-0.38%

Table 16
Change in Present Value of Capacity

Alternatives	Mean ($ million)	Median ($ million)	90% Exceed. ($ million)	Trace 94 ($ million)	10% Exceed. ($ million)
No Action	$0.00	$0.00	$0.00	$0.00	$0.00
Basin States	$0.69	$20.74	($41.75)	$62.97	$1.33
Conservation Before Shortage	$0.98	$20.81	($41.34)	$62.73	$1.64
Water Supply	($32.69)	$17.65	($80.30)	$34.52	($20.12)
Reservoir Storage	$12.45	$7.52	($11.45)	$6.60	$16.87
Preferred Alternative	$3.28	$18.44	($34.83)	$61.90	$4.30

Table 17
Percent Change in Present Value of Capacity

Alternatives	Mean (percent)	Median (percent)	90% Exceed. (percent)	Trace 94 (percent)	10% Exceed. (percent)
No Action	0.00%	0.00%	0.00%	0.00%	0.00%
Basin States	0.01%	0.39%	-0.95%	1.09%	0.02%
Conservation Before Shortage	0.02%	0.40%	-0.94%	1.08%	0.02%
Water Supply	-0.55%	0.34%	-1.83%	0.60%	-0.23%
Reservoir Storage	0.21%	0.14%	-0.26%	0.11%	0.19%
Preferred Alternative	0.06%	0.35%	-0.79%	1.07%	0.05%

Impact to Western Area Power Administration's SLCA/IP Firm Power Rate

Western performed a rate analysis of the present value results summarized in Table 13 above. Table 18 shows the results of the analysis on the SLCA/IP firm power rate, while Table 19 shows the difference of each alternative as compared to the No Action alternative, both in mills/kWh and in percent change. Because of time constraints, the rate analysis was confined to the Median and 90 percent exceedence hydrological conditions. (The 90 percent exceedence No Action SLCA/IP rate is a cursory study meant to illustrate the higher rate at low hydrologic levels. It shouldn't be mis-interpreted as the result of a thorough rate PRS.) An explanation of the methodology Western used to perform the rate analysis is presented below in Tables 18 and 19.

Table 18
SLIP Firm Power Rate

Alternatives	Median (Mill/kWh)	90% Exceed. (Mill/kWh)
No Action	25.28	27.34
Basin States	23.39	31.17
Conservation Before Shortage	23.41	31.17
Water Supply	23.17	30.83
Reservoir Storage	24.89	29.01
Preferred Alternative	23.65	31.17

Table 19
Change in SLIP Firm Power Rate

Alternatives	Median (Mill/kWh)	Median (percent)	90% Exceed. (Mill/kWh)	90% Exceed. (percent)
No Action	0.00	0.00%	0.00	0.00%
Basin States	(1.89)	-7.48%	3.83	14.01%
Conservation Before Shortage	(1.87)	-7.40%	3.83	14.01%
Water Supply	(2.11)	-8.35%	3.49	12.77%
Reservoir Storage	(0.39)	-1.54%	1.67	6.11%
Preferred Alternative	(1.63)	-6.45%	3.83	14.01%

Customer Rates

Western sets rates for firm electric service from Federal hydropower projects in its marketing territory based on Department of Energy regulations and applicable Federal statutes. Power rates are calculated using what is referred to as a power repayment study. The PRS is a special spreadsheet-based computer program that contains the general and any specific repayment rules associated with a particular hydro project such as the SLCA/IP. (The SLCA/IP comprises the Colorado River Storage Project [CRSP], Rio Grande, Collbran, Dolores, and Seedskadee Projects, consolidated for marketing and ratemaking purposes.) When coupled with pertinent project historical data and future projections, the PRS calculates the power rate that is charged to customers who receive SLCA/IP power. The PRS ensures that all identified project costs are repaid within the time frames established by law and regulation.

For the rate analysis work done for this report, two base case PRS's were developed. The two base cases correspond to the power rates for the No Action alternatives at Median and 90 percent Exceedence hydrological conditions. The first is basically the same as the PRS Western used for its current firm power rate. This case is based on Median hydrological conditions, meaning that it includes firming purchase cost estimates for future years based on Median generation estimates. The second base case is the same as the first, except that future firming purchase estimates are based on 90 percent exceedence (10th percentile) estimates of future generation, and firming purchases.

These two base case PRS's produce a rate of 25.28 mills per KWh (Median) and 27.34 mills per KWh (90 percent exceedence). Once the base case PRS's are done, the difference in NPV dollars of each Action alternative as compared to the No Action alternative is inserted into the PRS's and a change in the power rate is computed. These PRS results are what are displayed in Tables 5 and 5a above.

Discussion of Results

Overall, at all hydrological conditions, the Reservoir Storage alternative provides the most favorable conditions for power at GCD, while the Water Supply alternative provides the worst results for power generation, based on the above financial analysis. The Basin States, and Conservation Before Shortage alternatives and the Preferred Alternative show similar results and are ranked between the Reservoir Storage alternative and the Water Supply alternative in their effect on power resources at GCD.

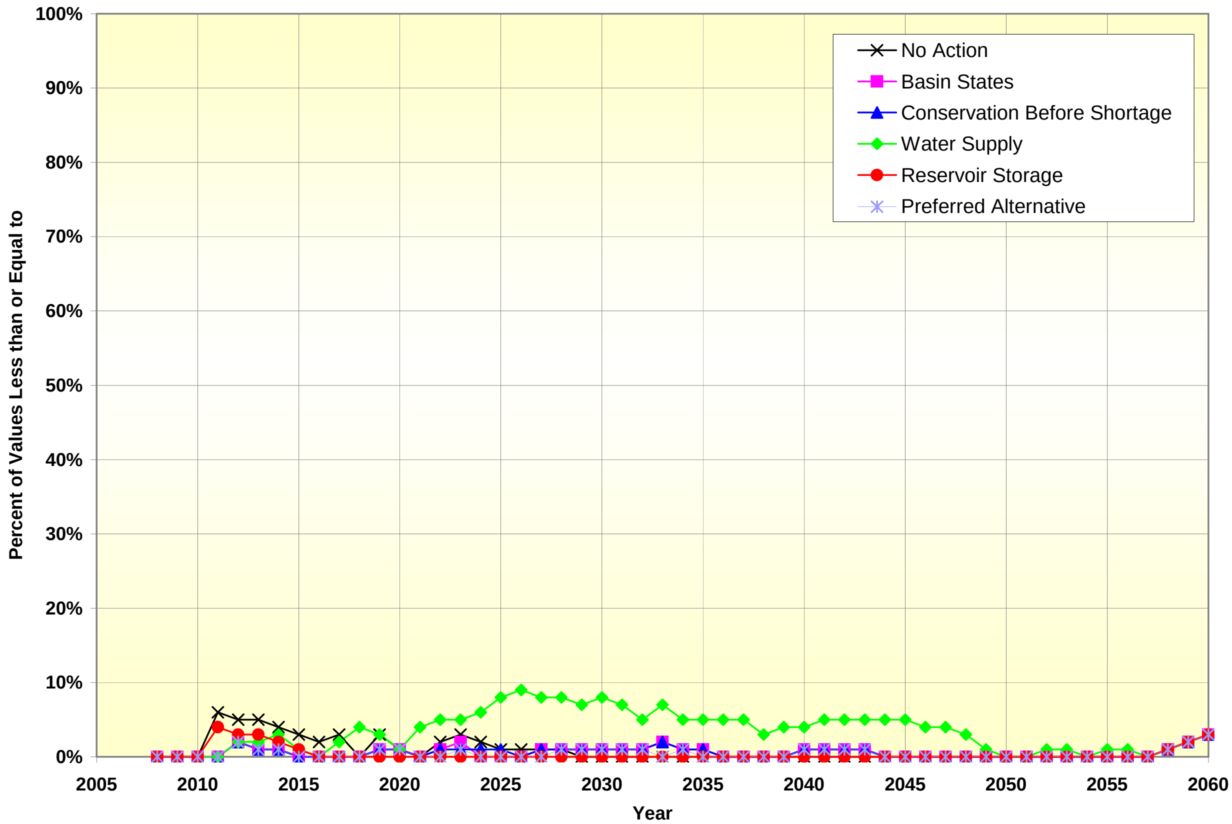
One result is common to Table 19 as well in the preceding tables. At 90 percent exeedence level, the Action Alternatives show consistently worse results (lower energy and capacity generation, lower NPV, higher SLCA/IP rate) than the No Action alternative. Likewise, at Median conditions, the Action alternatives show better results than the No Action alternative. Results at the Mean conditions are more mixed, with some results being better under No Action, and others at one or more of Action alternatives. Trace 94 shows consistent improvement in results of the Action alternatives as compared to No Action. The 10 percent exceedence cases show a lower present value in four of the five alternatives as compared to the No Action alternative, with only the Reservoir Storage alternative showing improvement. At the high levels of generation and revenues represented in the 10 percent exceedence case, the loss of generation in the action alternatives as compared to the No Action alternative is inconsequential to SLCA/IP financial health.

The practical effect of Action alternatives is to produce a widening effect on power generation, revenues, and rates as hydrological conditions range from wet to dry and back to wet. As conditions get drier, generation drops more under the Action alternatives as compared to No Action. Conversely, as conditions go from drier to wetter, generation improves more under the Action alternatives as compared to No Action. This could result in more variation in the CRSP Basin Fund cash reserves, and could lead to additional actions, such as power rate adjustments, rate surcharges, or reductions to customer allocations to respond to shortfalls in revenue under dry conditions. Under the Action alternatives, Western and its power customers would need to quickly respond to changing hydrological conditions to forestall financial problems.

Notwithstanding the financial analysis discussed above, the most important aspect of any of the Action alternatives to Western and the firm power customers is whether and how much the alternative reduces the probability of a total loss of generation from GCD. Loss of GCD generation would result in a huge loss of revenue to Western, Reclamation, and various environmental programs in the Upper Basin; loss of generation and replacement costs for power customers; and degradation to power system reliability.

Figure 8 on the following page is a graph showing the percentage of trace monthly elevations from Reclamation's CRSS modeling output that are less than or equal to elevation 3490'. This graph is an indicator of how well each alternative is able to forestall a shutdown of GCD generation as compared to the No Action alternative.

Figure 8
Lake Powell End-of-March Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Less than or Equal to Elevation 3,490 feet msl



Using this measure, the Water Supply alternative is worse than the No Action alternative, while the Reservoir Storage, Basin States, and Conservation before Shortage alternatives and the Preferred Alternative are equal to or better than No Action.

References Cited

Electric Power Information Solutions, Inc. *AURORA—Software for Forecasting Electric Market Price and Value.* West Linn, Oregon: EPIS, Inc. 2005.

Northwest Power and Conservation Council. *Fifth Northwest Electric Power and Conservation Plan.* Portland, Oregon: Northwest Power and Conservation Council. May 2005. Available from http://www.nwcouncil.org/energy/powerplan/plan/Default.htm .

Ouarda, Taha B.M.J. John W. Labadie and Darrell G. Fontane. "Indexed Sequential Hydrologic Modeling for Hydropower Capacity Estimation." *Journal of the American Water Resources Association.* 33 No. 6 (December 1997):1337-1349.

Appendix P

Additional CRSS Modeling Output

This appendix contains additional supporting CRSS modeling output and hydrologic information. Hydrologic information provided in this appendix is referenced in the Hydrologic Resources, Water Deliveries, Water Quality, Air Quality, Biological Resources, Cultural Resources, and Electrical Power Resources sections of the EIS.

Table of Contents

Hydrologic Resources Information

List of Figures

List of Tables

Water Deliveries information

List of Figures

List of Tables

Water Quality and Air Quality Information

List of Figures

Biological Resources and Cultural Resources Information

List of Figures

List of Tables

Electrical Power Resources Information

List of Figures

Hydrologic Resources Information

This section contains additional information that was used in the hydrologic analysis (Section 4.3 of this Final EIS). The specific information provided in this section consists of a series of figures that provide comparisons of Lake Powell and Lake Mead under the modeled action alternatives to those under the modeled No Action Alternative. Also, this section contains the results of analysis that compares the probability of Beach/Habitat Building Flow release from Glen Canyon Dam under the No Action Alternative to the action alternatives.

Figure P-HR-1
Lake Powell Annual Evaporation
Comparison of Action Alternatives to No Action Alternative
Average Values

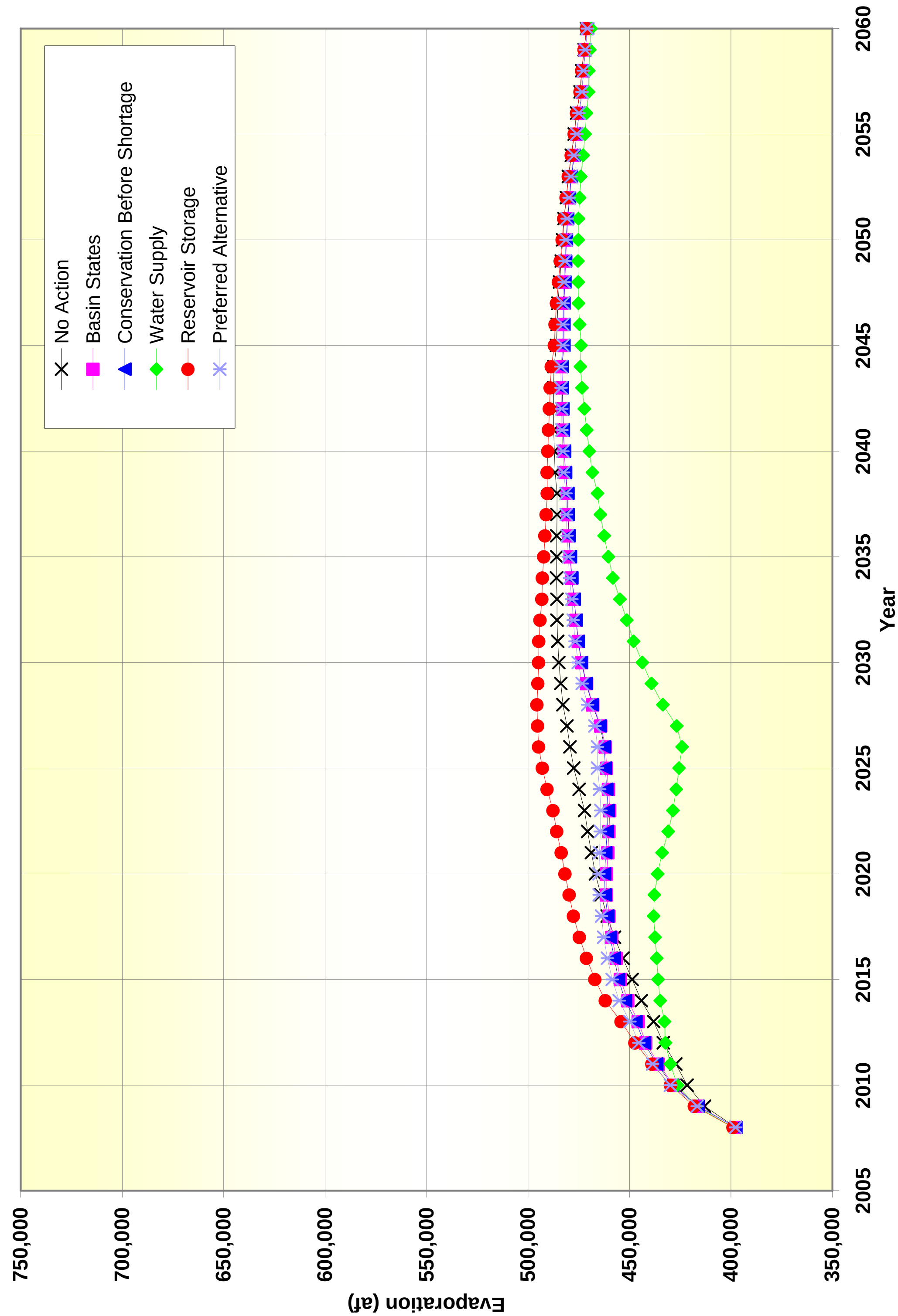


Figure P-HR-2
Lake Powell Annual Evaporation
Comparison of Action Alternatives to No Action Alternative
Median Values (50th Percentile)

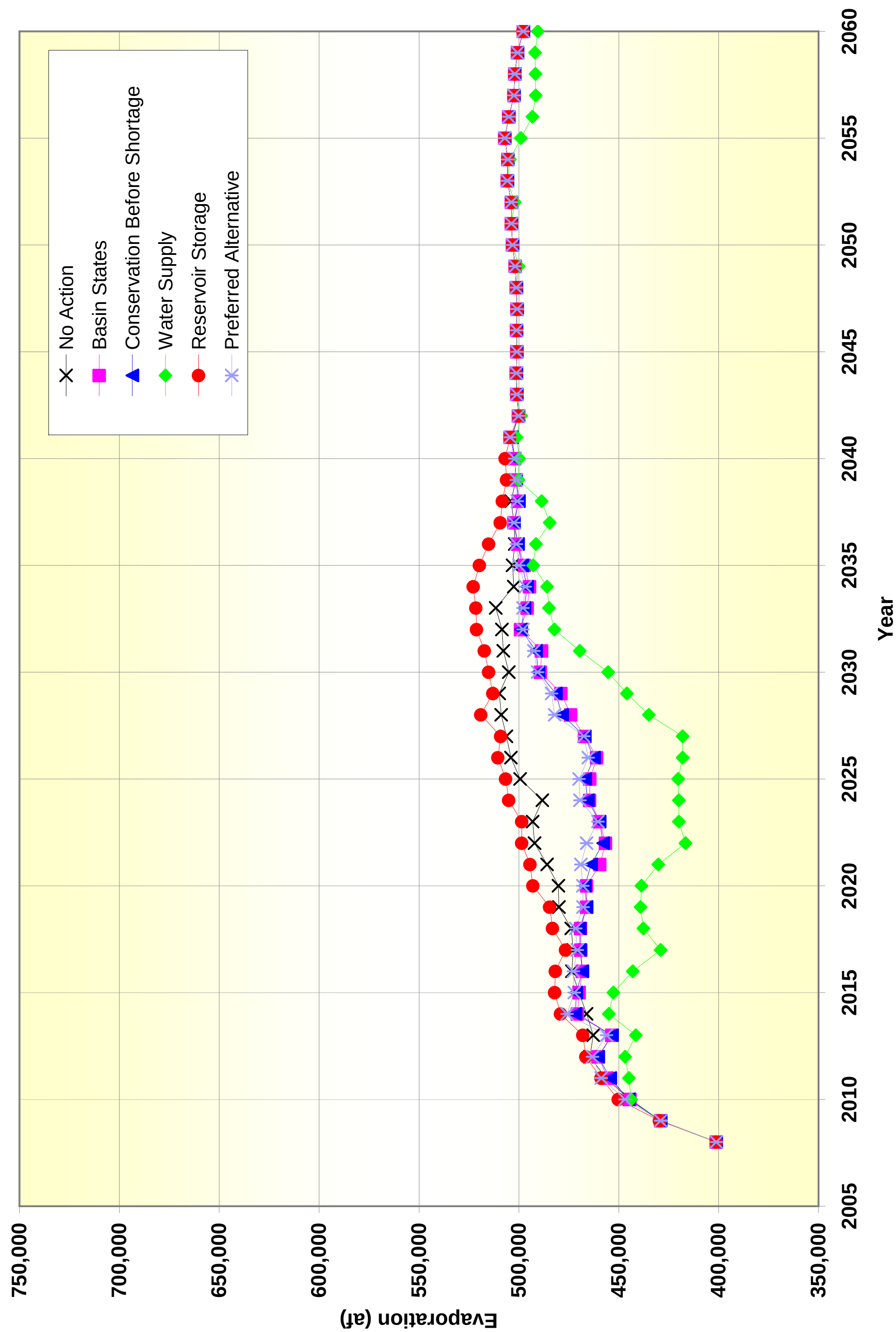


Figure P-HR-3
Lake Mead Annual Evaporation
Comparison of Action Alternatives to No Action Alternative
Average Values

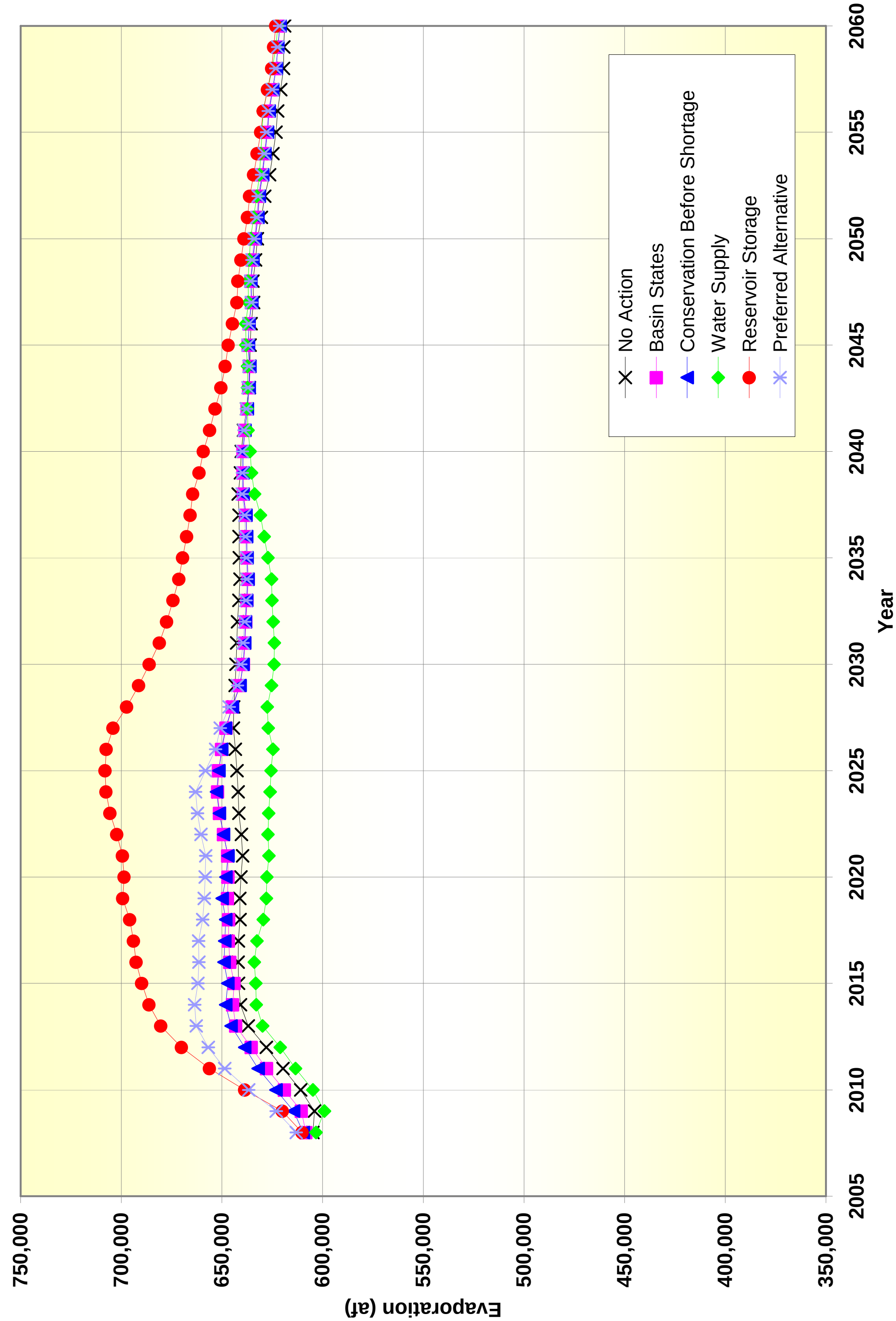
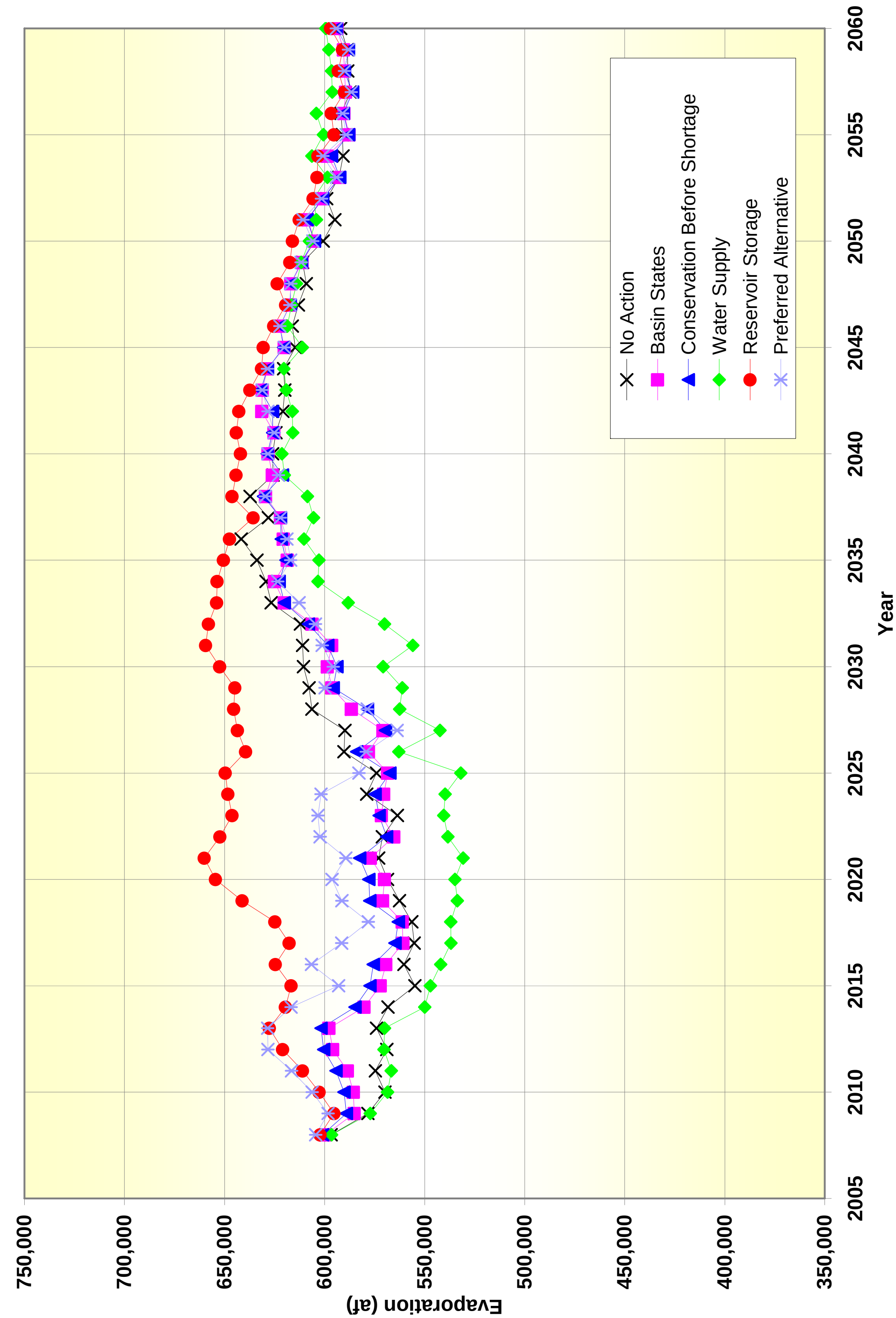


Figure P-HR-4
Lake Mead Annual Evaporation
Comparison of Action Alternatives to No Action Alternative
Median Values (50th Percentile)



P-HR.1 Beach/Habitat-Building Flows

P-HR.1.1 Introduction

The construction and operation of Glen Canyon Dam has caused two major changes related to sediment resources downstream in Glen Canyon and Grand Canyon. The first change is reduced sediment supply. Because Glen Canyon Dam and Lake Powell trap virtually all of the incoming sediment from the Upper Basin, releases from Glen Canyon Dam are mostly as clear water. The second major change is the reduction in the high water zone from pre-dam annual flood elevations to powerplant release elevations. Thus, the height of annual sediment deposition and erosion in the Colorado River reaches downstream of Glen Canyon Dam has been reduced.

During the investigations leading to the preparation of the *Operation of Glen Canyon Dam Final EIS* (Reclamation 1995), the relationships between releases from Glen Canyon Dam and downstream sedimentation processes were brought sharply into focus, and flow patterns designed to conserve sediment for building beaches and habitat (i.e., beach/habitat-building flow, or BHBF releases) were identified. The BHBF releases are scheduled high releases of short duration that exceed the hydraulic capacity of the powerplant. Such releases were presented as a commitment in the 1996 ROD for the *Operation of the Glen Canyon Dam FEIS* (Reclamation 1996e), at a then-assumed frequency of one in five years.

In addition to these BHBF releases that exceed the hydraulic capacity of Glen Canyon Powerplant, the *Operation of Glen Canyon Dam FEIS* identified the need for Beach/Habitat Maintenance Flow (BHMF) releases which do not exceed the hydraulic capacity of the powerplant. These flows were designed to prevent backwater habitat from filling with sediment and to reduce vegetation on camping beaches in years between BHBFs. BHBF and BHMF releases serve as a tool for maintaining a mass balance of sediment in Glen Canyon and Grand Canyon.

P-HR.1.2 Methodology

The frequencies at which BHBF releases from Glen Canyon Dam would occur under the No Action Alternative and the action alternatives were estimated through the use of the Colorado River Simulation System (CRSS) and modeling as described in Section 4.2.3 of this Final EIS.

The model was configured to simulate BHBF releases by incorporating the BHBF hydrologic triggering criteria (contained in Section P-HR.1.3) into the Glen Canyon Dam operating rules. The model was also configured to make no more than one BHBF release in any given year.

P-HR.1.3 Existing Conditions

Sediment along the Colorado River downstream of Glen Canyon Dam is an important and dynamic resource which affects fish and wildlife habitat along the river, creates camping beaches for recreation, and serves to protect cultural resources. Except for remnants of high river terraces deposited prior to the closure of Glen Canyon Dam, the now-limited sediment supply that exists along the river channel is affected by Glen Canyon Dam operations.

Since construction of Glen Canyon Dam, the measured suspended sediment load (sand, silt, and clay) at Phantom Ranch (in the Grand Canyon) averages 11 million tons per year. Most of this load comes from the Paria River and the Little Colorado River. Flash floods from other side canyons also contribute to the sediment supply (Reclamation 1995). The suspended sediment load is sporadic in occurrence, depending on Glen Canyon Dam releases and tributary inputs.

Beneficial sediment mobilization and deposition downstream of Glen Canyon Dam depends on the interaction of two occurrences for full effectiveness: the addition of sediment to the river corridor and BHBF releases. The higher energy of BHBF releases mobilizes suspended and riverbed-stored sediment and deposits it as beaches in beach and shoreline areas. Once a BHBF release has been made, additional sediment supply from tributary inflows is needed before subsequent BHBF releases are fully effective in promoting further beach and sandbar deposition along the river.

Subsequent to the 1996 ROD, specific operating criteria were developed which further refined conditions under which BHBFs would be made. The criteria provide that under either of the following two triggering conditions, BHBF releases may be made from Glen Canyon Dam:

1) if the January forecast for the January-July unregulated spring runoff into Lake Powell exceeds 13 maf (about 140 percent of normal) when January 1 content is greater than 21.5 maf; or

2) any time a Lake Powell inflow forecast would require a monthly powerplant release greater than 1.5 maf.

Research concerning the relationships among dam operations, downstream sediment inflow, river channel and sandbar characteristics, and particle-size distribution along the river is ongoing.

P-HR.1.4 Modeling Results

The effects of the No Action Alternative and the action alternatives on BHBF releases from Glen Canyon Dam were analyzed in terms of the yearly frequency at which BHBF releases could be made. Specifically, the frequency was indicated by the occurrence of one or both of the triggering criteria cited above, during a calendar year. The following discussion presents probability of occurrence under the No Action Alternative, and then compares the probability of BHBF releases under each action alternative to the No Action Alternative.

Figure P-HR-5 shows the probabilities that BHBF releases could be made under the No Action Alternative and the action alternatives. This figure shows that in the initial two years of the modeling period (2008 and 2009), under the assumed hydrologic sequences and reservoir starting conditions, there is a zero probability of BHBF releases. From 2010 through about 2016, the probability of BHBF releases under the No Action Alternative increases each year to about ten percent. Between 2017 and 2039, the probability under the No Action Alternative varies between nine percent to 12 percent. Between 2040 and 2060, the probability under the No Action Alternative increases slightly and varies between nine percent to 15 percent.

The probability of BHBF releases under the Basin States, Conservation Before Shortage, and Water Supply Alternatives, and the Preferred Alternative, are similar to those observed under the No Action Alternative and differ no more than one percentage point in any one year. The exception to this occurs in 2042 when the probability under all of these alternatives is three percent lower than that of the No Action Alternative. This occurrence is the result of the relatively lower reservoir conditions in 2026 that occur under these alternatives.

The Reservoir Storage Alternative generally provides a higher probability of BHBF releases than the No Action Alternative and the other action alternatives between 2011 through 2045. This occurs due to the generally higher reservoir elevations that are provided under the Reservoir Storage Alternative. Because these elevations are higher than the first part of the BHBF release triggering criteria, The Reservoir Storage Alternative provides slightly higher probability for BHBF releases.

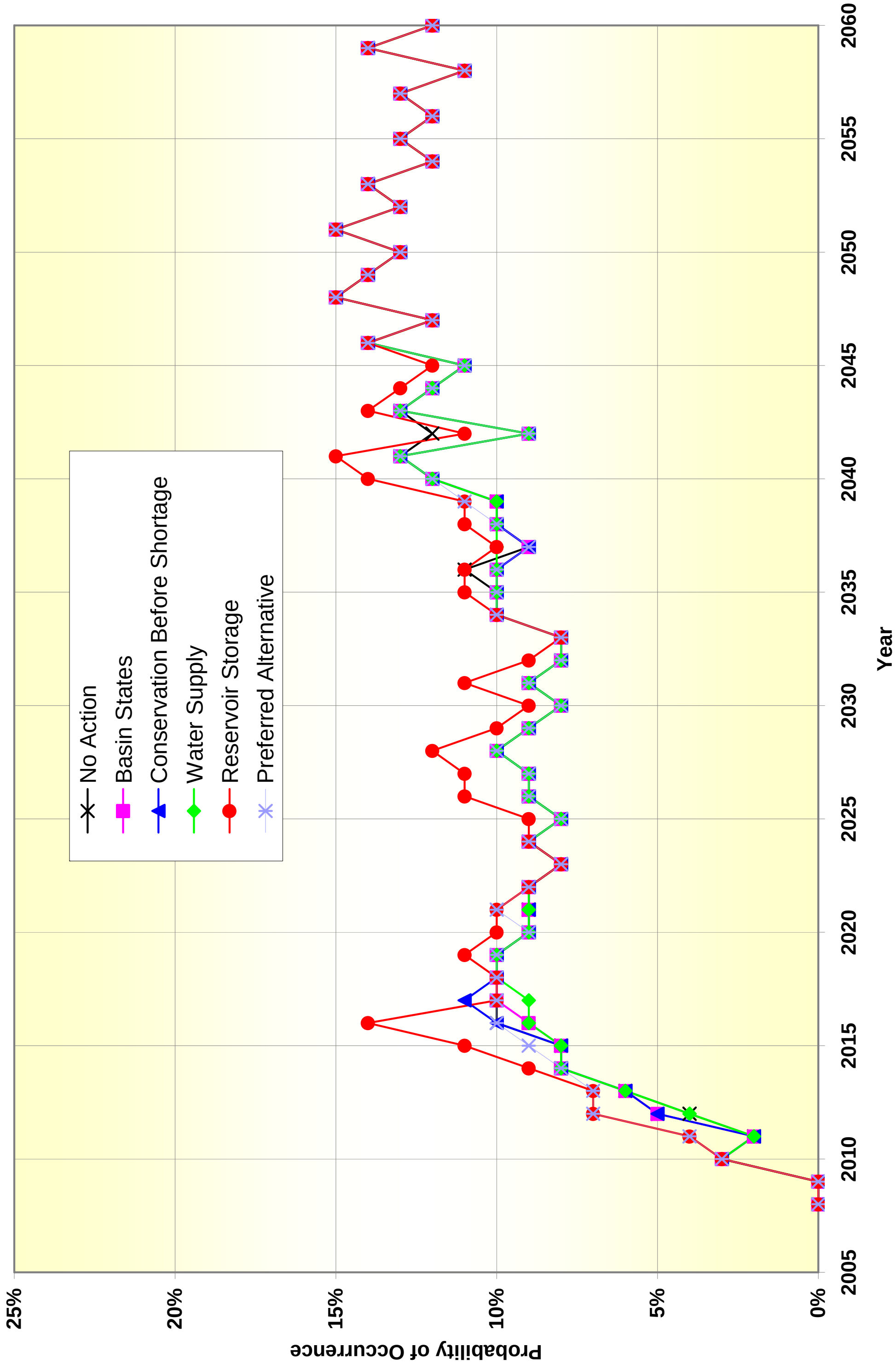
The probability of BHBF releases under the No Action Alternative and the action alternatives all converge in about 2046 and remain the same through 2060.

Table P-HR-1 summarizes the BHBF release probabilities during the interim period (2008 through 2026) and the subsequent period to 2060, based on the data plotted in Figure P-HR-5. The table reflects the higher average probability during the post-interim period than during the interim period due to the low reservoir starting conditions in 2008.

Table P-HR-1
Average Probability of BHBF Releases from Glen Canyon Dam

Period	Percent of Time That Conditions Needed for BHBF Releases Would Occur at Lake Powell					
	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
2008 - 2026	6.9	6.9	7.1	6.8	8.0	7.4
2027 - 2060	11.5	11.4	11.4	11.4	12.1	11.4

Figure P-HR-5
Glen Canyon Dam Releases
Probability of Occurrence of BHBF Releases



Water Deliveries Information

This section contains additional information used in the analysis of water deliveries (Section 4.4). Specifically, this information is used in the analysis of multi-year shortages. In this EIS, occurrences of shortages in consecutive years are termed multi-year shortages. The information consists of a series of figures that provide comparisons of the probability of multi-year shortages with volumes equal to or greater than 400 kafy, 500 kafy, 600 kafy, and 1,000 kafy. Consecutive year shortages with durations of two or more years, five or more years, ten or more years, and 15 or more years were considered for these shortage analyses.

Figure P-WD-1
Consecutive Shortages of Two Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

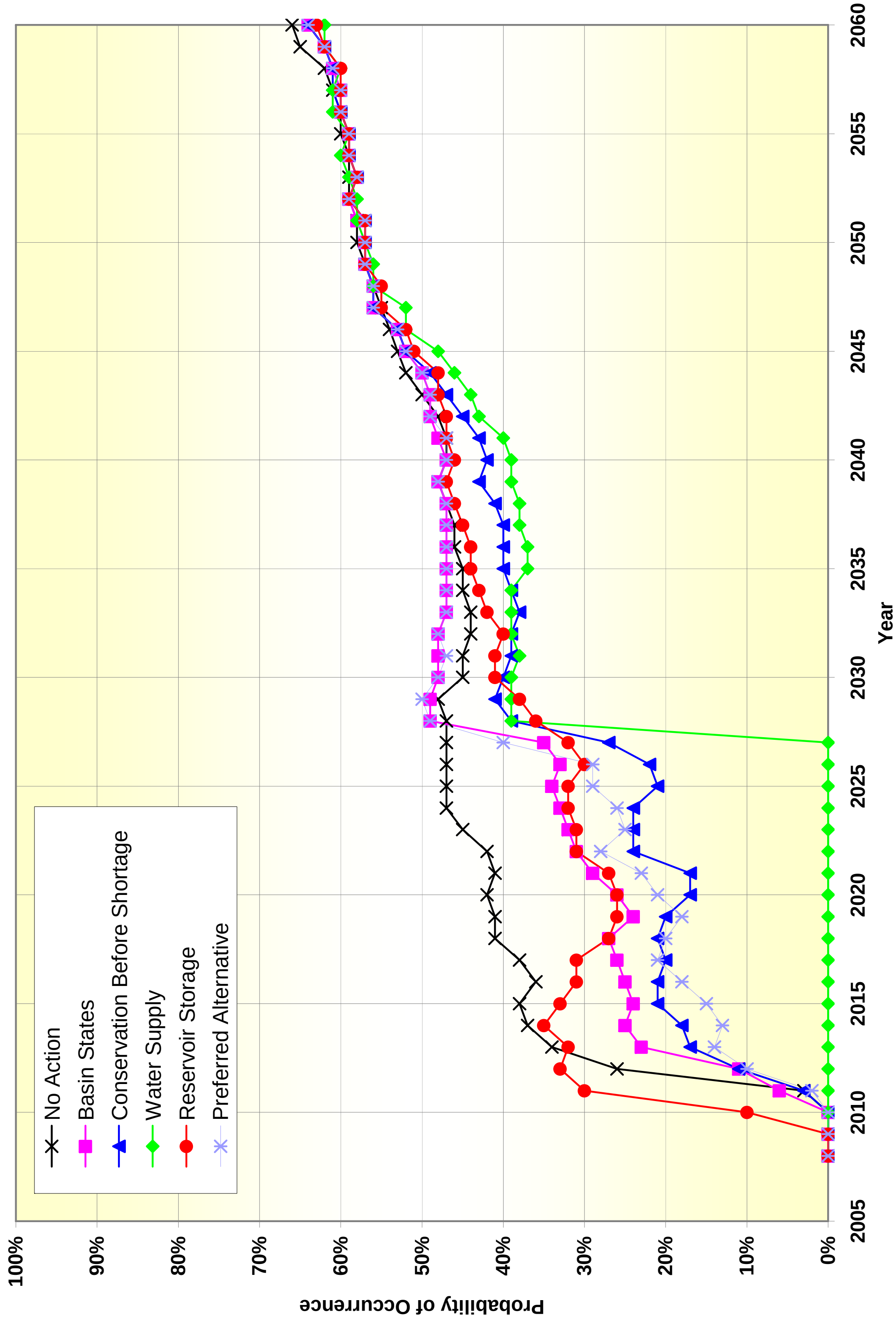
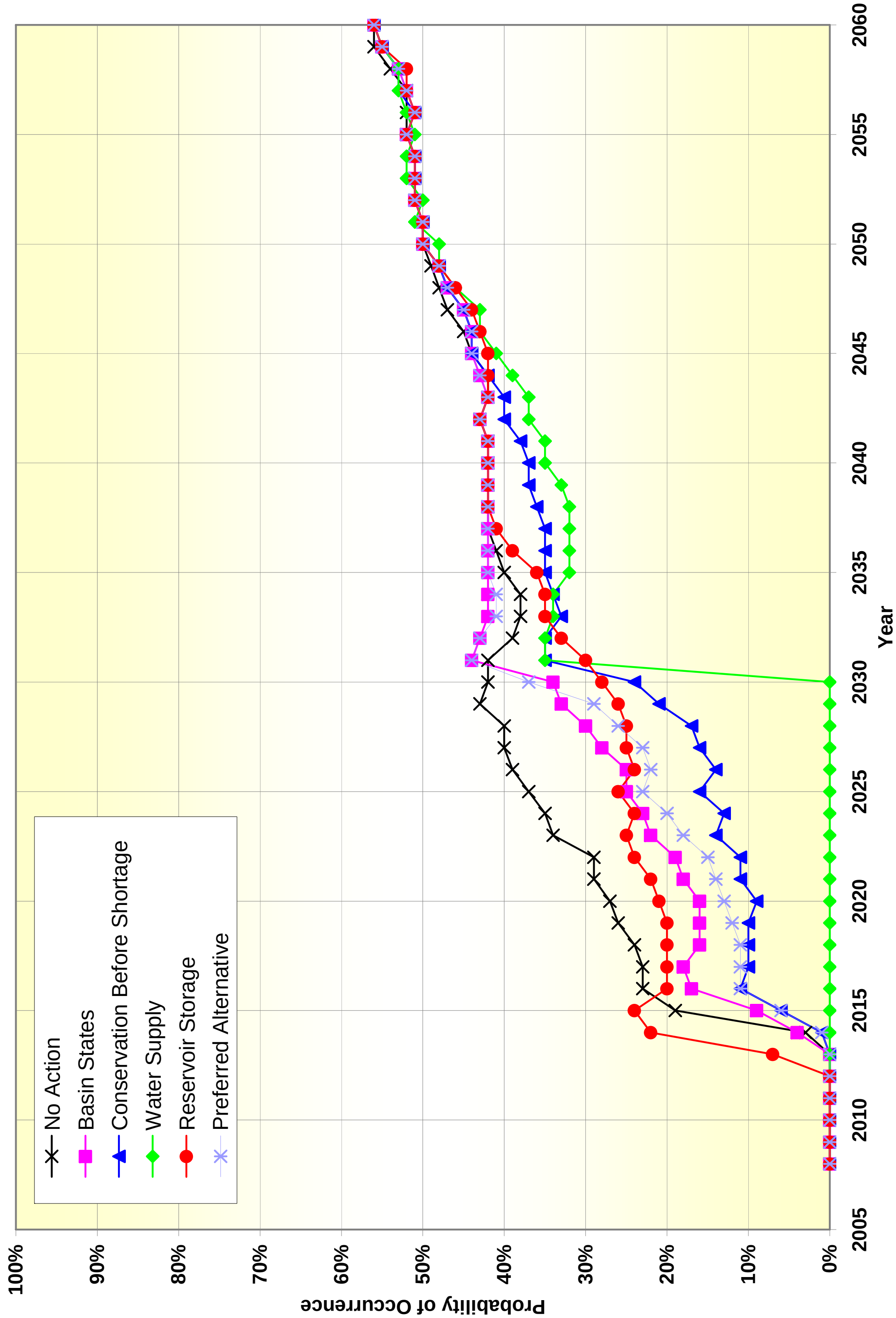


Figure P-WD-2
Consecutive Shortages of Five Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf



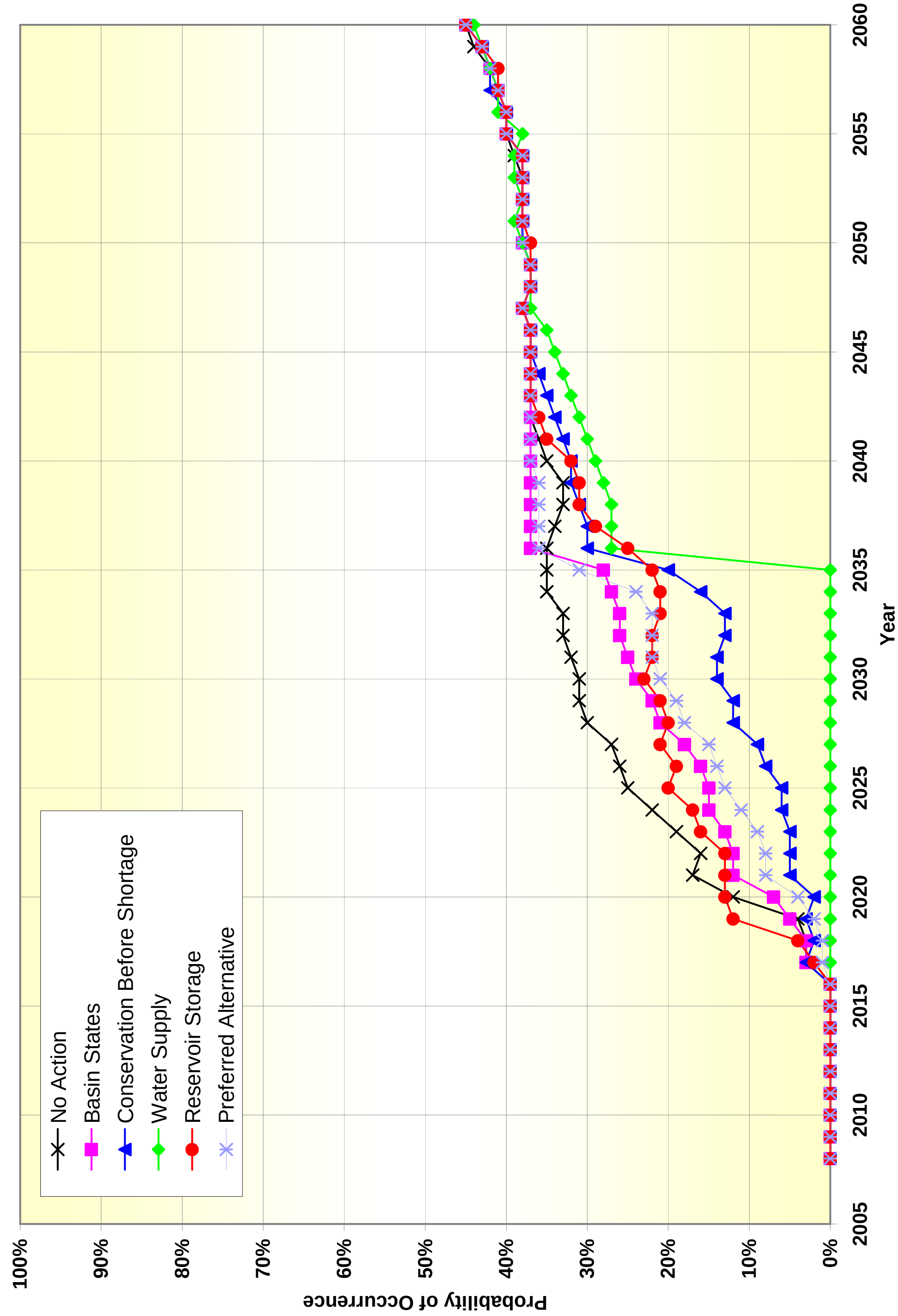


Figure P-WD-3
Consecutive Shortages of Ten Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

Figure P-WD-4
Consecutive Shortages of 15 Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

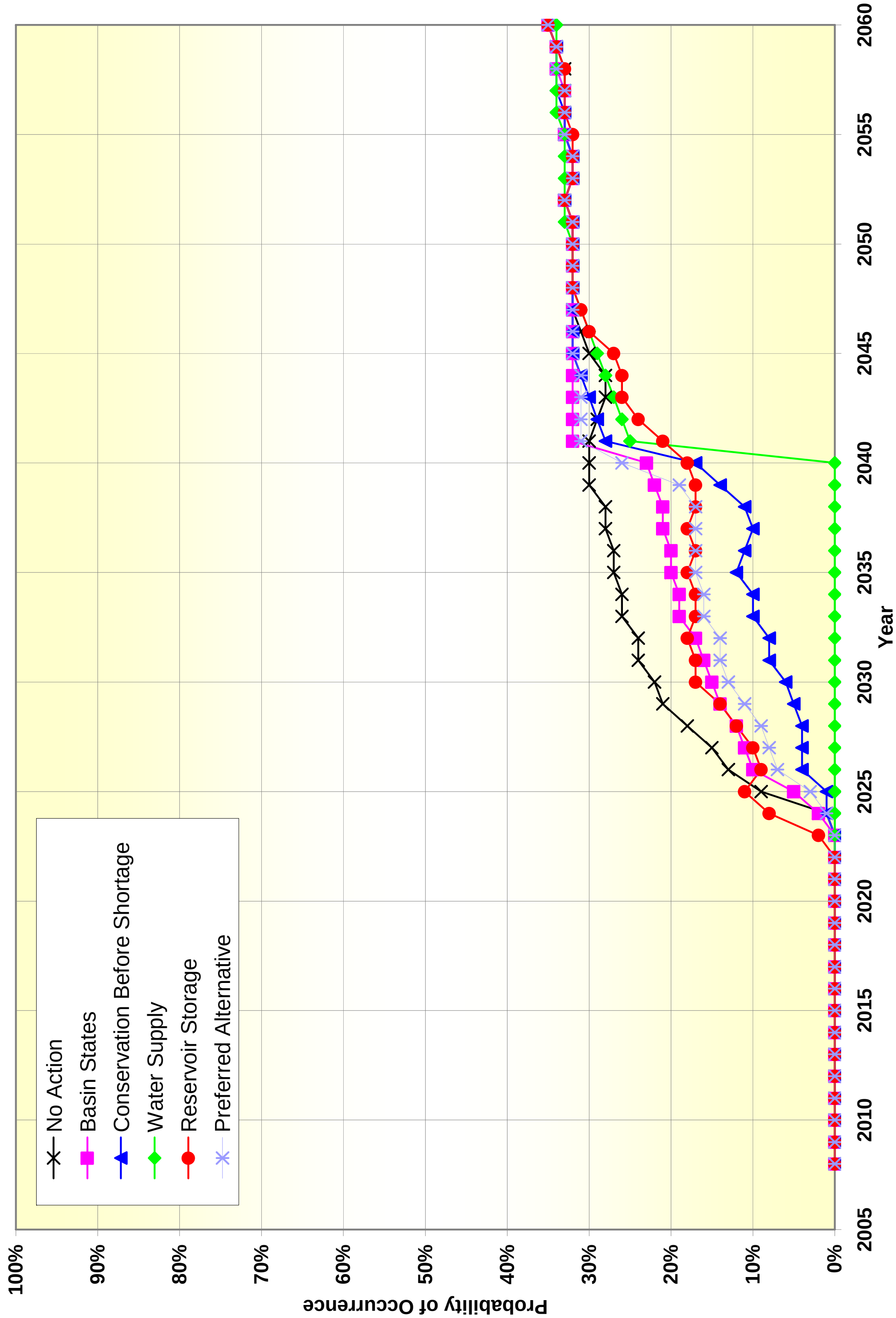


Figure P-WD-5
Consecutive Shortages of Two Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 500 kaf

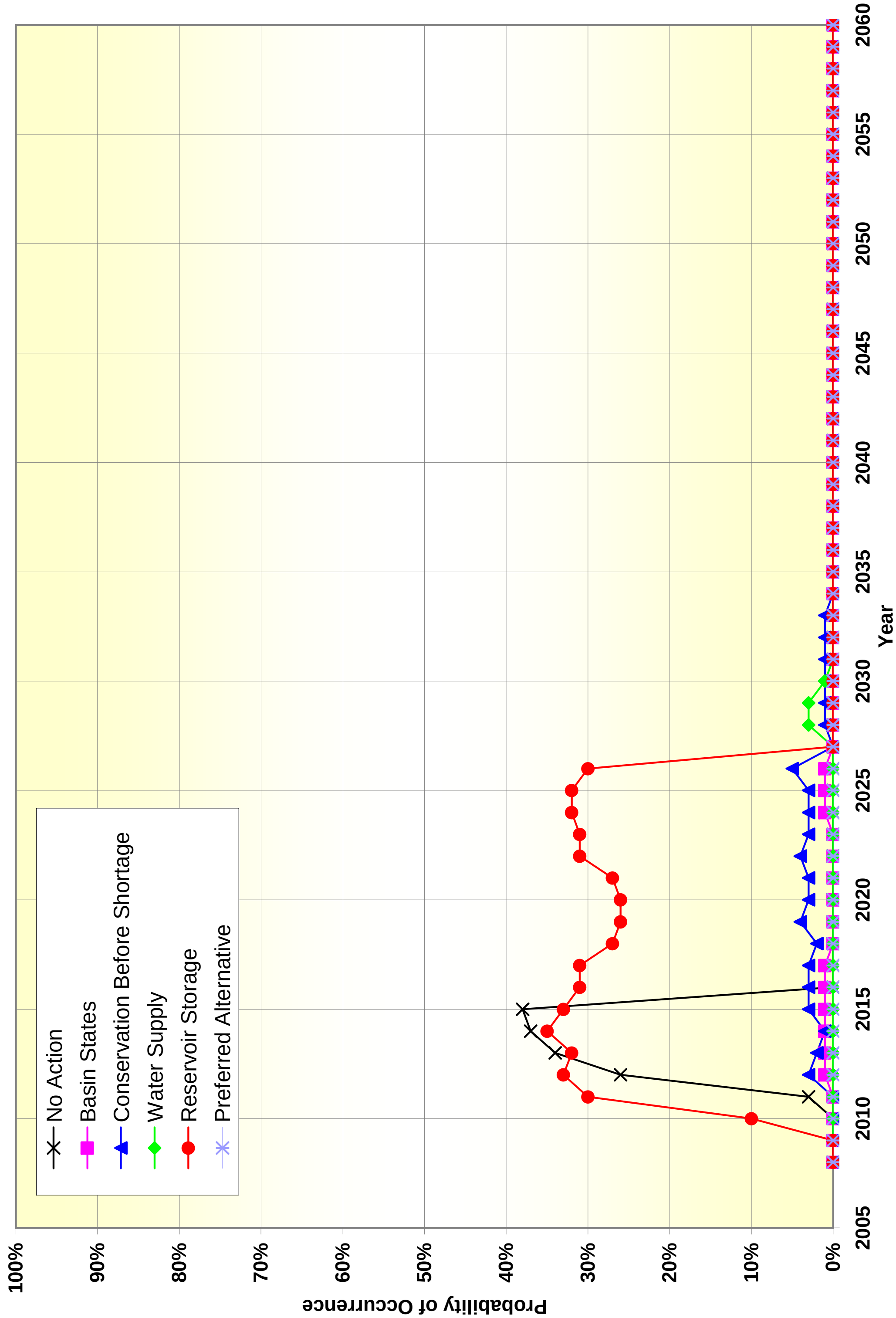


Figure P-WD-6
Consecutive Shortages of Five Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 500 kaf

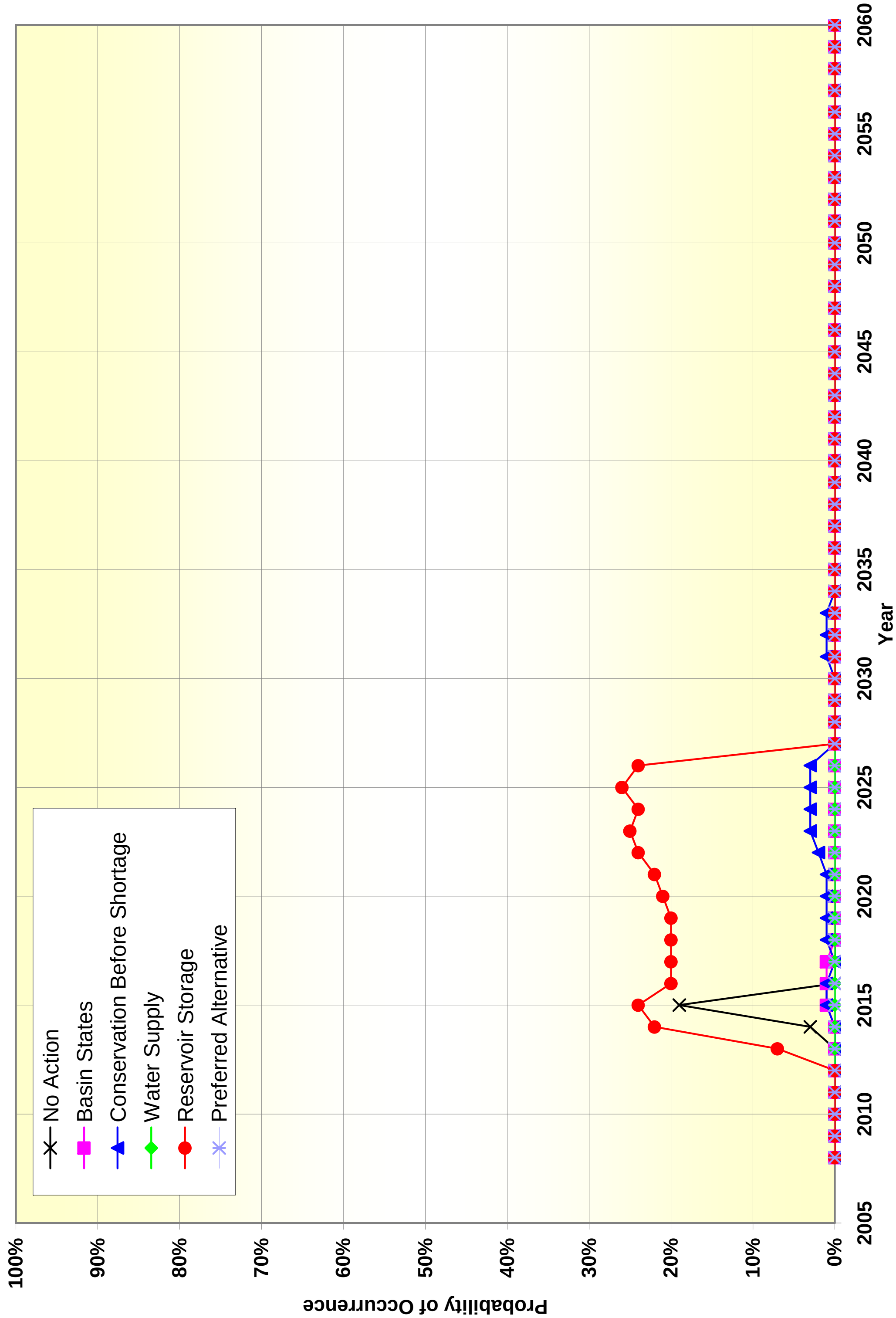


Figure P-WD-7
Consecutive Shortages of Ten Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 500 kaf

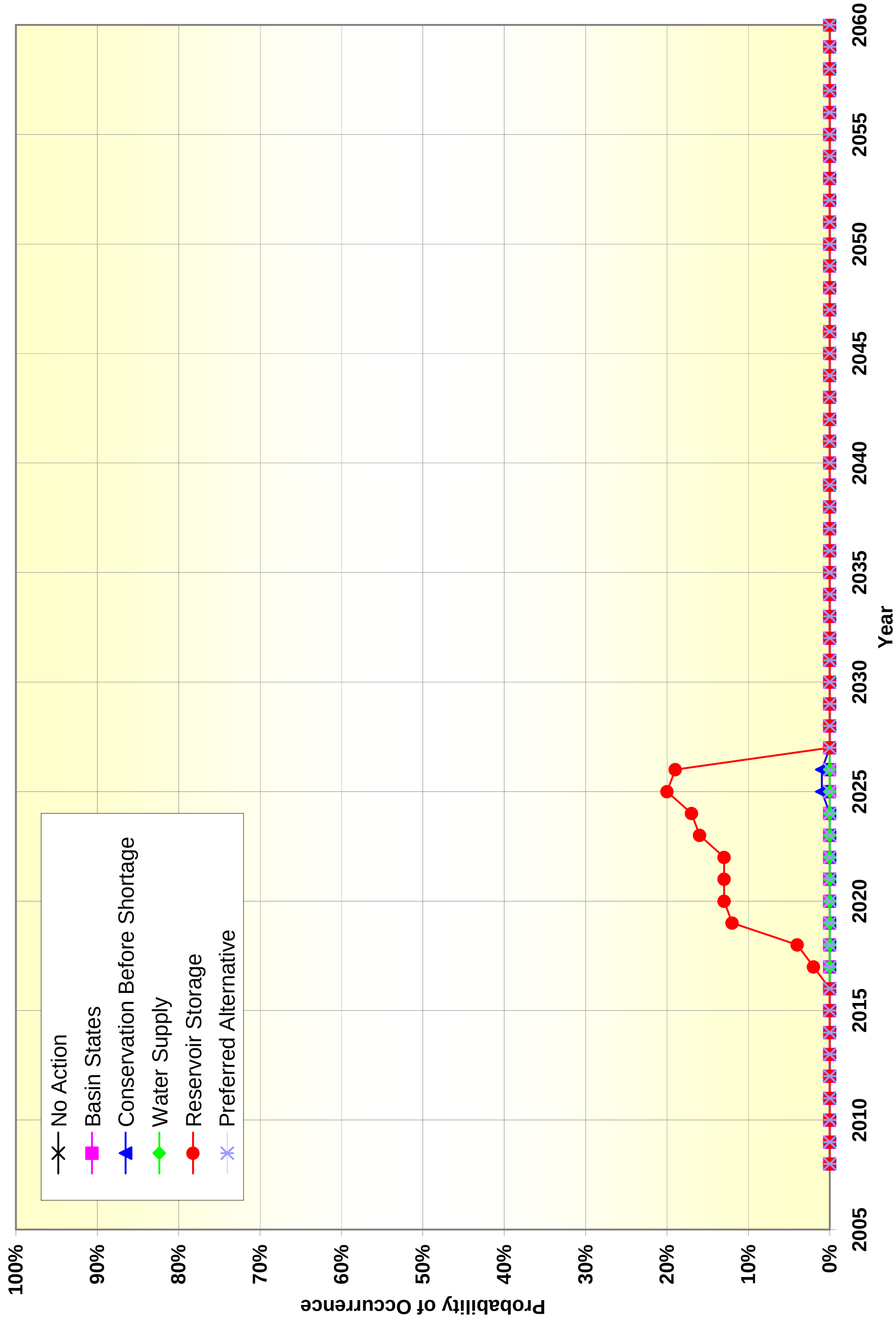


Figure P-WD-8
Consecutive Shortages of 15 Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 500 kaf

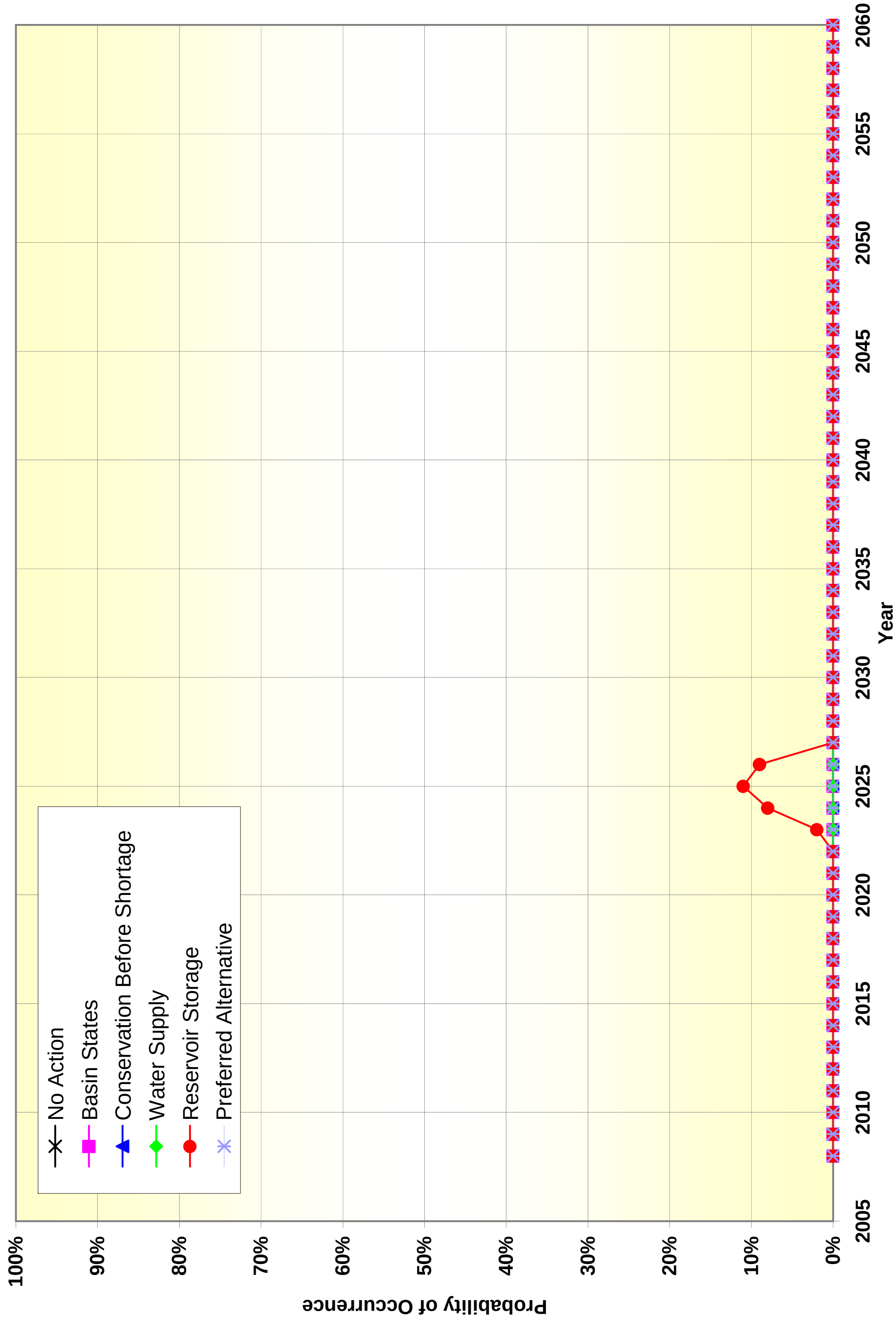


Figure P-WD-9
Consecutive Shortages of Two Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 600 kaf

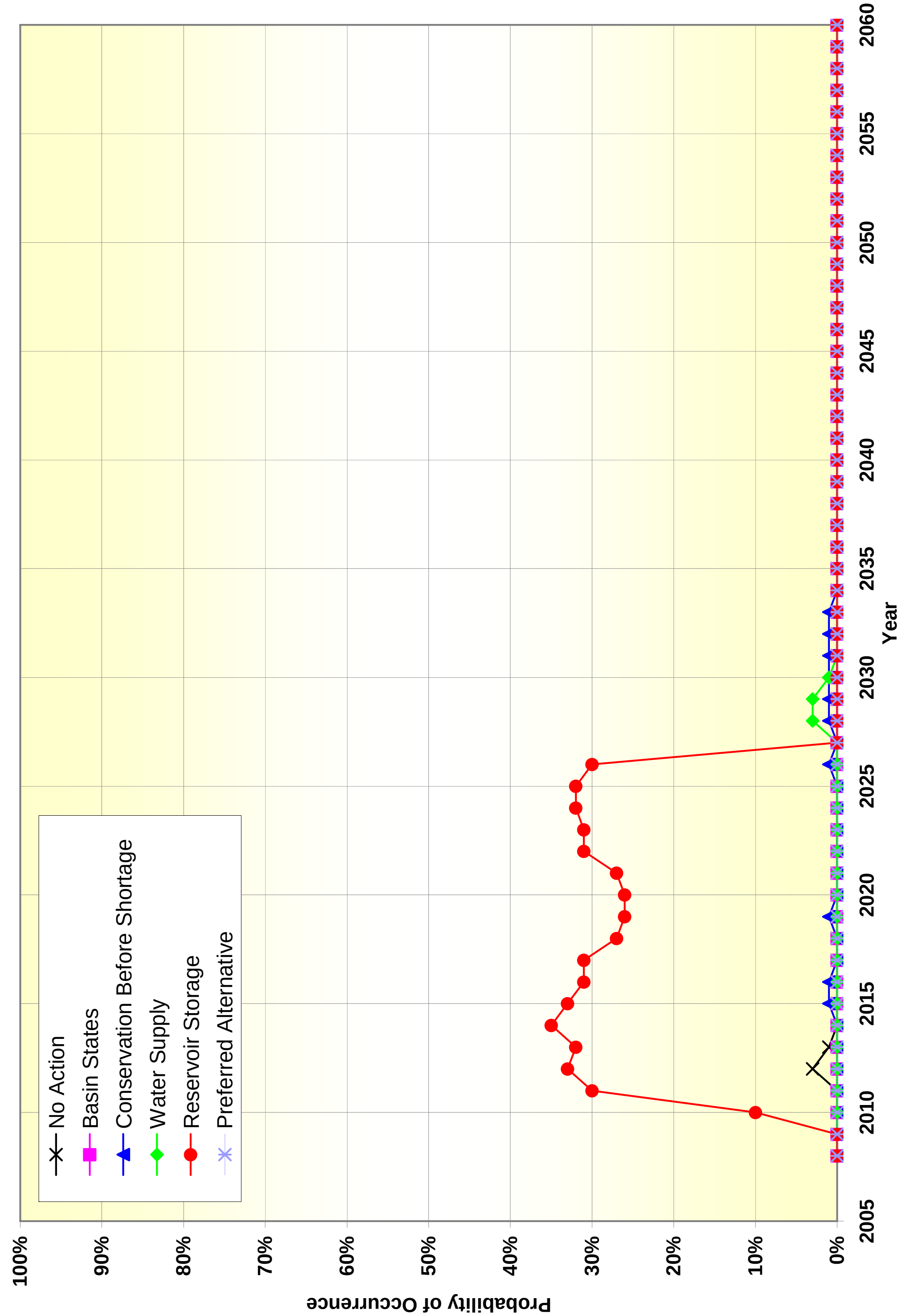
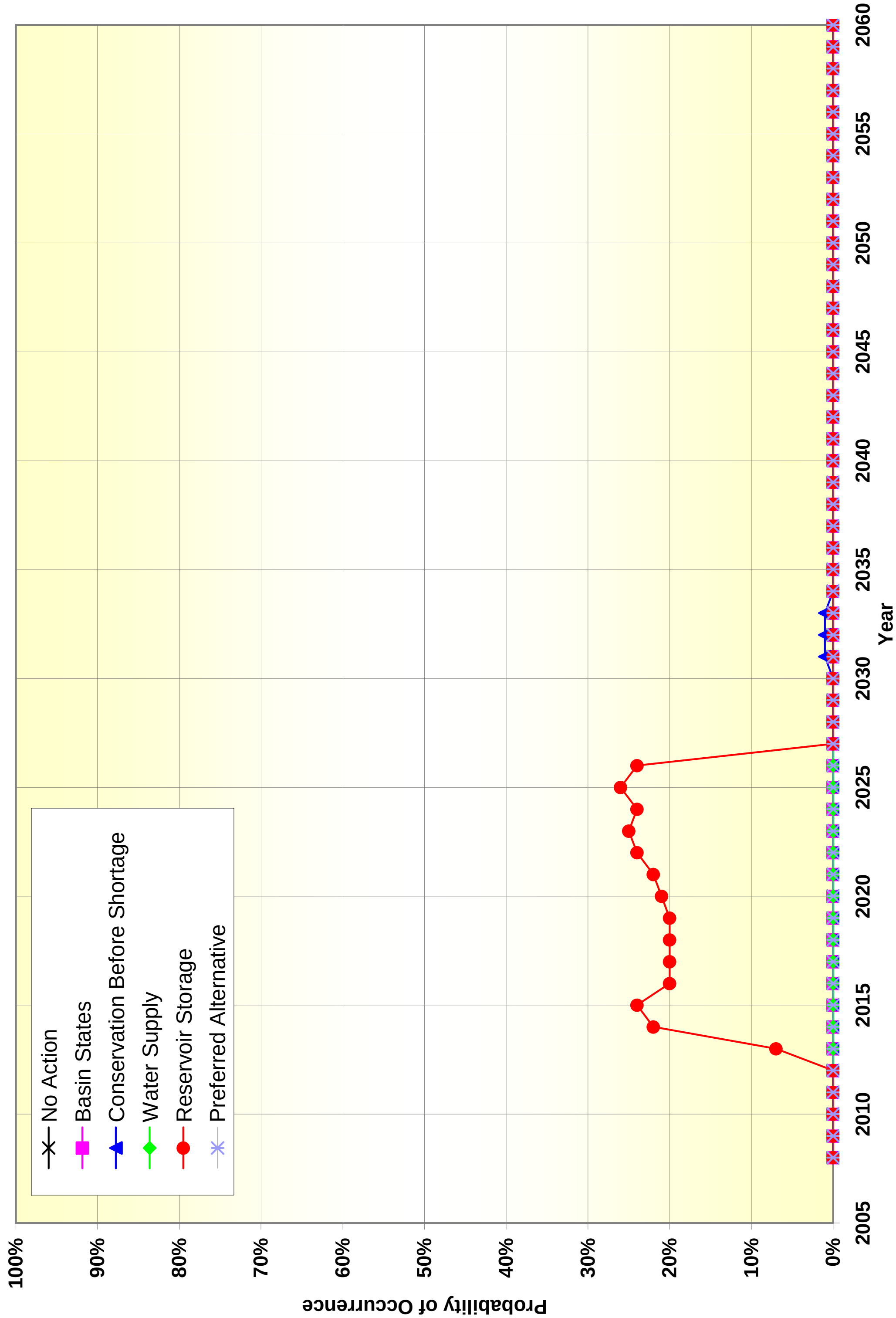


Figure P-WD-10
Consecutive Shortages of Five Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 600 kaf



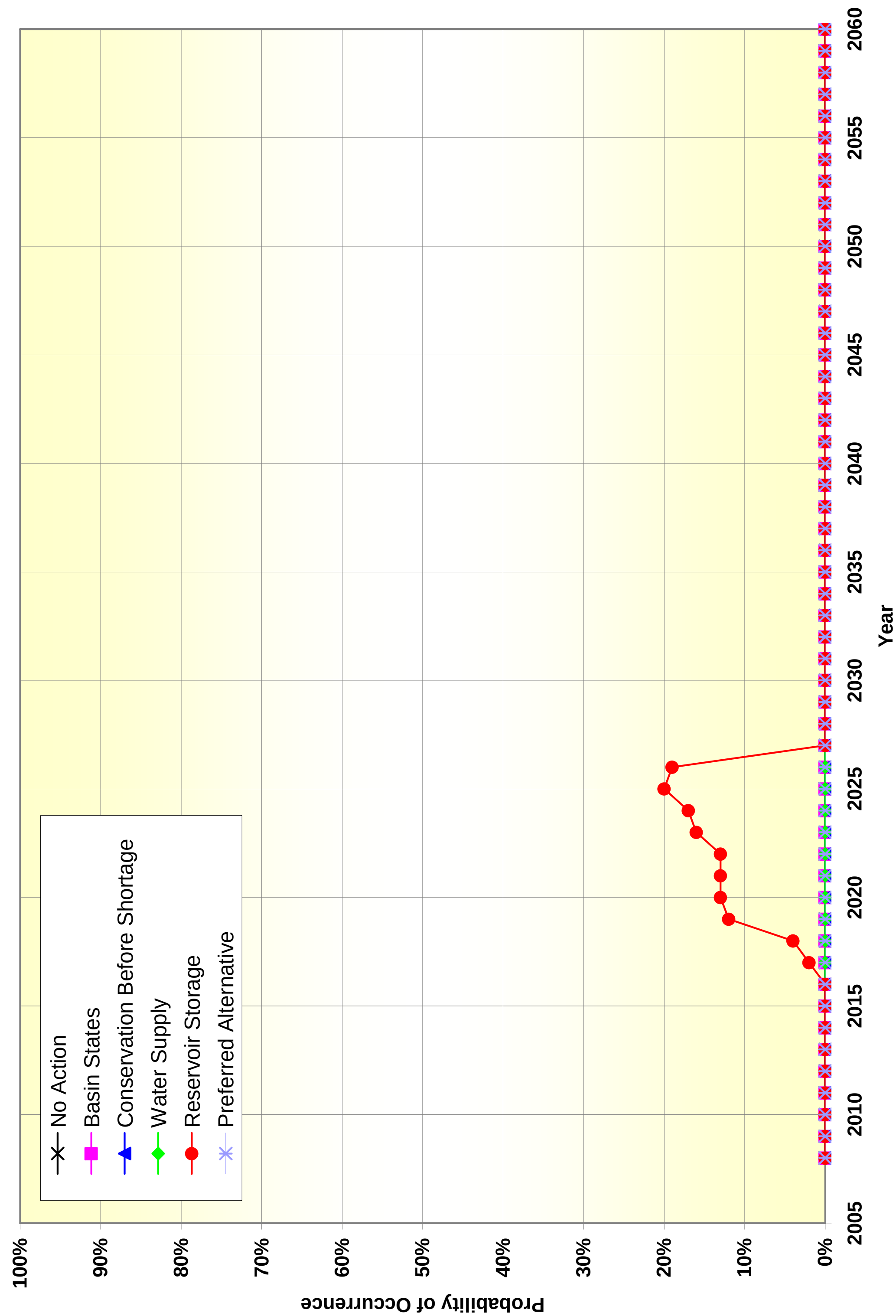


Figure P-WD-11
Consecutive Shortages of Ten Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 600 kaf

Figure P-WD-12
Consecutive Shortages of 15 Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 600 kaf

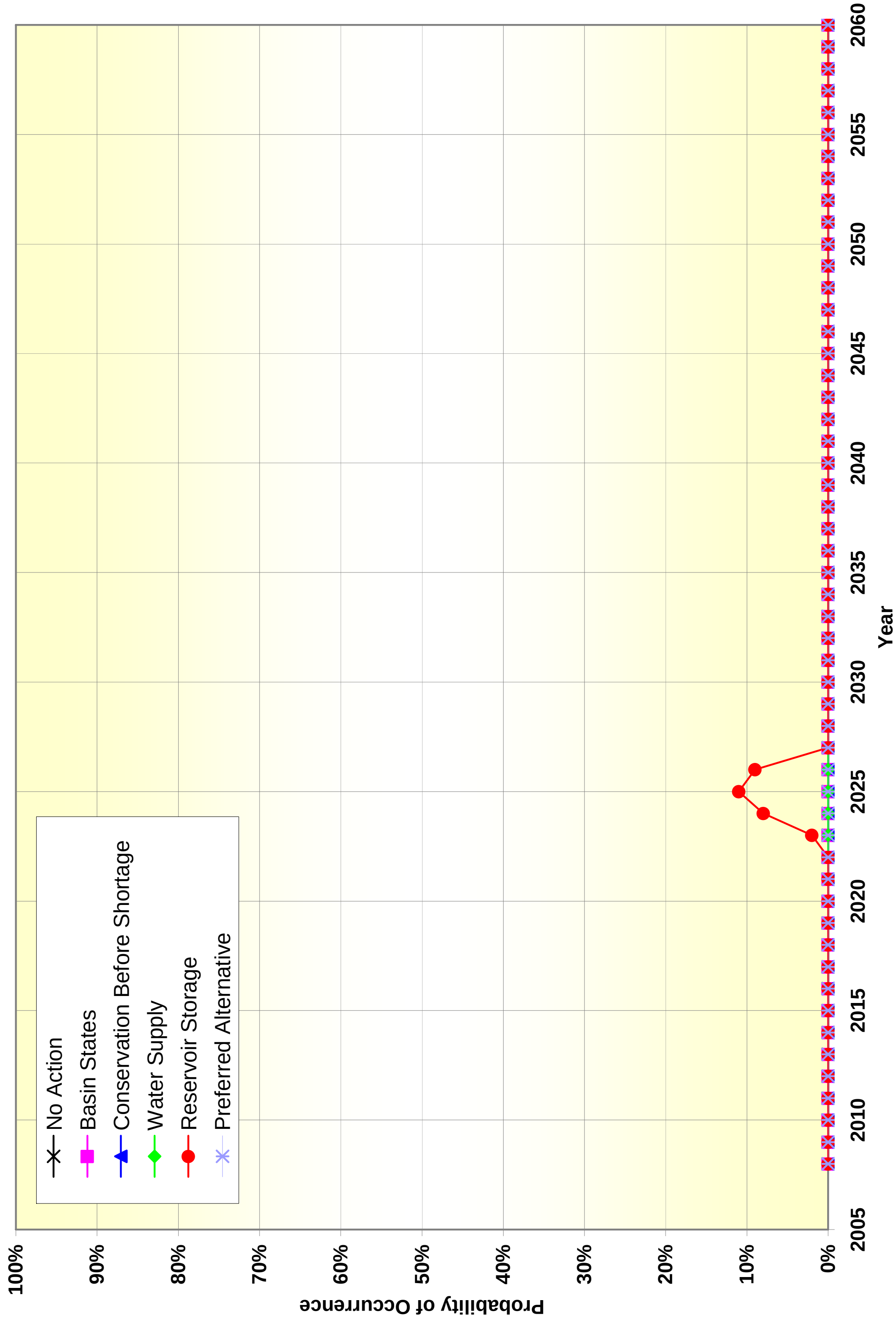


Figure P-WD-13
Consecutive Shortages of Two Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 1,000 kaf

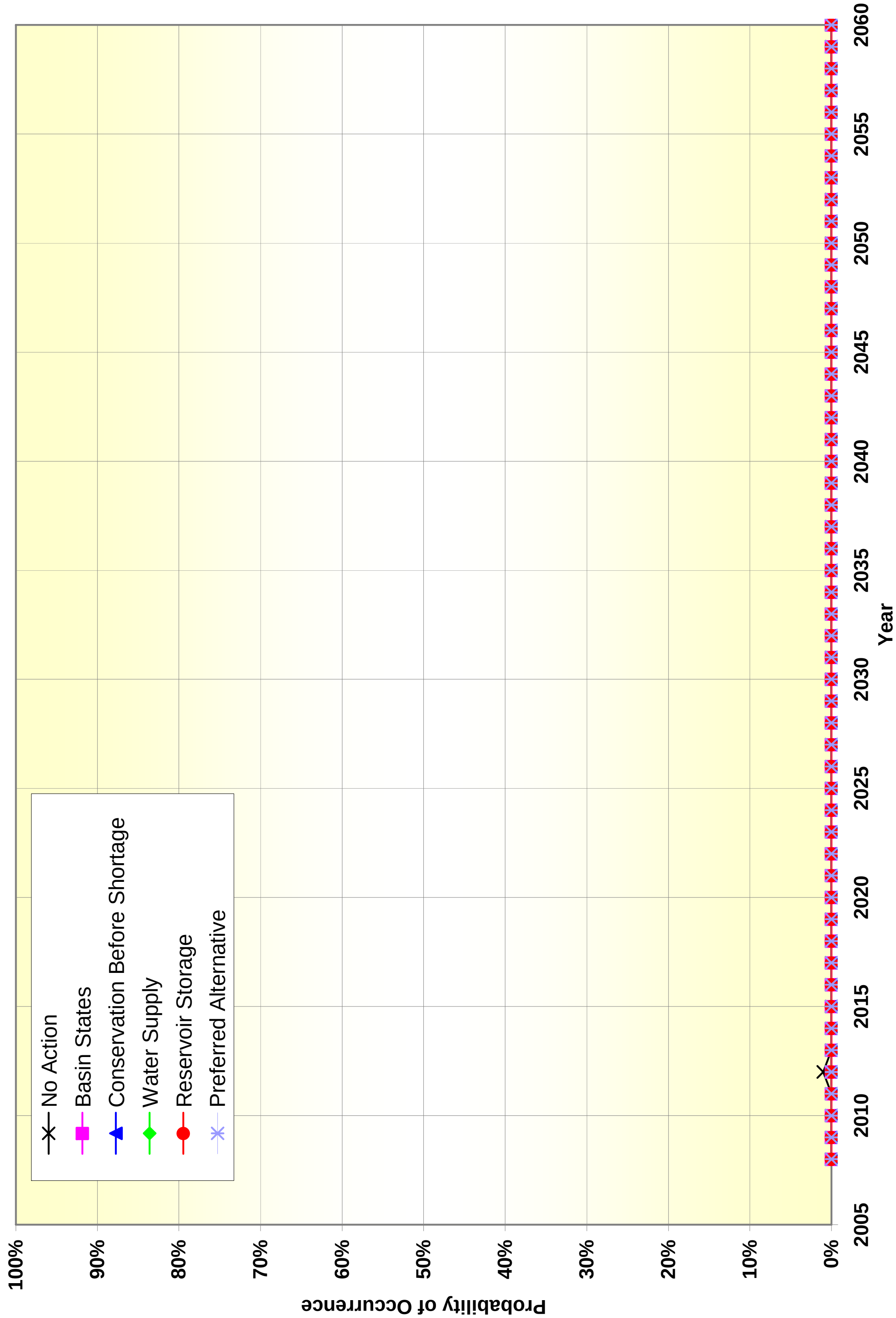


Table P-WD-1
Consecutive Shortages With Durations of Two or More Years, Five or More Years, Ten or More Years, and 15 or More Years
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Probability of Annual Shortage Volume Greater Than or Equal to 400 kaf Occurring in Two or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	10.0	0.0
2016	36.0	25.0	21.0	0.0	31.0	18.0
2020	42.0	26.0	17.0	0.0	26.0	21.0
2026	47.0	33.0	22.0	0.0	30.0	29.0
2030	45.0	48.0	40.0	39.0	41.0	48.0
2035	45.0	47.0	40.0	37.0	44.0	47.0
2040	47.0	47.0	42.0	39.0	46.0	47.0
2050	58.0	57.0	57.0	57.0	57.0	57.0
2060	66.0	64.0	64.0	62.0	63.0	64.0
Probability of Annual Shortage Volume Greater Than or Equal to 400 kaf Occurring in Five or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	23.0	17.0	11.0	0.0	20.0	11.0
2020	27.0	16.0	9.0	0.0	21.0	13.0
2026	39.0	25.0	14.0	0.0	24.0	22.0
2030	42.0	34.0	24.0	0.0	28.0	37.0
2035	40.0	42.0	35.0	32.0	36.0	42.0
2040	42.0	42.0	37.0	35.0	42.0	42.0
2050	50.0	50.0	50.0	48.0	50.0	50.0
2060	56.0	56.0	56.0	56.0	56.0	56.0
Probability of Annual Shortage Volume Greater Than or Equal to 400 kaf Occurring in Ten or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0
2020	12.0	7.0	2.0	0.0	13.0	4.0
2026	26.0	16.0	8.0	0.0	19.0	14.0
2030	31.0	24.0	14.0	0.0	23.0	21.0
2035	35.0	28.0	20.0	0.0	22.0	31.0
2040	35.0	37.0	32.0	29.0	32.0	37.0
2050	38.0	38.0	38.0	38.0	37.0	38.0
2060	45.0	45.0	45.0	44.0	45.0	45.0
Probability of Annual Shortage Volume Greater Than or Equal to 400 kaf Occurring in 15 or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0
2020	0.0	0.0	0.0	0.0	0.0	0.0
2026	13.0	10.0	4.0	0.0	9.0	7.0
2030	22.0	15.0	6.0	0.0	17.0	13.0
2035	27.0	20.0	12.0	0.0	18.0	17.0
2040	30.0	23.0	17.0	0.0	18.0	26.0
2050	32.0	32.0	32.0	32.0	32.0	32.0
2060	35.0	35.0	35.0	34.0	35.0	35.0

Table P-WD-2
Consecutive Shortages With Durations of Two or More Years, Five or More Years, Ten or More Years, and 15 or More Years
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 500 kaf

	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Probability of Annual Shortage Volume Greater Than or Equal to 500 kaf Occurring in Two or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	10.0	0.0
2016	0.0	1.0	3.0	0.0	31.0	0.0
2020	0.0	0.0	3.0	0.0	26.0	0.0
2026	0.0	1.0	5.0	0.0	30.0	0.0
2030	0.0	0.0	1.0	1.0	0.0	0.0
2035	0.0	0.0	0.0	0.0	0.0	0.0
2040	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0
2060	0.0	0.0	0.0	0.0	0.0	0.0
Probability of Annual Shortage Volume Greater Than or Equal to 500 kaf Occurring in Five or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	1.0	1.0	0.0	20.0	0.0
2020	0.0	0.0	1.0	0.0	21.0	0.0
2026	0.0	0.0	3.0	0.0	24.0	0.0
2030	0.0	0.0	0.0	0.0	0.0	0.0
2035	0.0	0.0	0.0	0.0	0.0	0.0
2040	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0
2060	0.0	0.0	0.0	0.0	0.0	0.0
Probability of Annual Shortage Volume Greater Than or Equal to 500 kaf Occurring in Ten or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0
2020	0.0	0.0	0.0	0.0	13.0	0.0
2026	0.0	0.0	1.0	0.0	19.0	0.0
2030	0.0	0.0	0.0	0.0	0.0	0.0
2035	0.0	0.0	0.0	0.0	0.0	0.0
2040	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0
2060	0.0	0.0	0.0	0.0	0.0	0.0
Probability of Annual Shortage Volume Greater Than or Equal to 500 kaf Occurring in 15 or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0
2020	0.0	0.0	0.0	0.0	0.0	0.0
2026	0.0	0.0	0.0	0.0	9.0	0.0
2030	0.0	0.0	0.0	0.0	0.0	0.0
2035	0.0	0.0	0.0	0.0	0.0	0.0
2040	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0
2060	0.0	0.0	0.0	0.0	0.0	0.0

Table P-WD-3
Consecutive Shortages With Durations of Two Or More Years, Five or More Years, Ten or More Years, and 15 or More Years
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 600 kaf

	No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative
Probability of Annual Shortage Volume Greater Than or Equal to 600 kaf Occurring in Two or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	10.0	0.0
2016	0.0	0.0	1.0	0.0	31.0	0.0
2020	0.0	0.0	0.0	0.0	26.0	0.0
2026	0.0	0.0	1.0	0.0	30.0	0.0
2030	0.0	0.0	1.0	1.0	0.0	0.0
2035	0.0	0.0	0.0	0.0	0.0	0.0
2040	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0
2060	0.0	0.0	0.0	0.0	0.0	0.0
Probability of Annual Shortage Volume Greater Than or Equal to 600 kaf Occurring in Five or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	20.0	0.0
2020	0.0	0.0	0.0	0.0	21.0	0.0
2026	0.0	0.0	0.0	0.0	24.0	0.0
2030	0.0	0.0	0.0	0.0	0.0	0.0
2035	0.0	0.0	0.0	0.0	0.0	0.0
2040	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0
2060	0.0	0.0	0.0	0.0	0.0	0.0
Probability of Annual Shortage Volume Greater Than or Equal to 600 kaf Occurring in Ten or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0
2020	0.0	0.0	0.0	0.0	13.0	0.0
2026	0.0	0.0	0.0	0.0	19.0	0.0
2030	0.0	0.0	0.0	0.0	0.0	0.0
2035	0.0	0.0	0.0	0.0	0.0	0.0
2040	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0
2060	0.0	0.0	0.0	0.0	0.0	0.0
Probability of Annual Shortage Volume Greater Than or Equal to 600 kaf Occurring in 15 or More Consecutive Years (percent)						
2008	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0
2020	0.0	0.0	0.0	0.0	0.0	0.0
2026	0.0	0.0	0.0	0.0	9.0	0.0
2030	0.0	0.0	0.0	0.0	0.0	0.0
2035	0.0	0.0	0.0	0.0	0.0	0.0
2040	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0
2060	0.0	0.0	0.0	0.0	0.0	0.0

Water Quality and Air Quality Information

This section contains additional information used in the water quality and air quality analyses (Section 4.5 and Section 4.6 of the EIS, respectively). This information consists of a series of figures that provide comparisons of flow-weighted annual average salinity concentrations under the modeled action alternatives to those under the modeled No Action Alternative. Additional figures that compare Lake Powell and Lake Mead elevations during different months (End-of-October and End-of-March elevations) are also included in this section.

Figure P-WAQ-1
Colorado River Salinity Downstream of Hoover Dam
Comparison of Action Alternatives to No Action Alternative
Flow-weighted Annual Average Salinity Concentrations

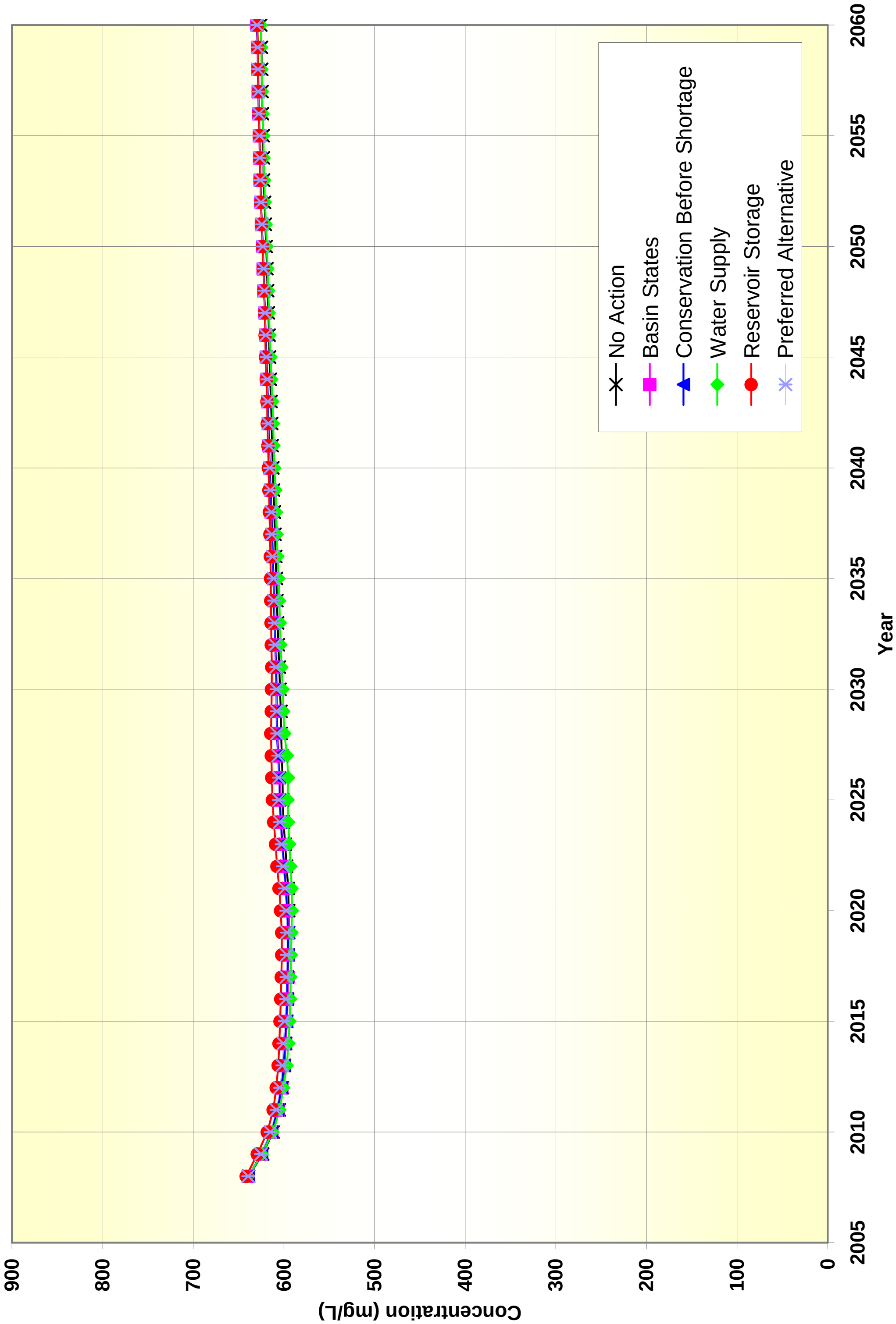


Figure P-WAQ-2
Colorado River Salinity Downstream of Parker Dam
Comparison of Action Alternatives to No Action Alternative
Flow-weighted Annual Average Salinity Concentrations

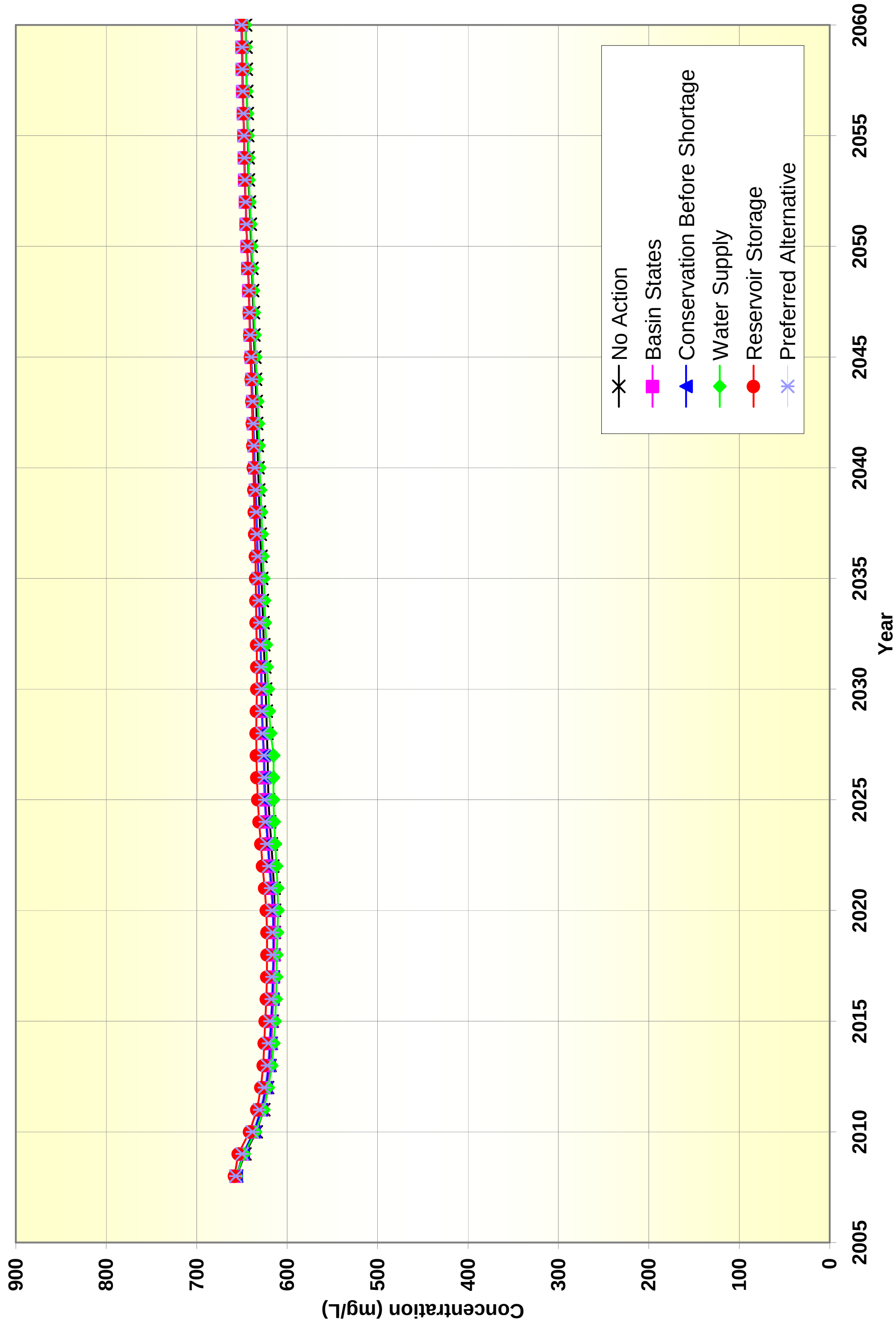


Figure P-WAQ-3
Colorado River Salinity Upstream of Imperial Dam
Comparison of Action Alternatives to No Action Alternative
Flow-weighted Annual Average Salinity Concentrations

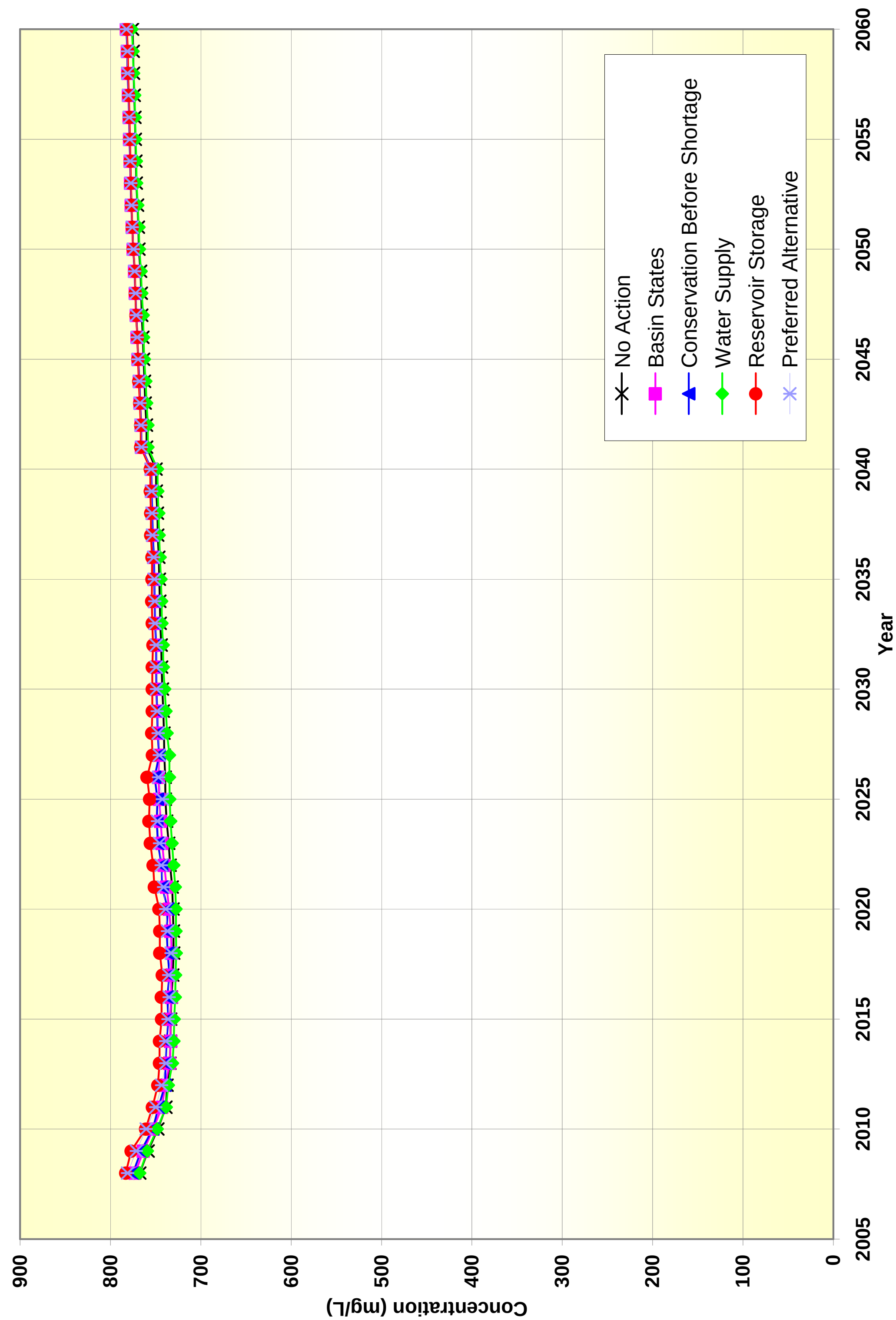


Figure P-WAQ-4
Lake Powell End-of-October Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

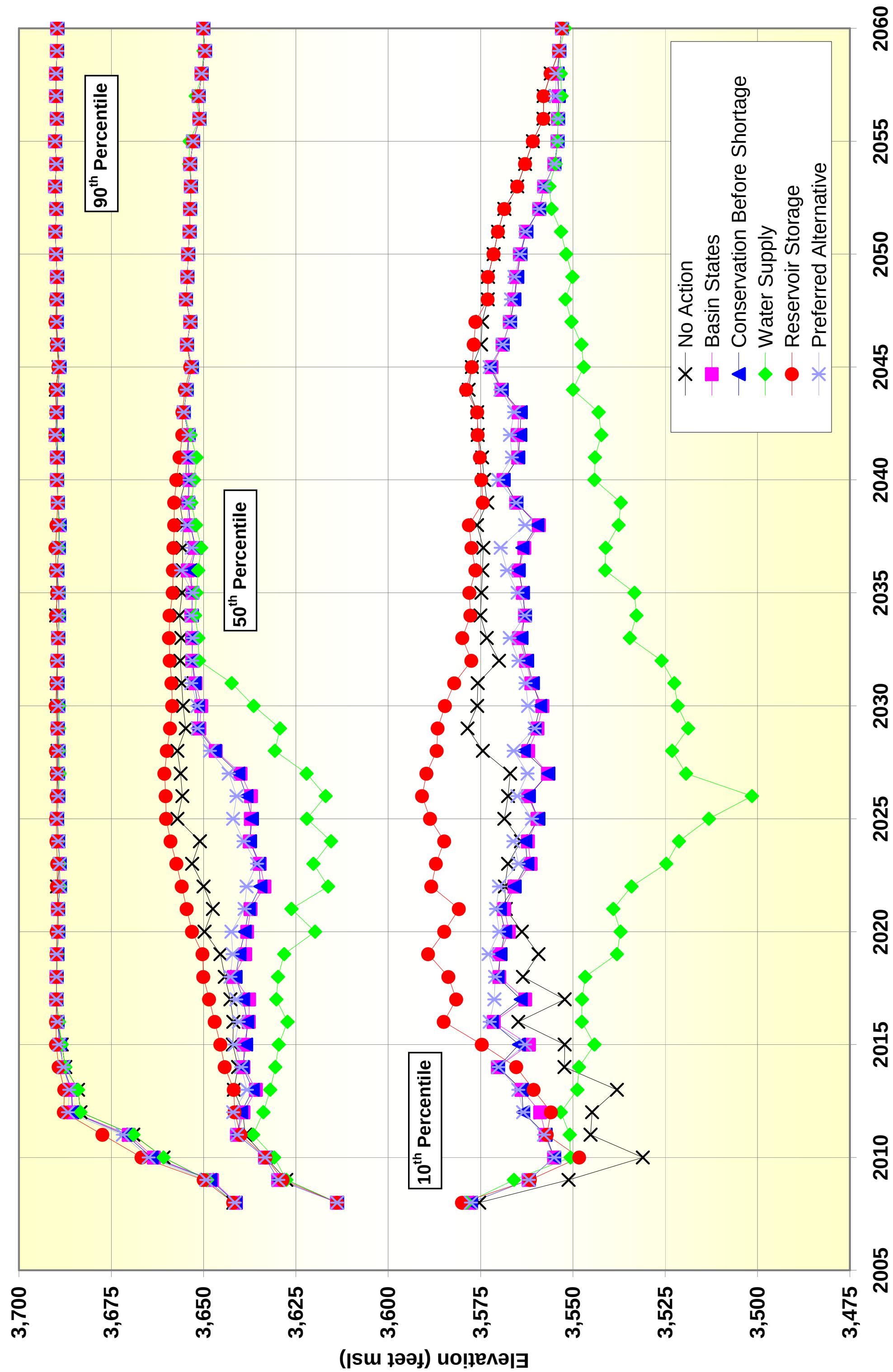


Figure P-WAQ-5
Lake Mead End-of-October Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

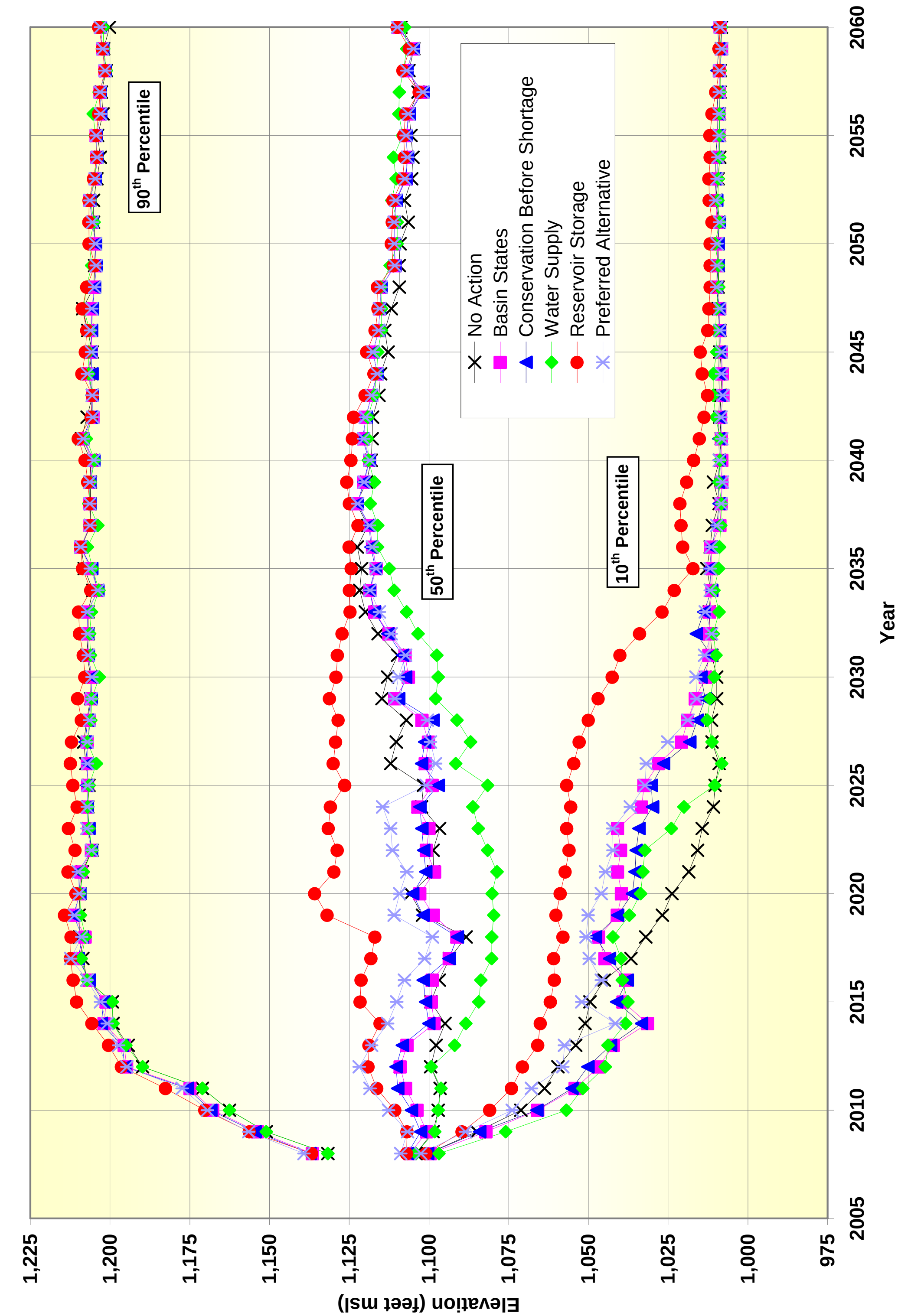
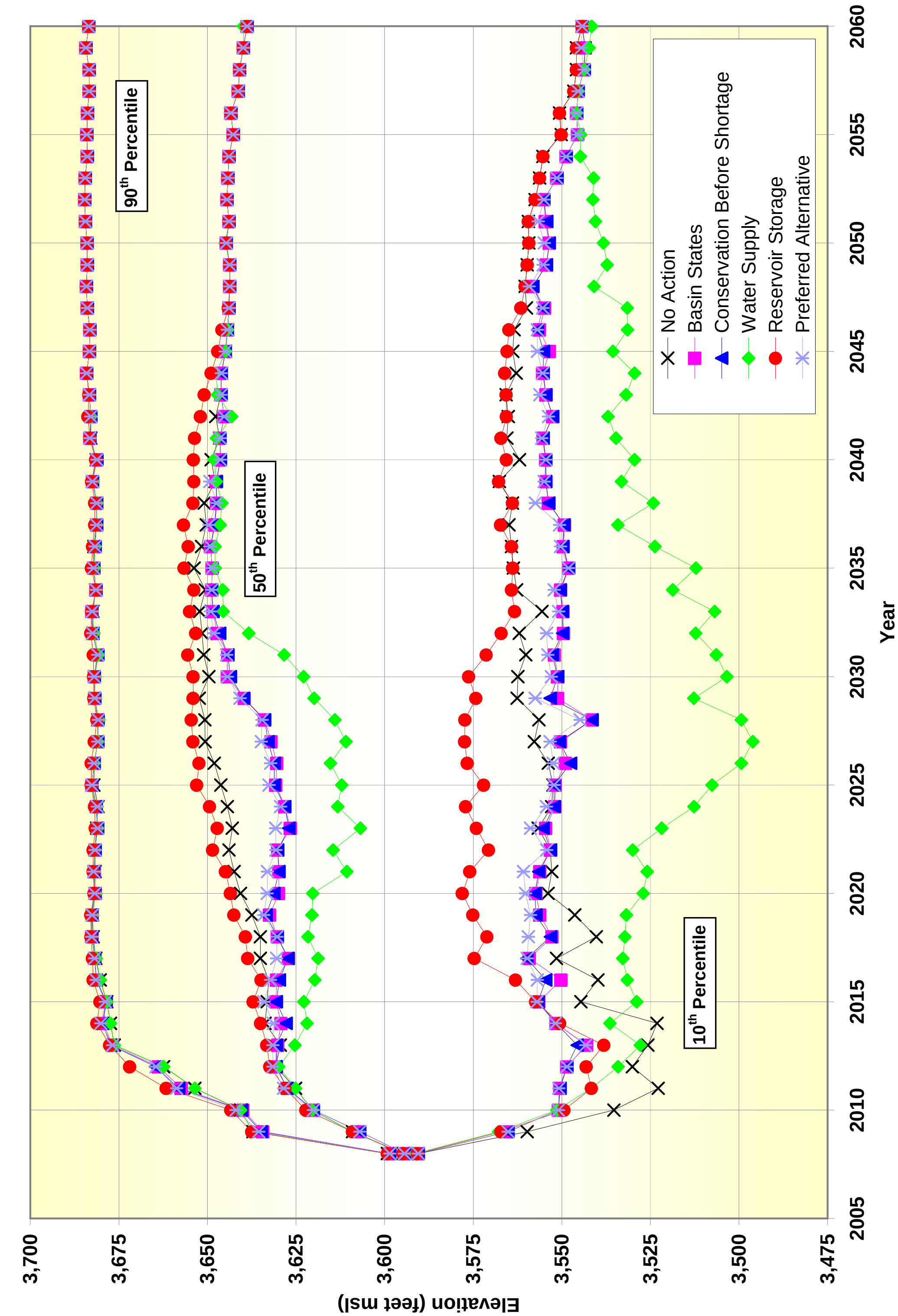


Figure P-WAQ-6
Lake Powell End-of-March Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values



Biological Resources and Cultural Resources Information

This section contains additional information used in the biological and cultural resources impact analyses (Section 4.8 and Section 4.9 of the EIS, respectively). The information consists of a series of graphs and tables. The initial group of graphs provides comparisons of Lake Powell and Lake Mead elevations under the modeled action alternatives to those under the modeled No Action Alternative. These graphs compare Lake Powell end-of-month elevations for the months of July and September, and Lake Mead end-of-month elevations for the months of March, July, and September under each alternative. The second group of graphs provide a comparison of monthly release volumes (January through December) from Glen Canyon Dam, Hoover Dam, Davis Dam, and Parker Dam. The next graph provides a comparison of the probability of occurrence for excess flows downstream of Morelos Diversion Dam under each alternative. The last group of graphs provide comparisons of the modeled water temperature for various locations along the mainstream Colorado River, including downstream Glen Canyon Dam (Glen Canyon Dam releases), at Lees Ferry, downstream of the Little Colorado River, and near Diamond Creek. The remainder of the information provided in this section consists of tables that provide comparisons of the average modeled water temperature along the mainstream of the Colorado River at Lees Ferry, downstream of the Little Colorado River, and near Diamond Creek.

Figure P-BCR-1
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

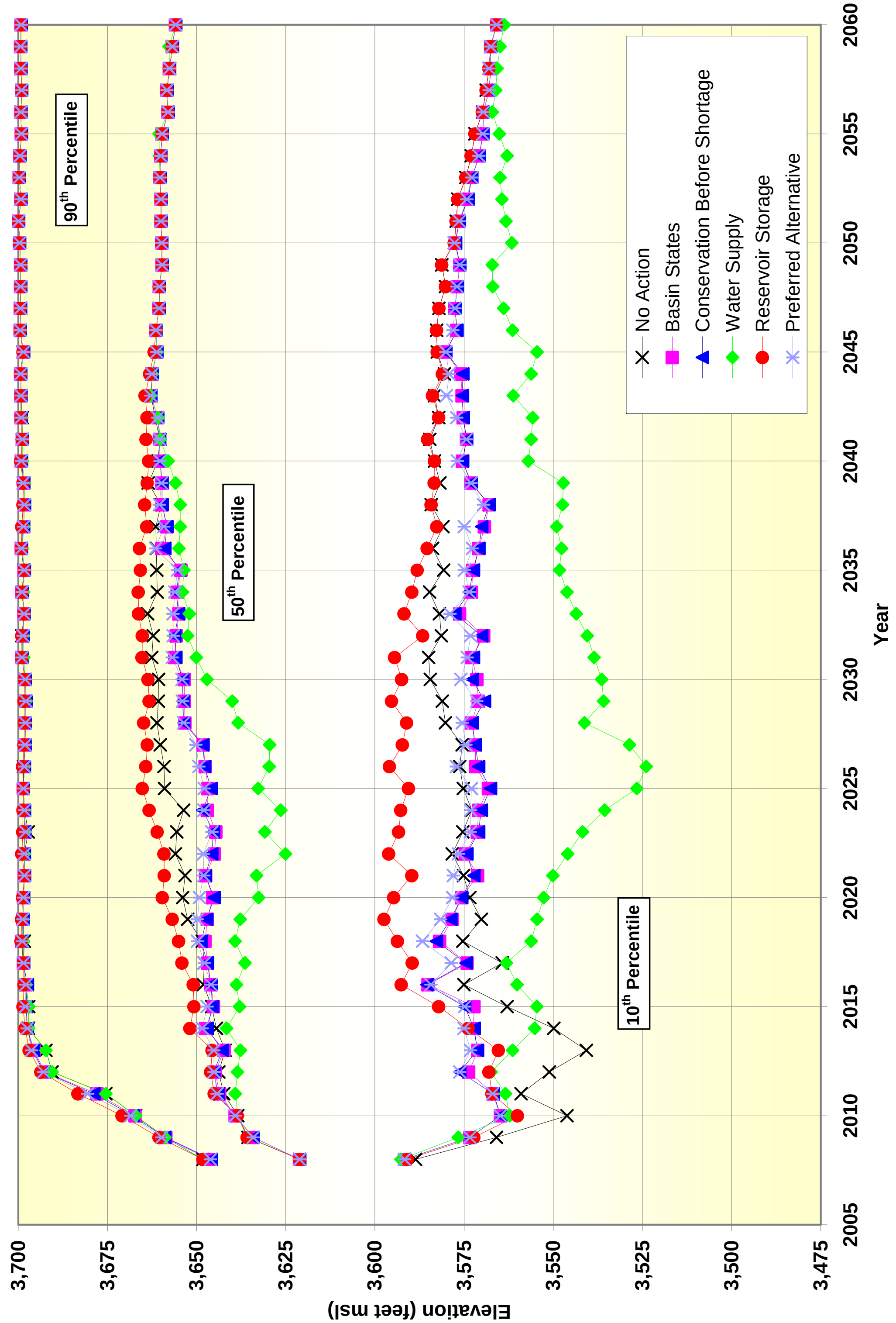


Figure P- BCR-2
Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

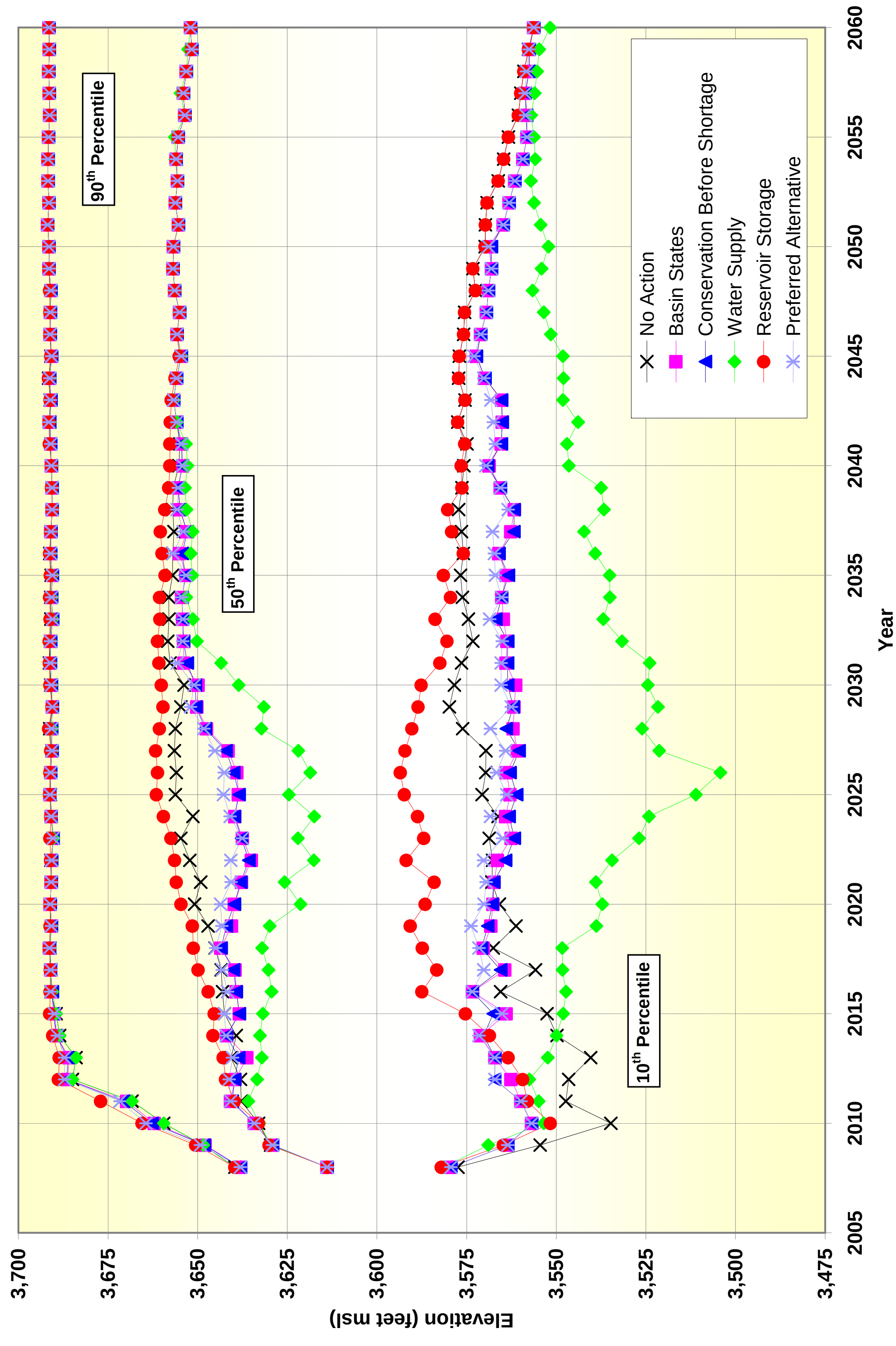


Figure P- BCR-3
Lake Mead End-of-February Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

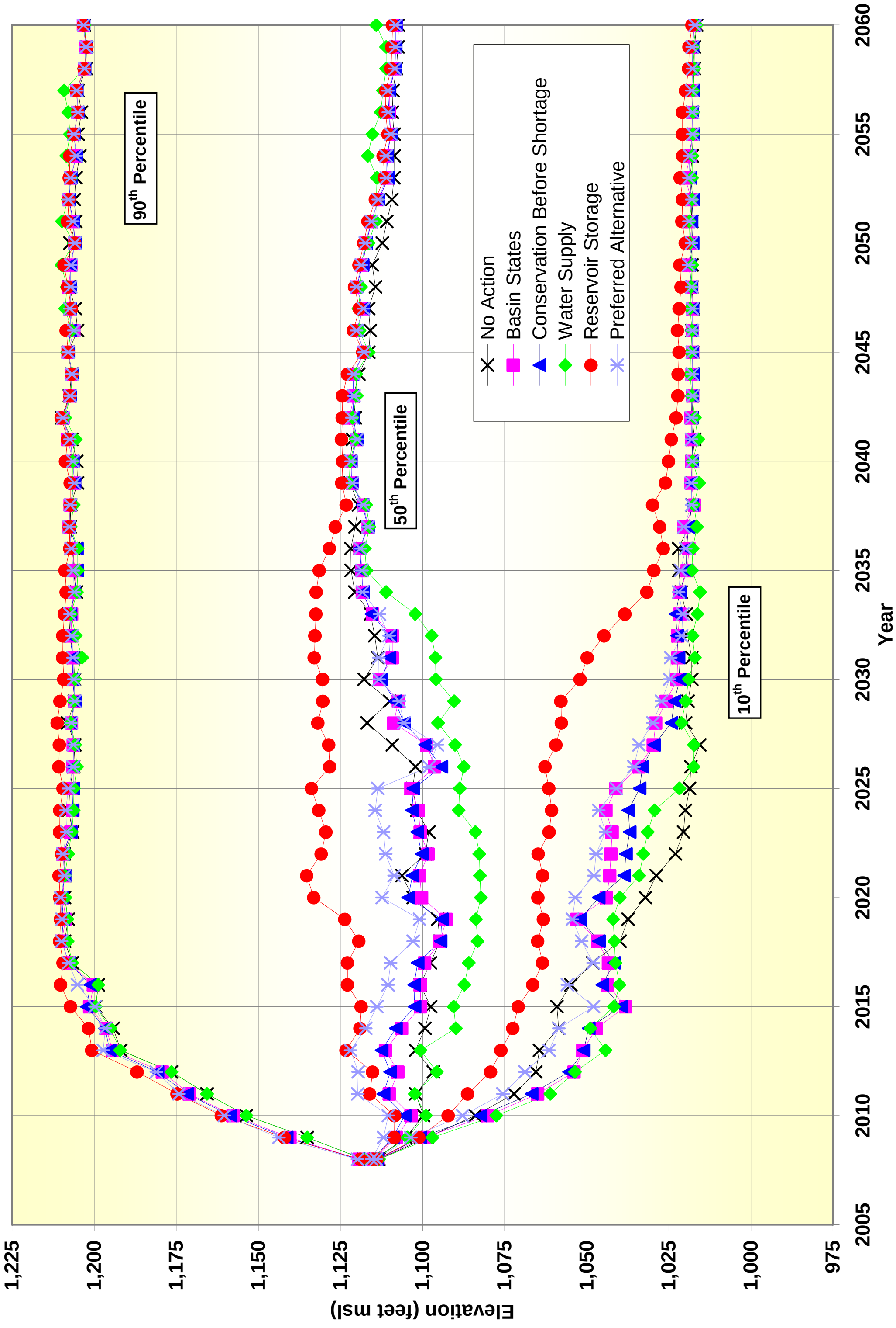


Figure P- BCR-4
Lake Mead End-of-March Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

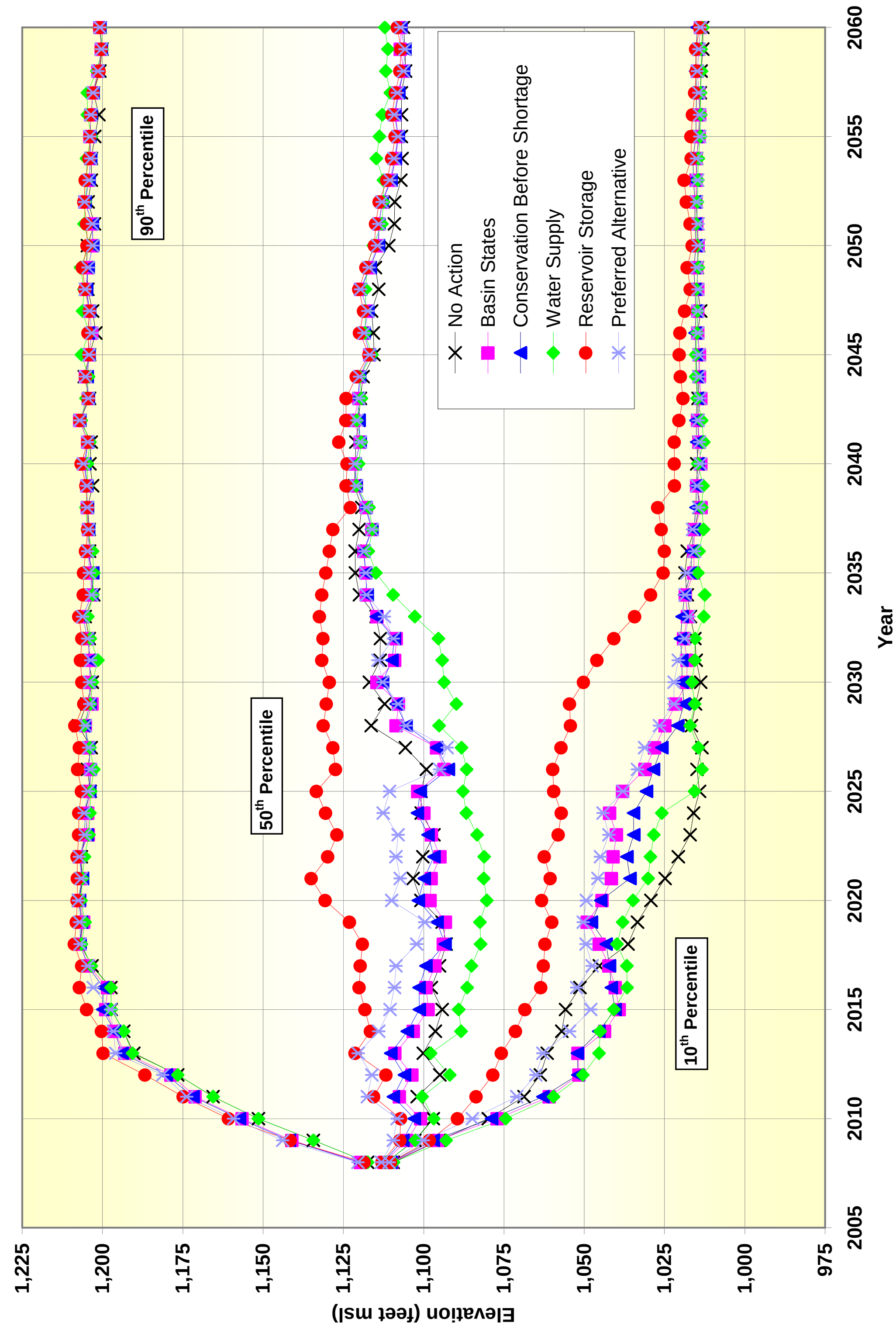


Figure P- BCR-5
Lake Mead End-of-April Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

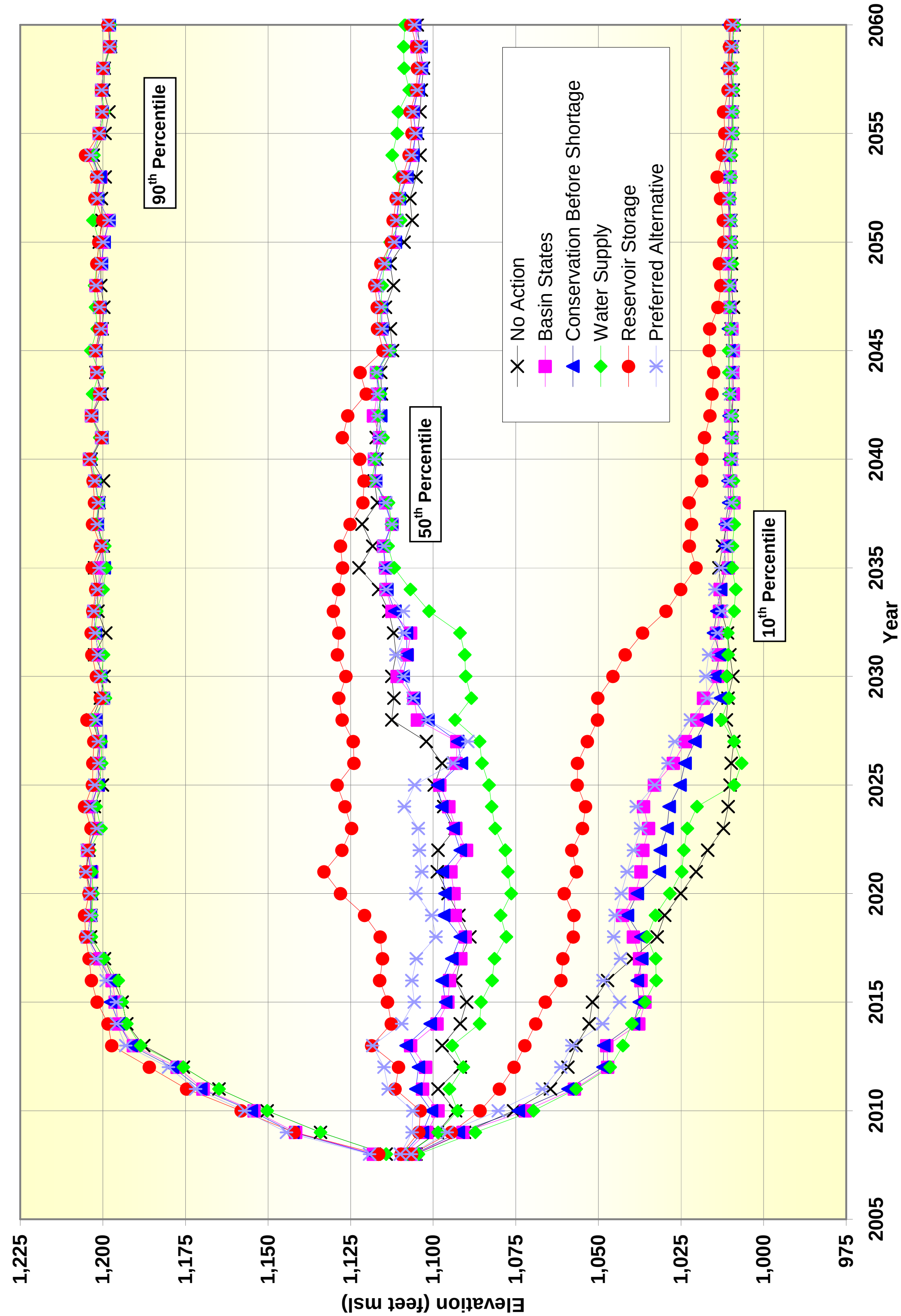


Figure P- BCR-6
Lake Mead End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

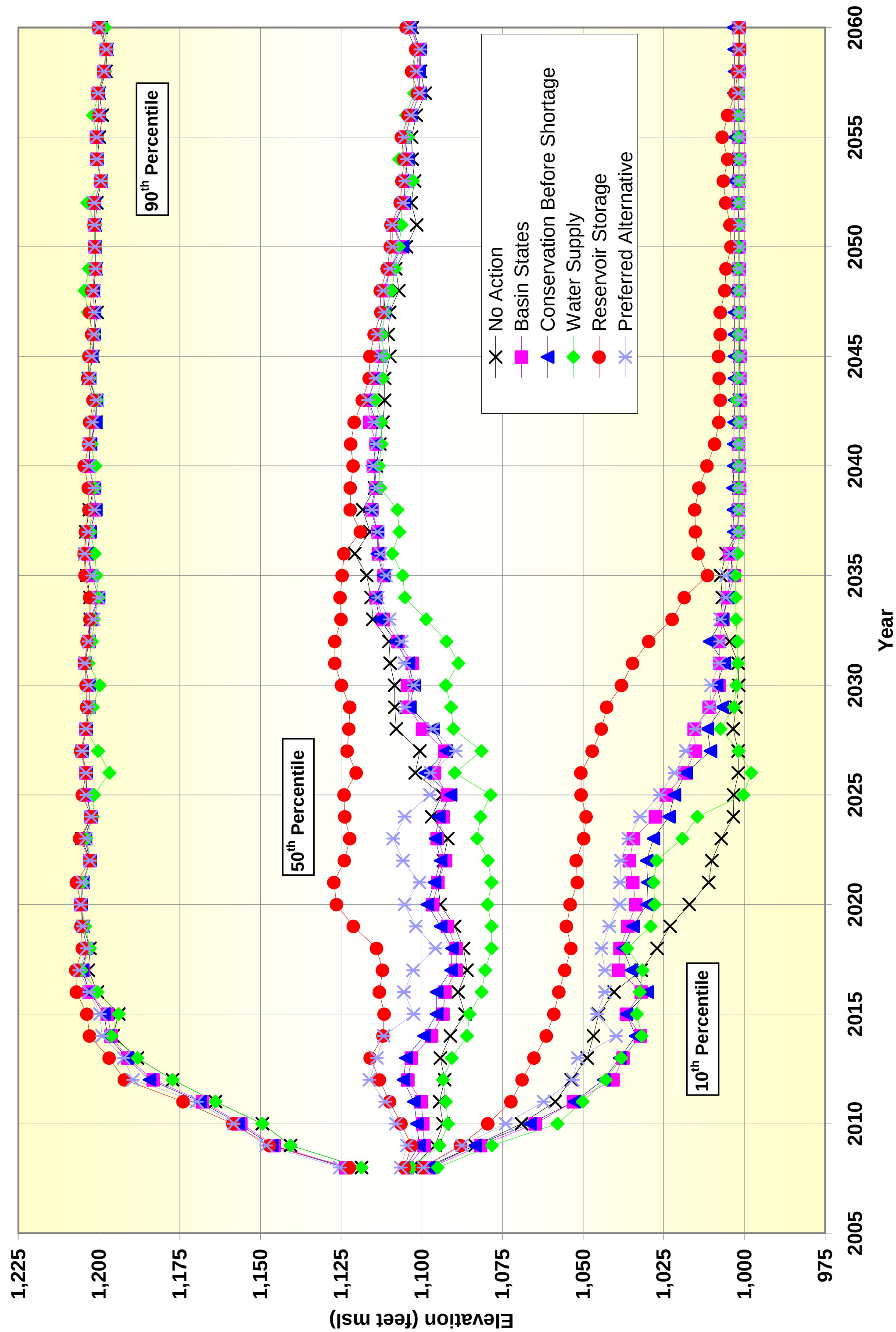


Figure P- BCR-7
Lake Mead End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

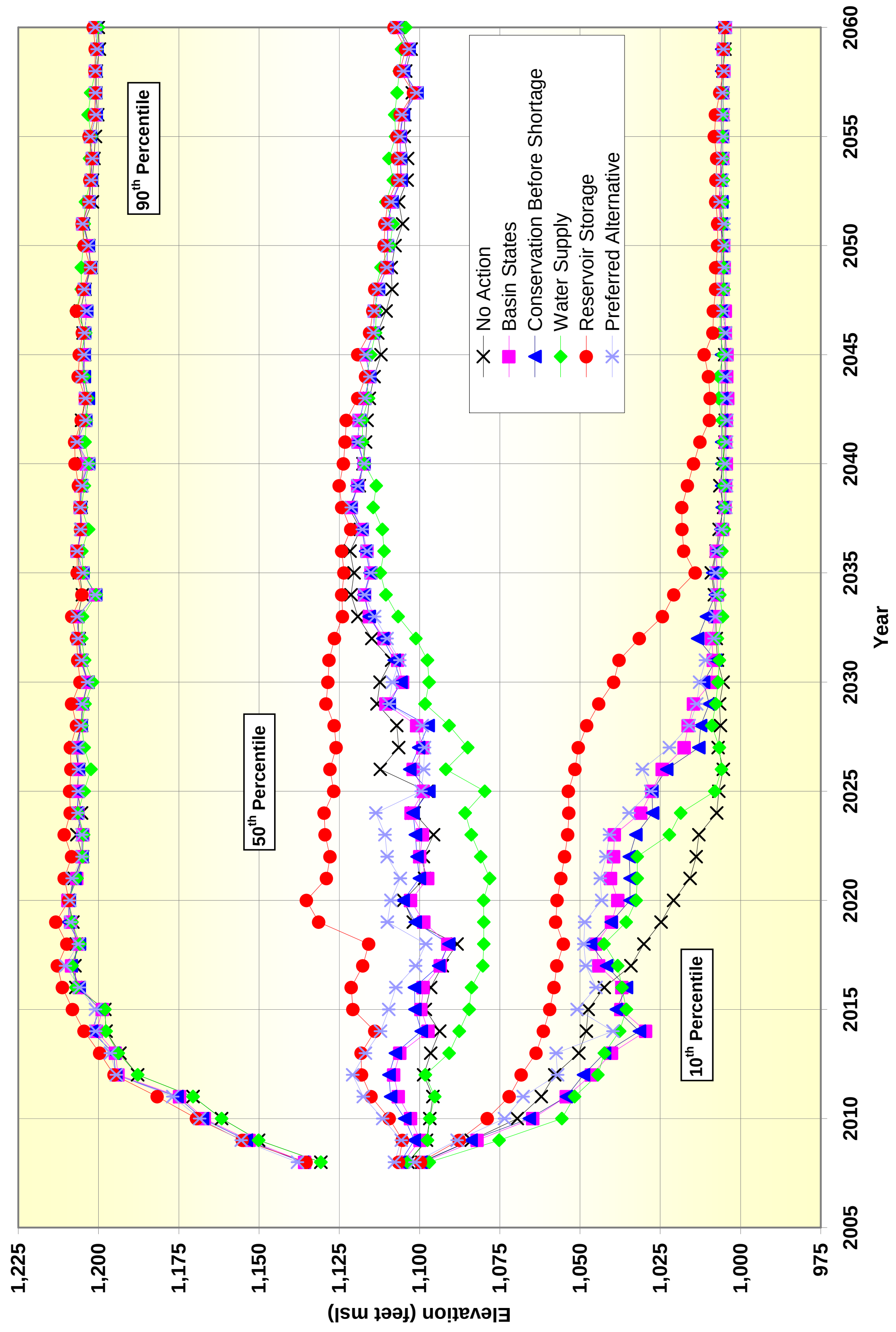


Figure P- BCR-8
Glen Canyon Dam January Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

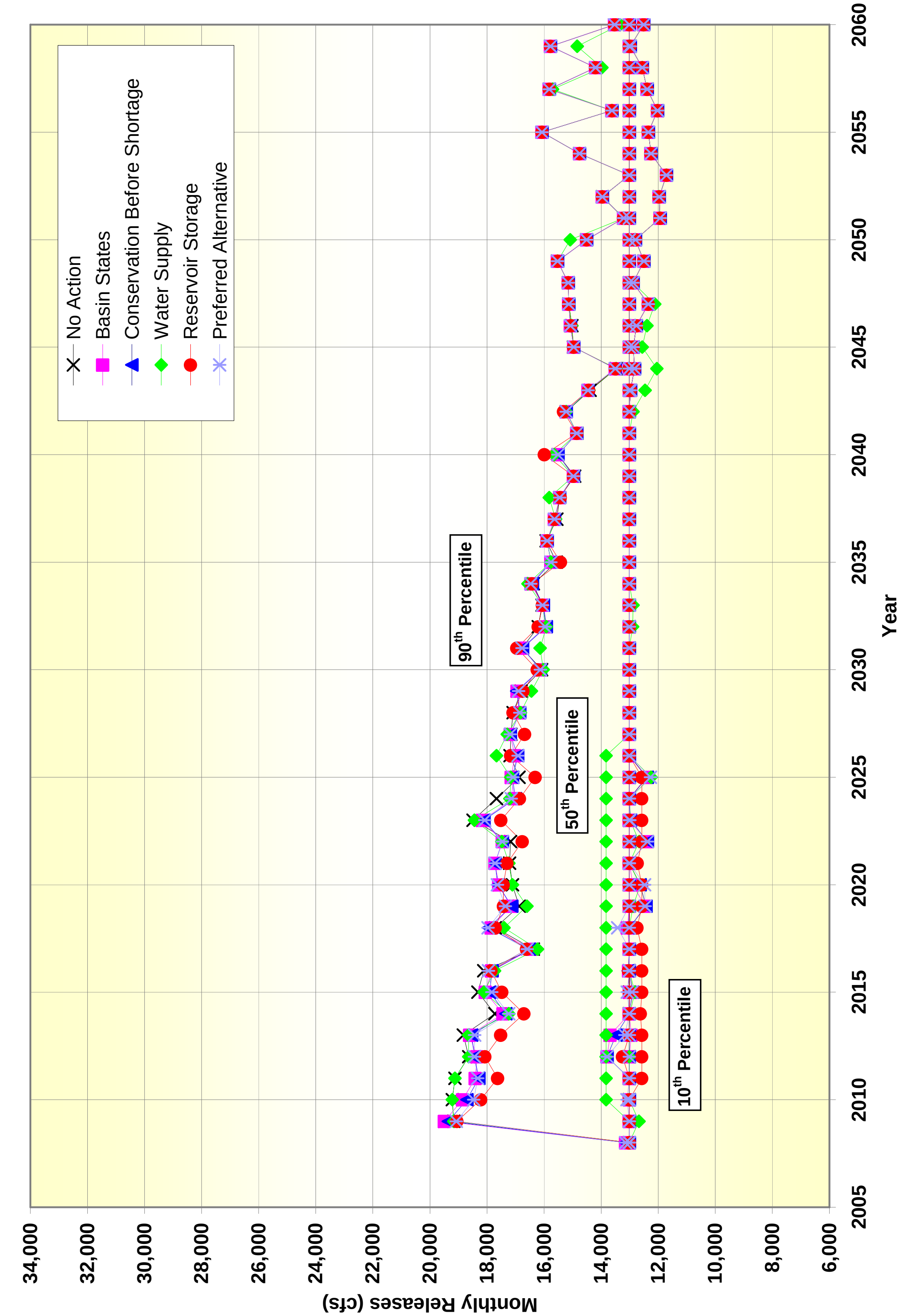


Figure P- BCR-9
Glen Canyon Dam February Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

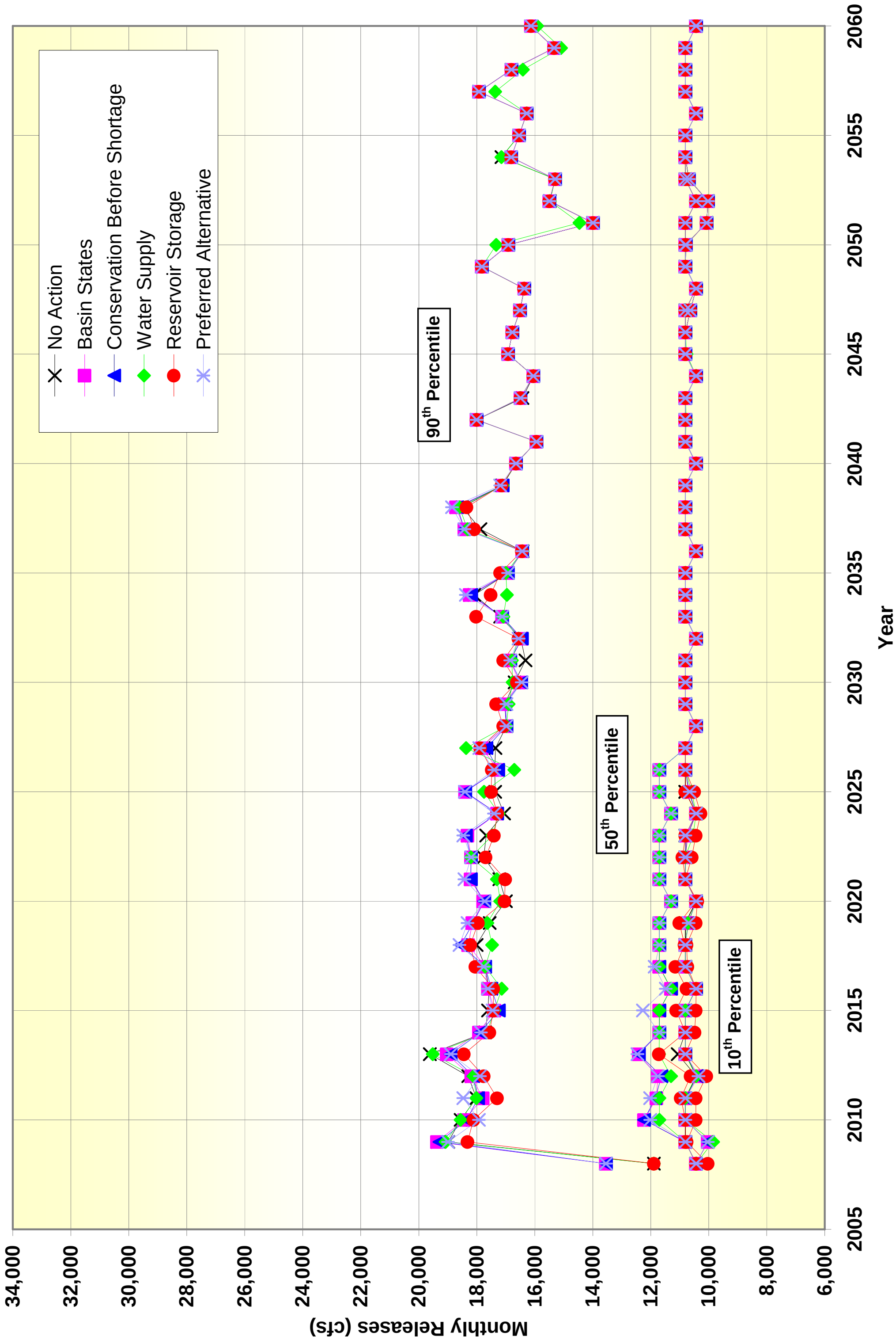


Figure P- BCR-10
Glen Canyon Dam March Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

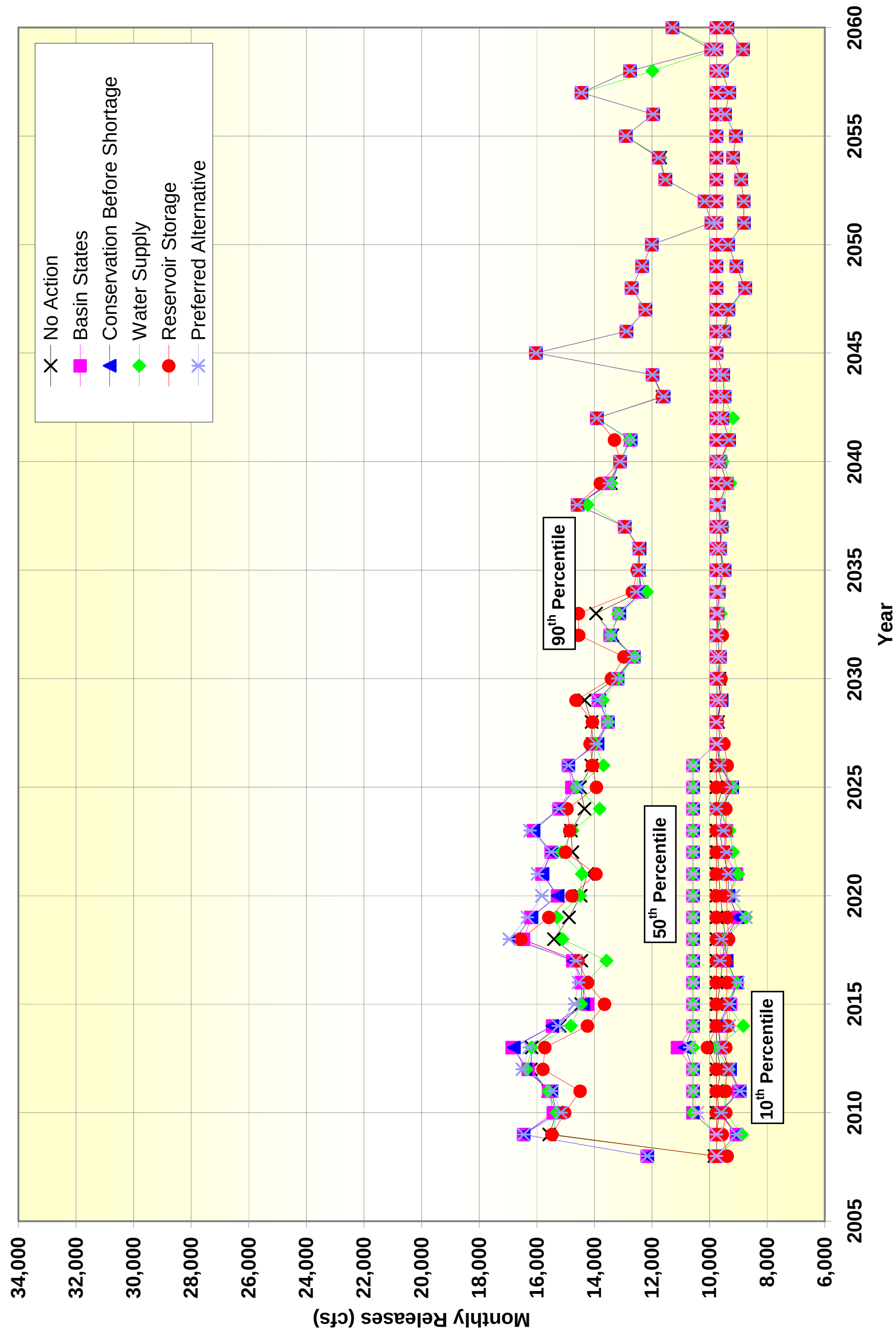


Figure P- BCR-11
Glen Canyon Dam April Releases
Comparison of Action Alternatives to No Action Alternative
90^{th}, 50^{th}, and 10^{th} Percentile Values

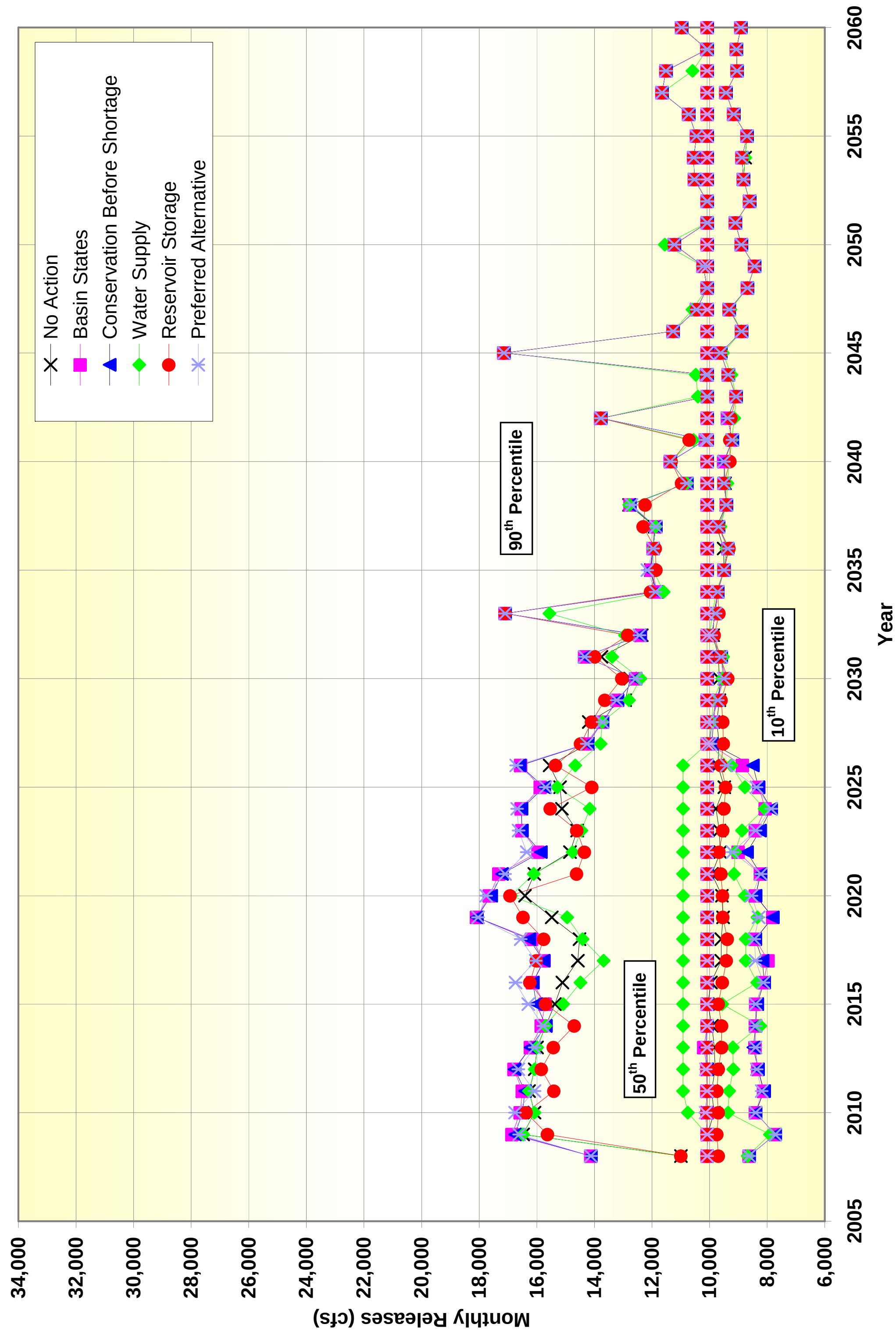


Figure P- BCR-12
Glen Canyon Dam May Releases
Comparison of Action Alternatives to No Action Alternative
90^{th}, 50^{th}, and 10^{th} Percentile Values

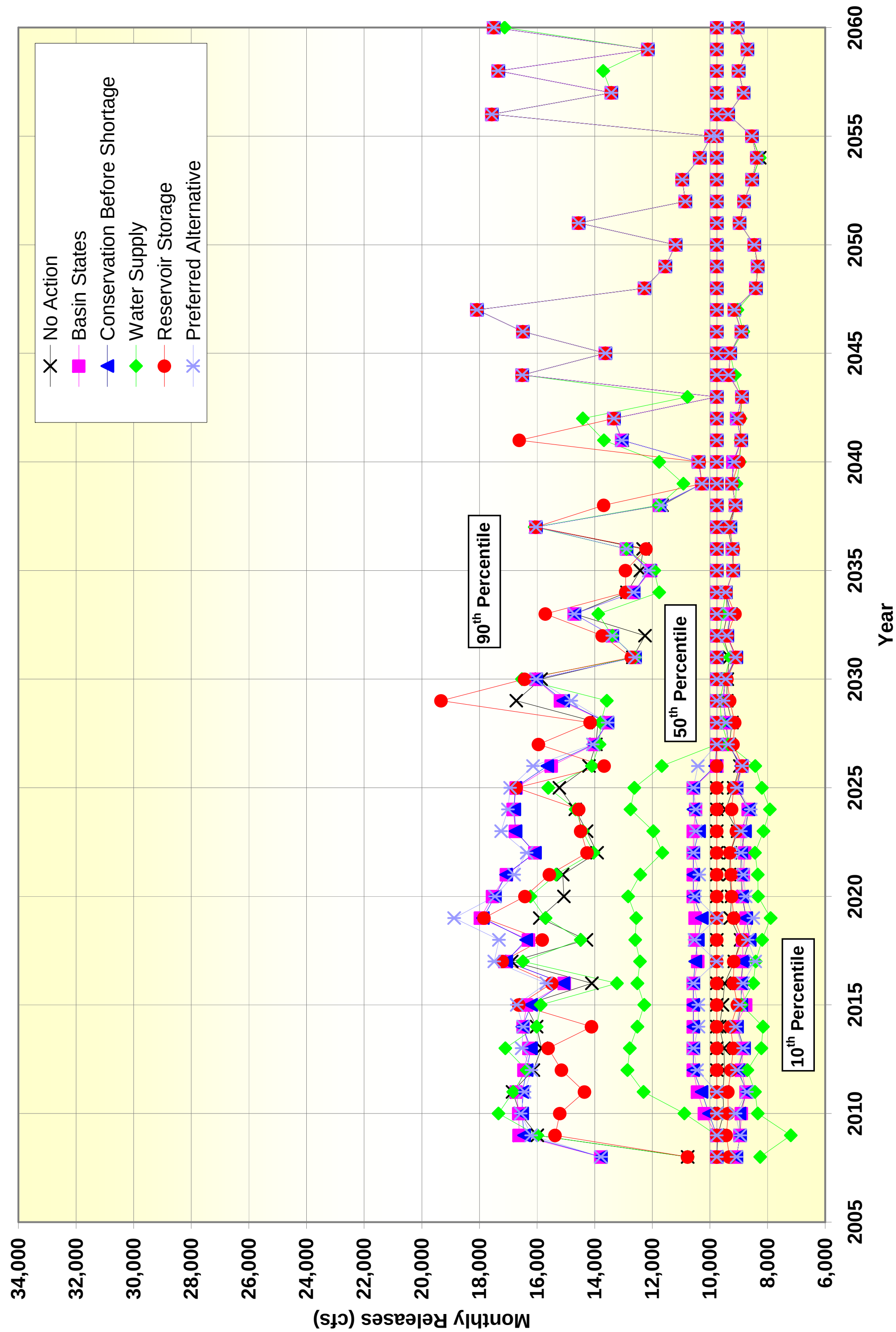


Figure P- BCR-13
Glen Canyon Dam June Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

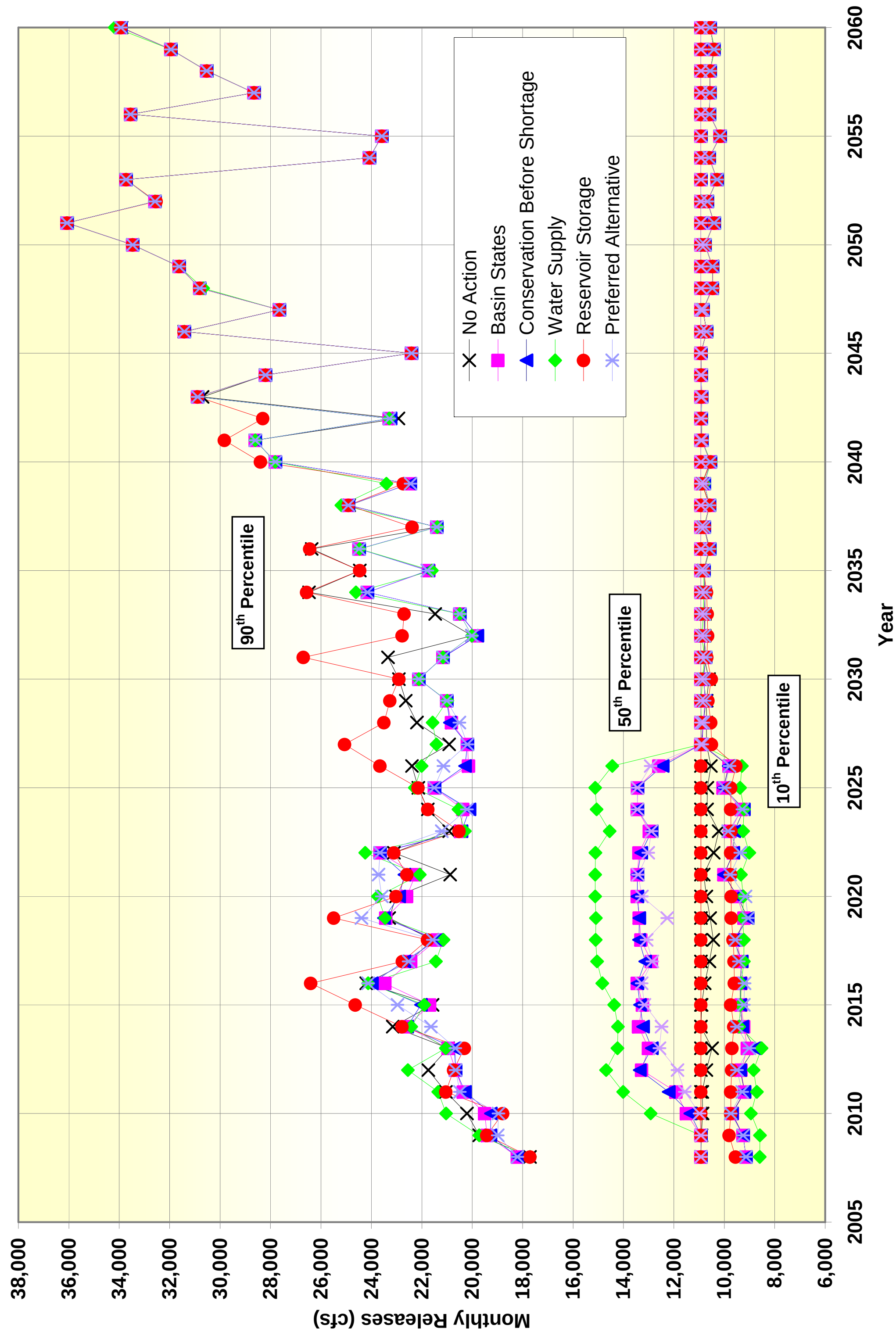


Figure P- BCR-14
Glen Canyon Dam July Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

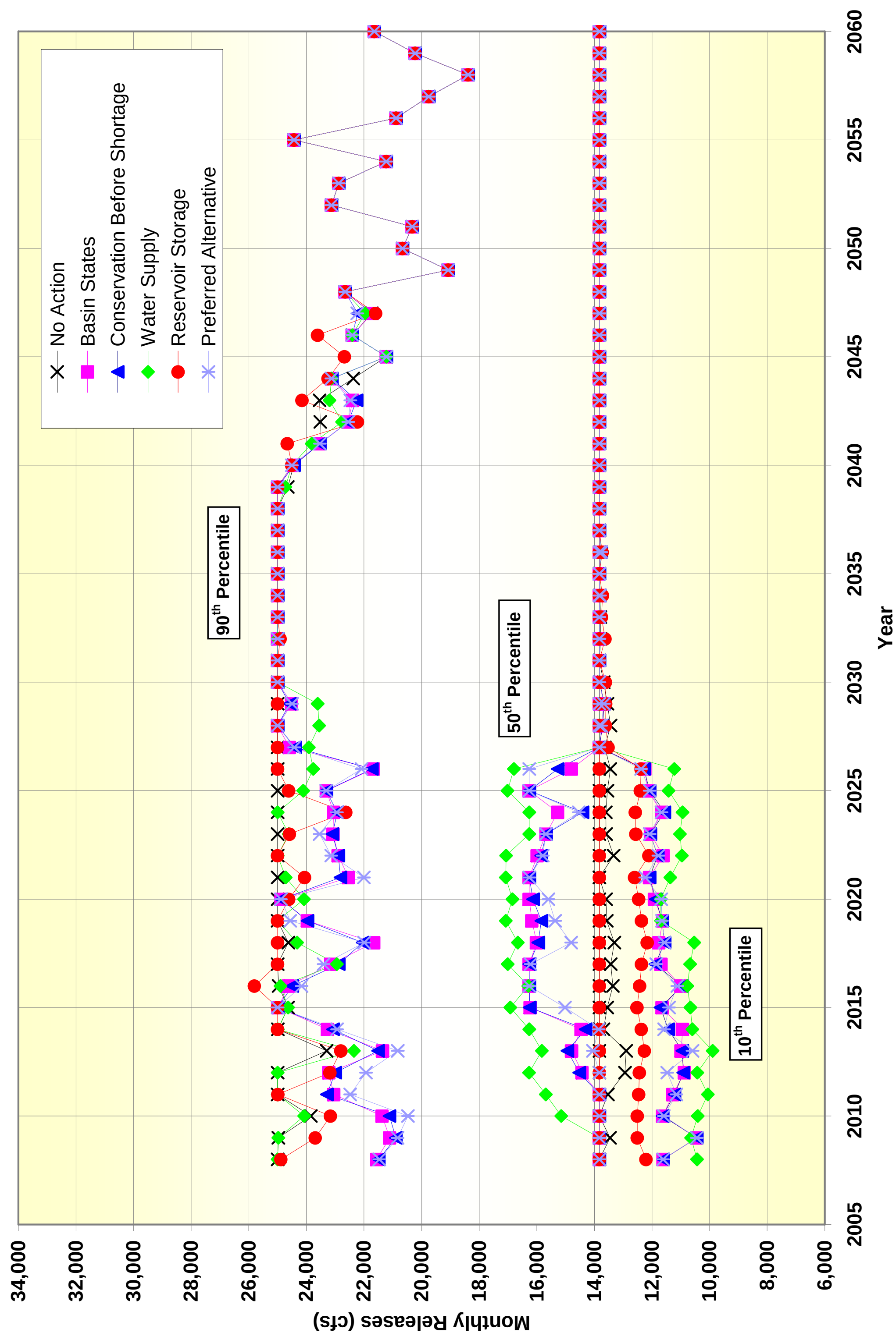


Figure P- BCR-15
Glen Canyon Dam August Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

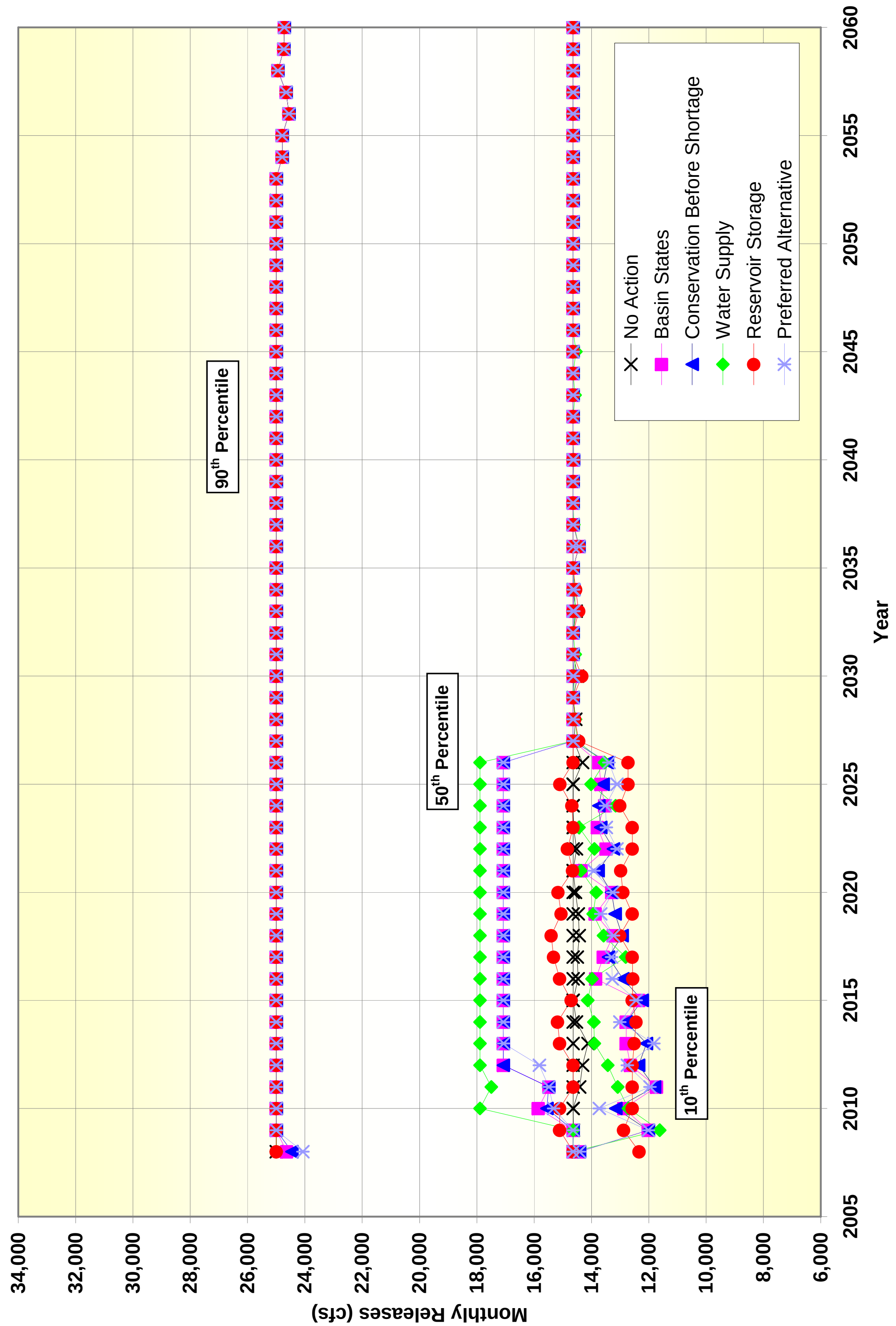


Figure P- BCR-16
Glen Canyon Dam September Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

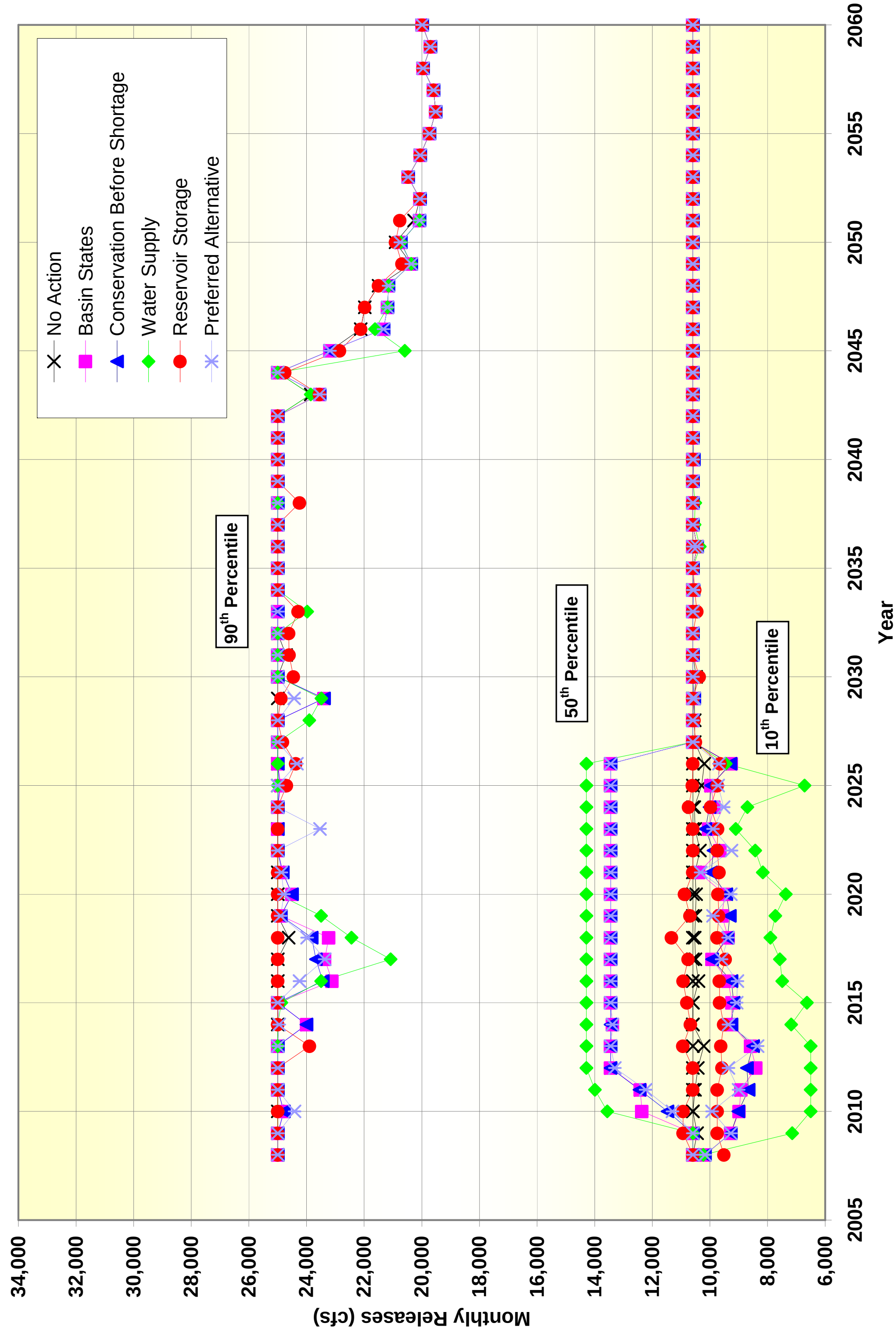


Figure P- BCR-17
Glen Canyon Dam October Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

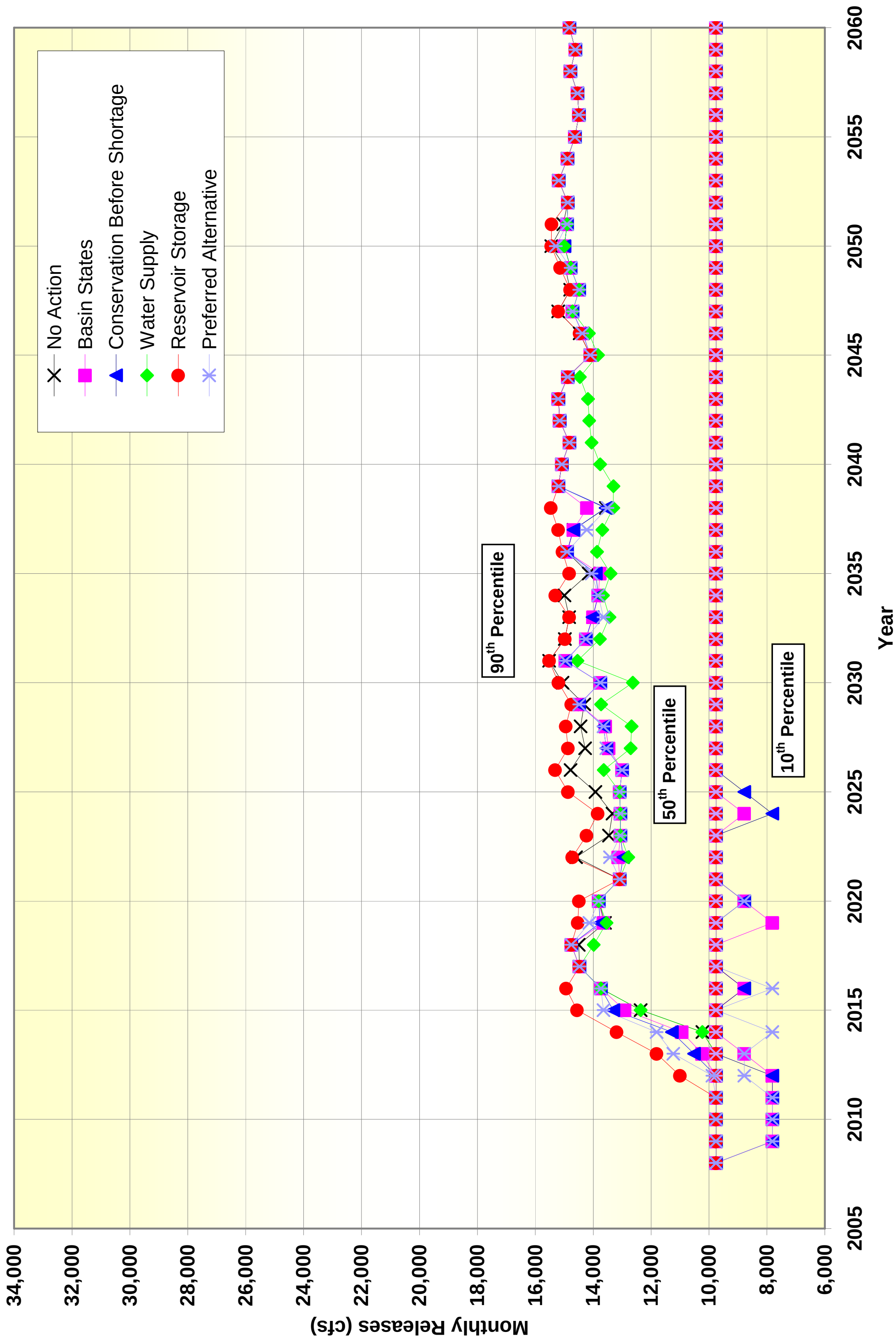


Figure P- BCR-18
Glen Canyon Dam November Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

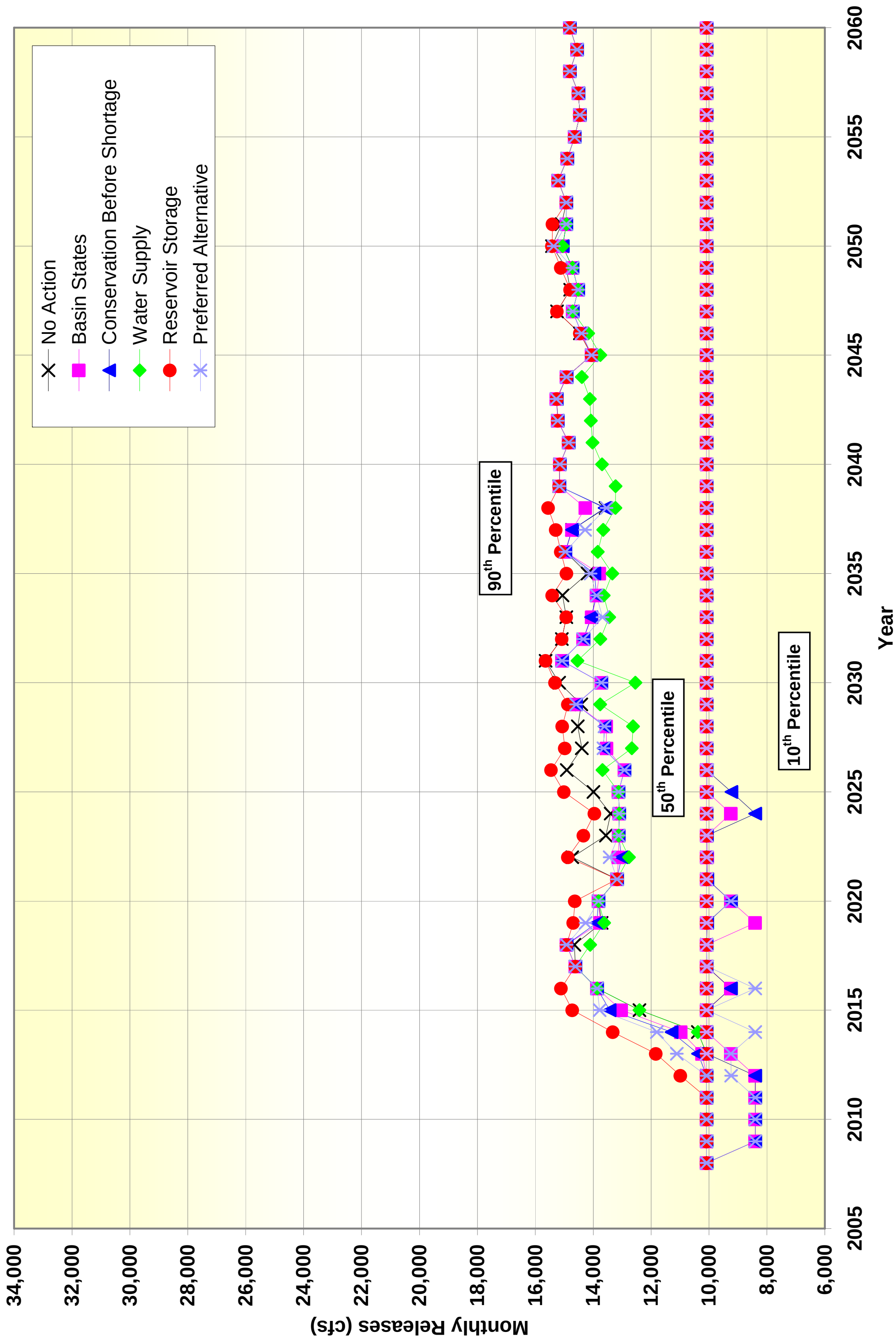


Figure P- BCR-19
Glen Canyon Dam December Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

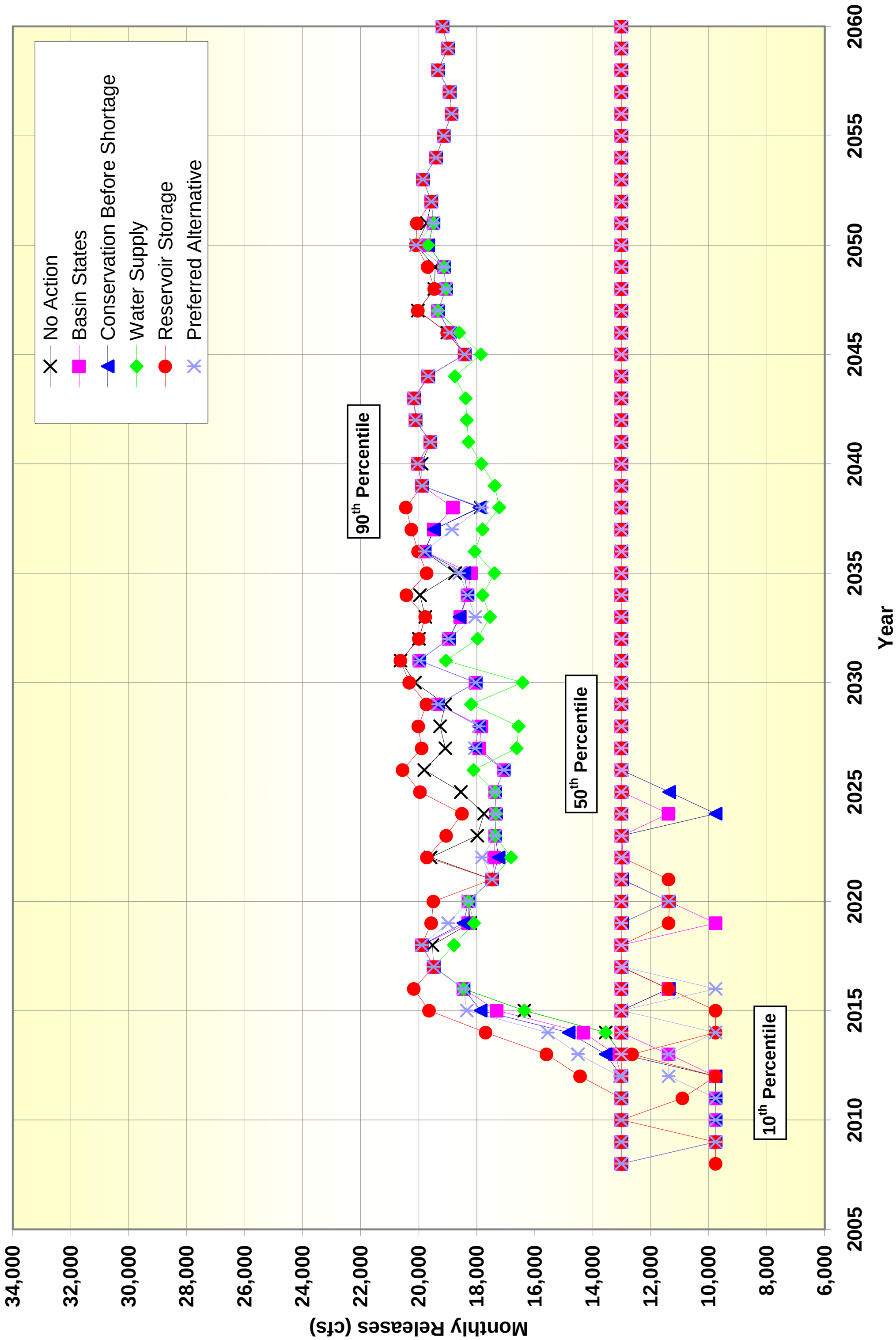


Figure P- BCR-20
Hoover Dam January Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

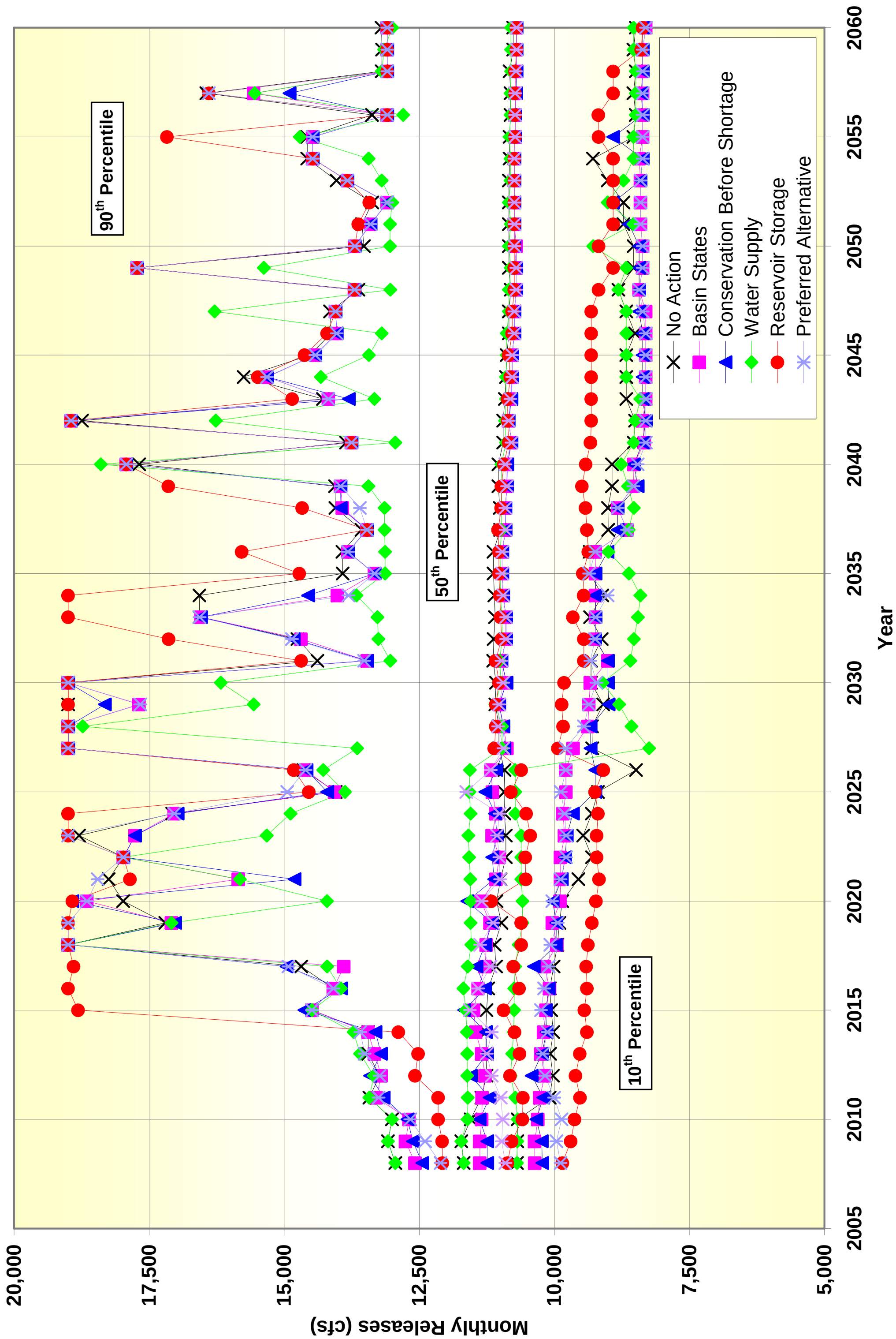


Figure P- BCR-21
Hoover Dam February Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

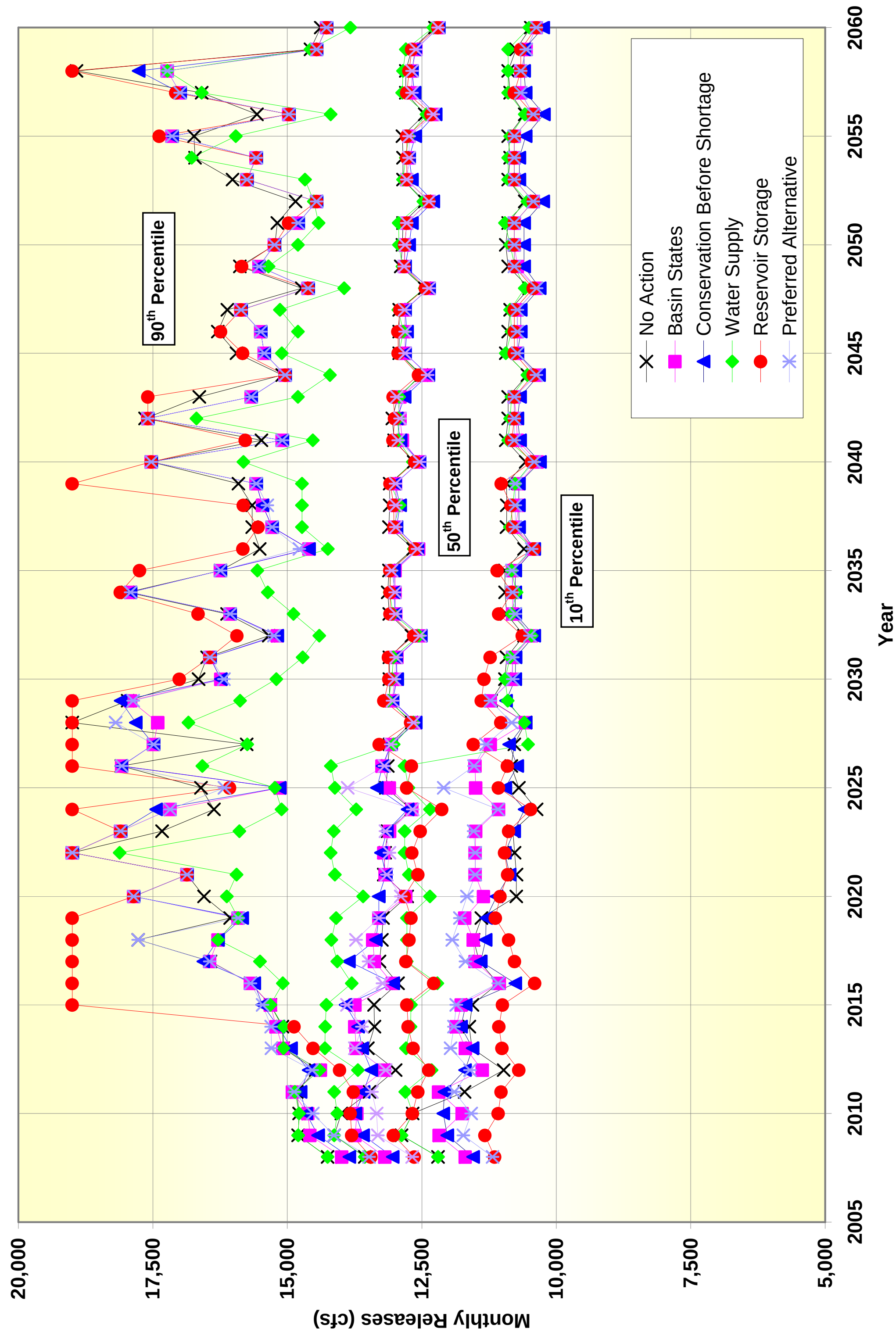


Figure P- BCR-22
Hoover Dam March Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

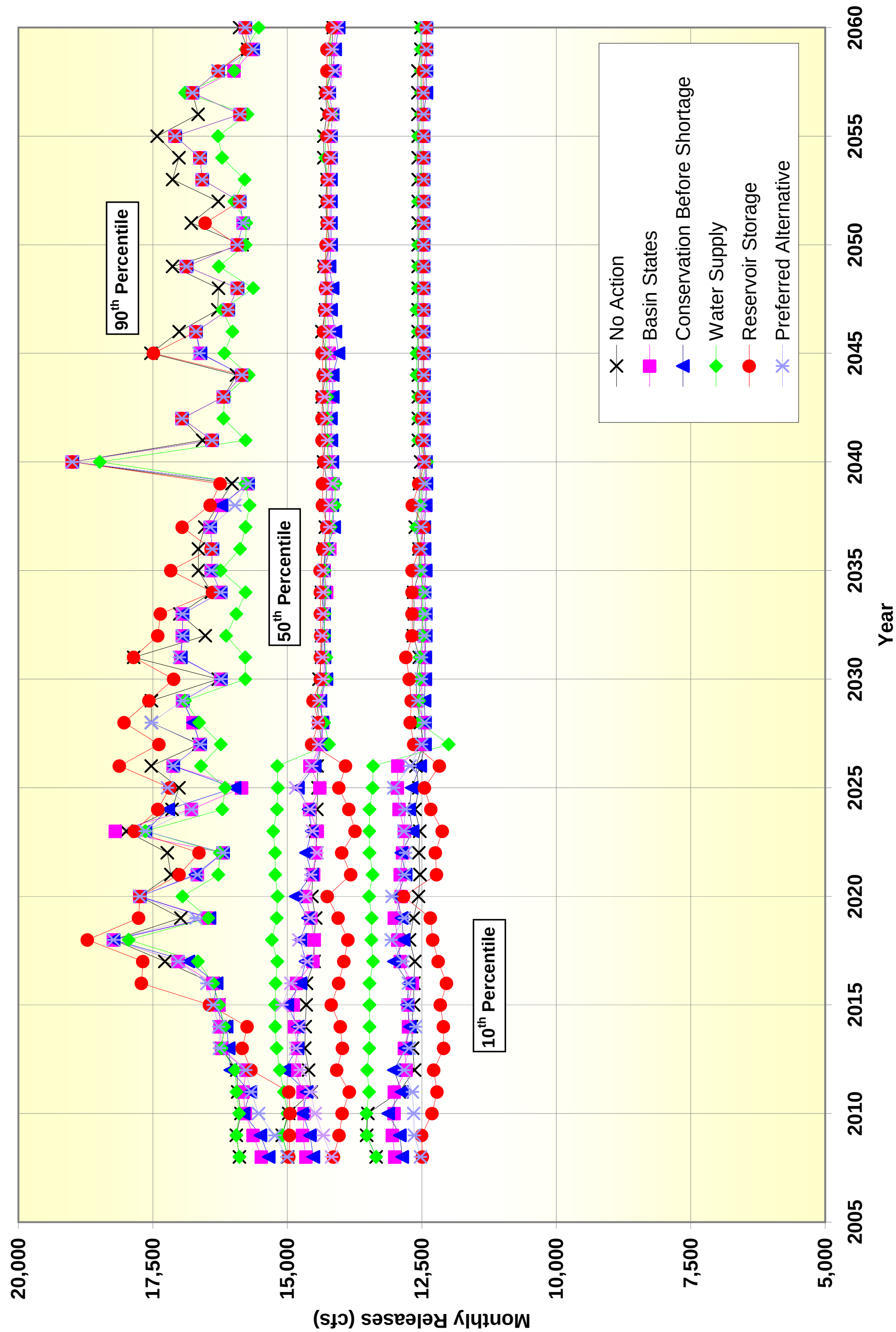


Figure P- BCR-23
Hoover Dam April Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

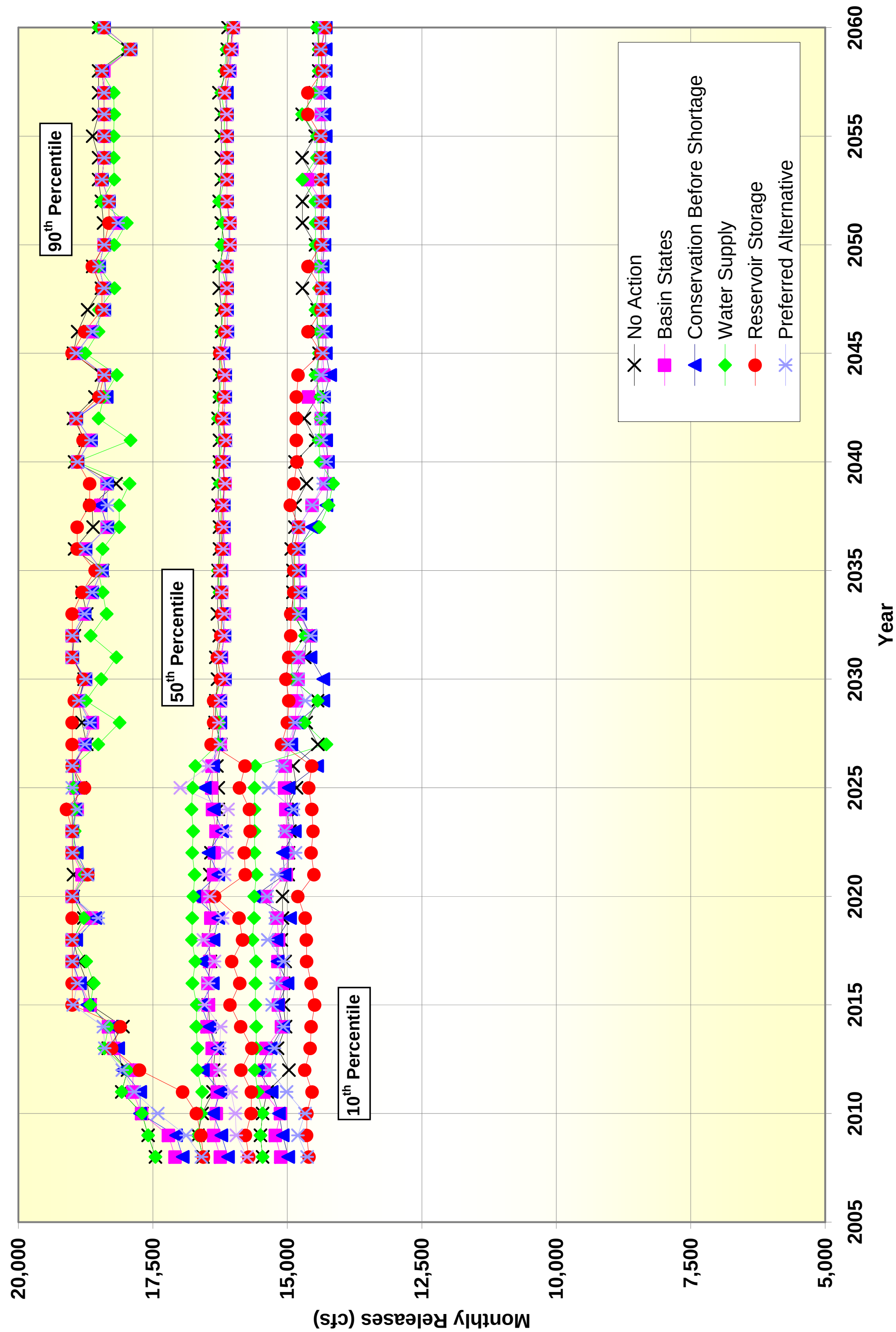


Figure P- BCR-24
Hoover Dam May Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

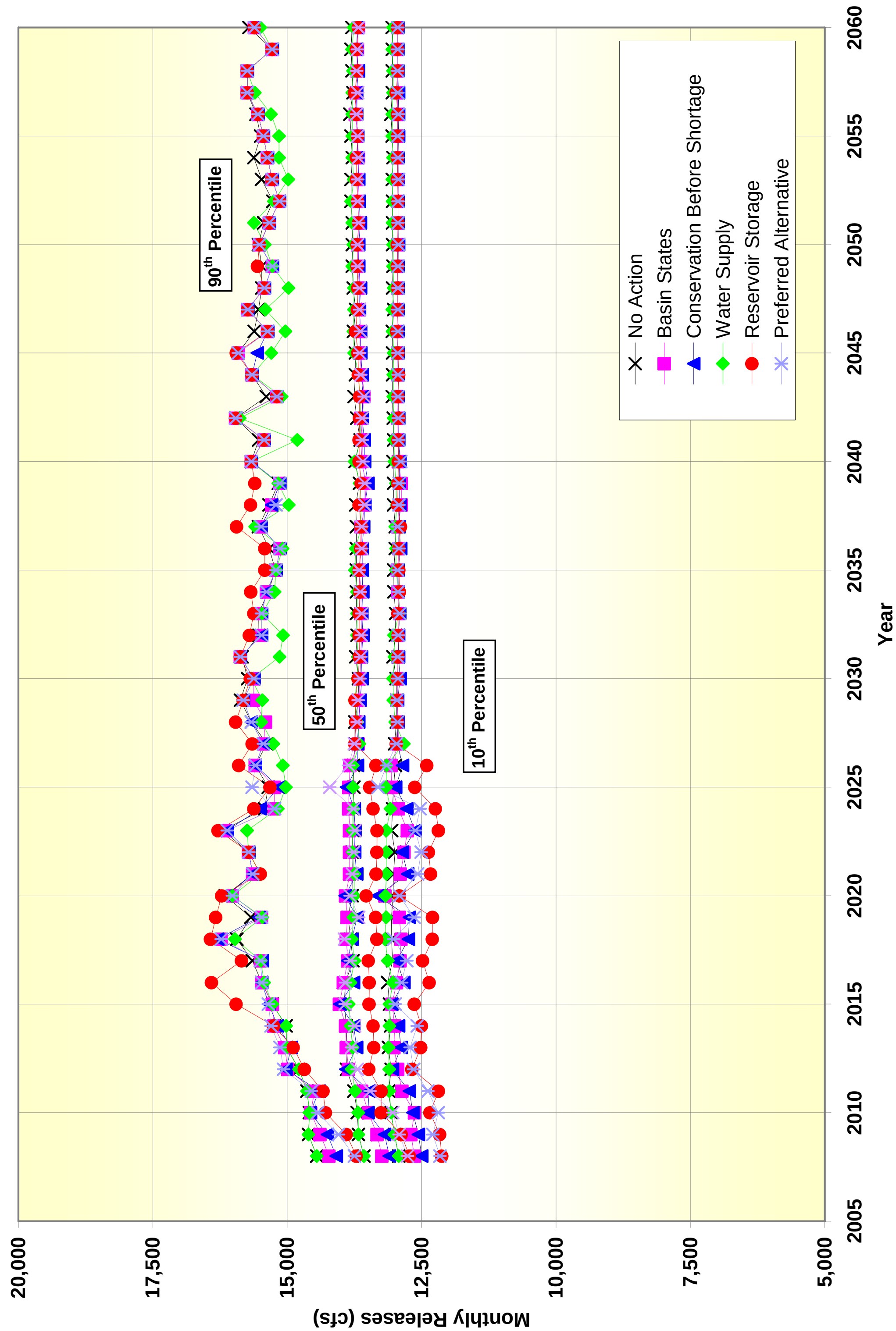


Figure P- BCR-25
Hoover Dam June Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

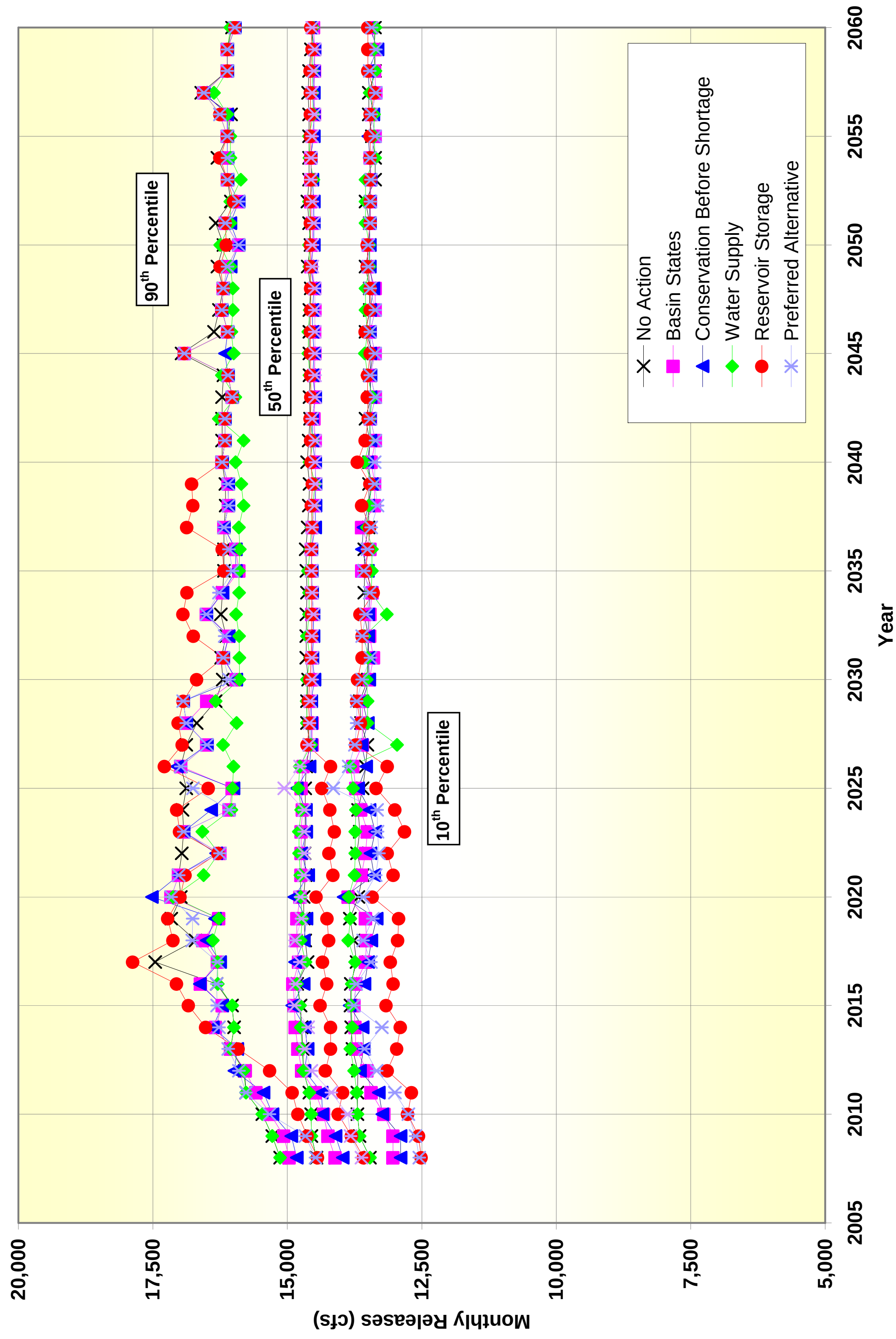


Figure P- BCR-26
Hoover Dam July Releases
Comparison of Action Alternatives to No Action Alternative
90^{th}, 50^{th}, and 10^{th} Percentile Values

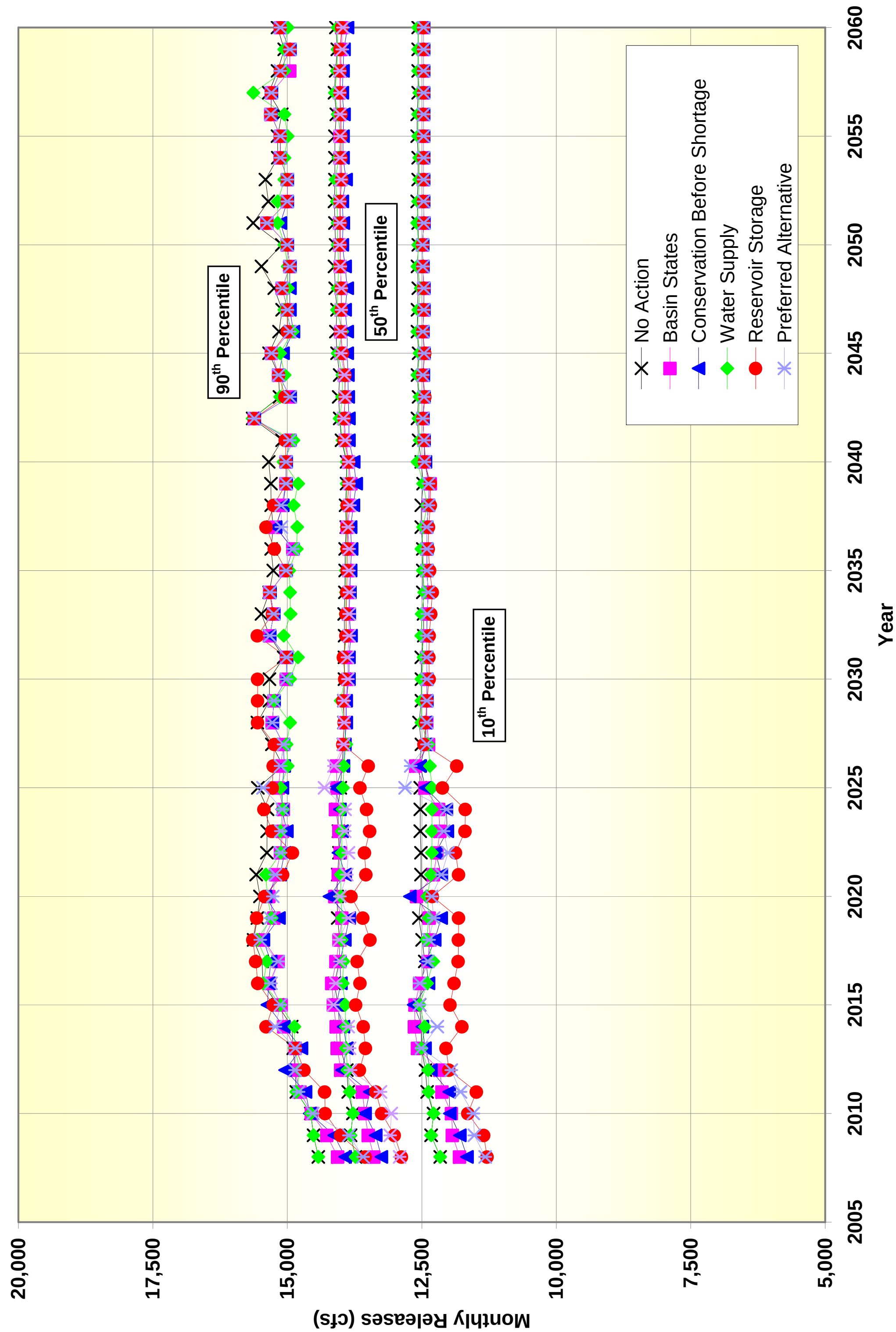


Figure P- BCR-27
Hoover Dam August Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

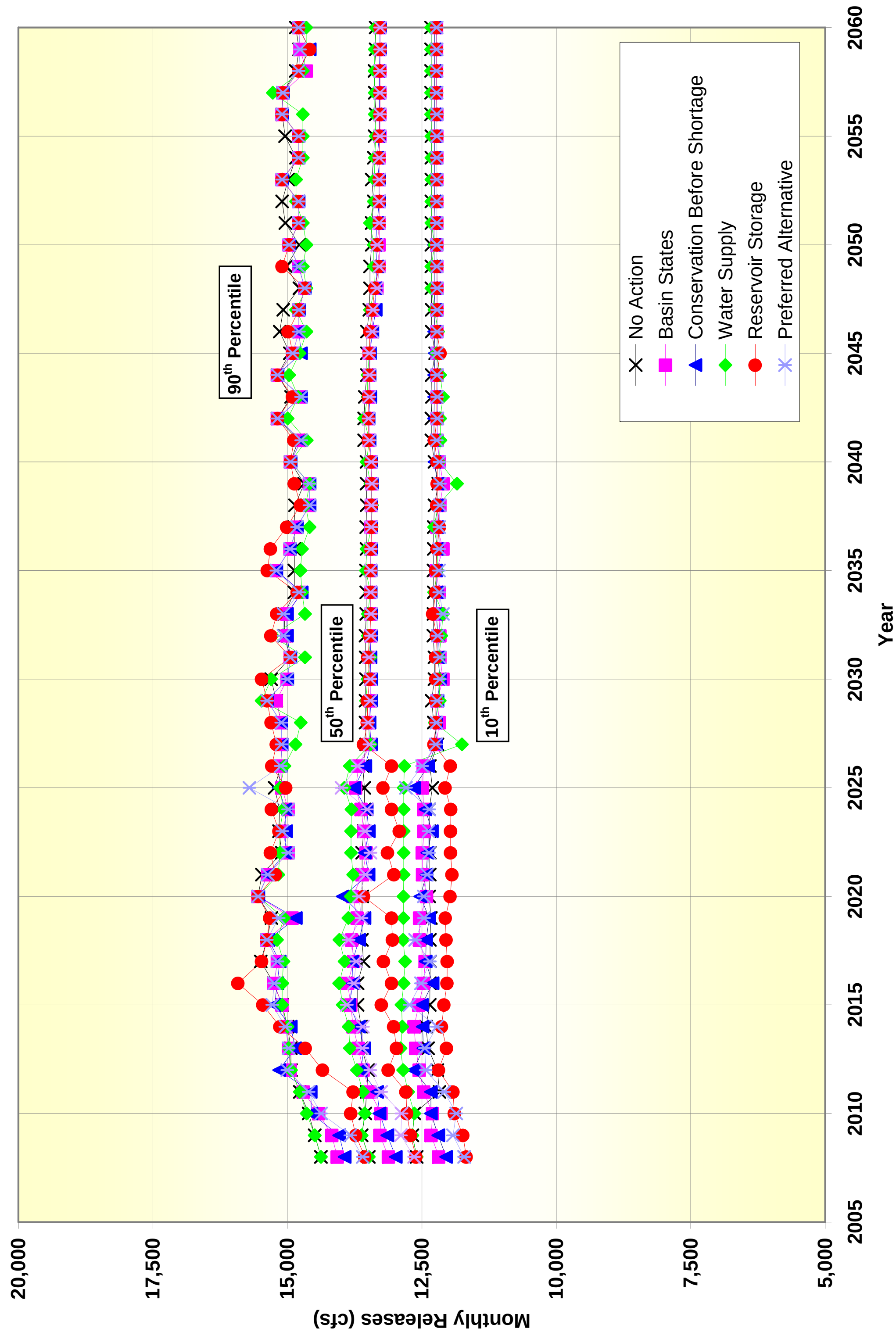


Figure P- BCR-28
Hoover Dam September Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

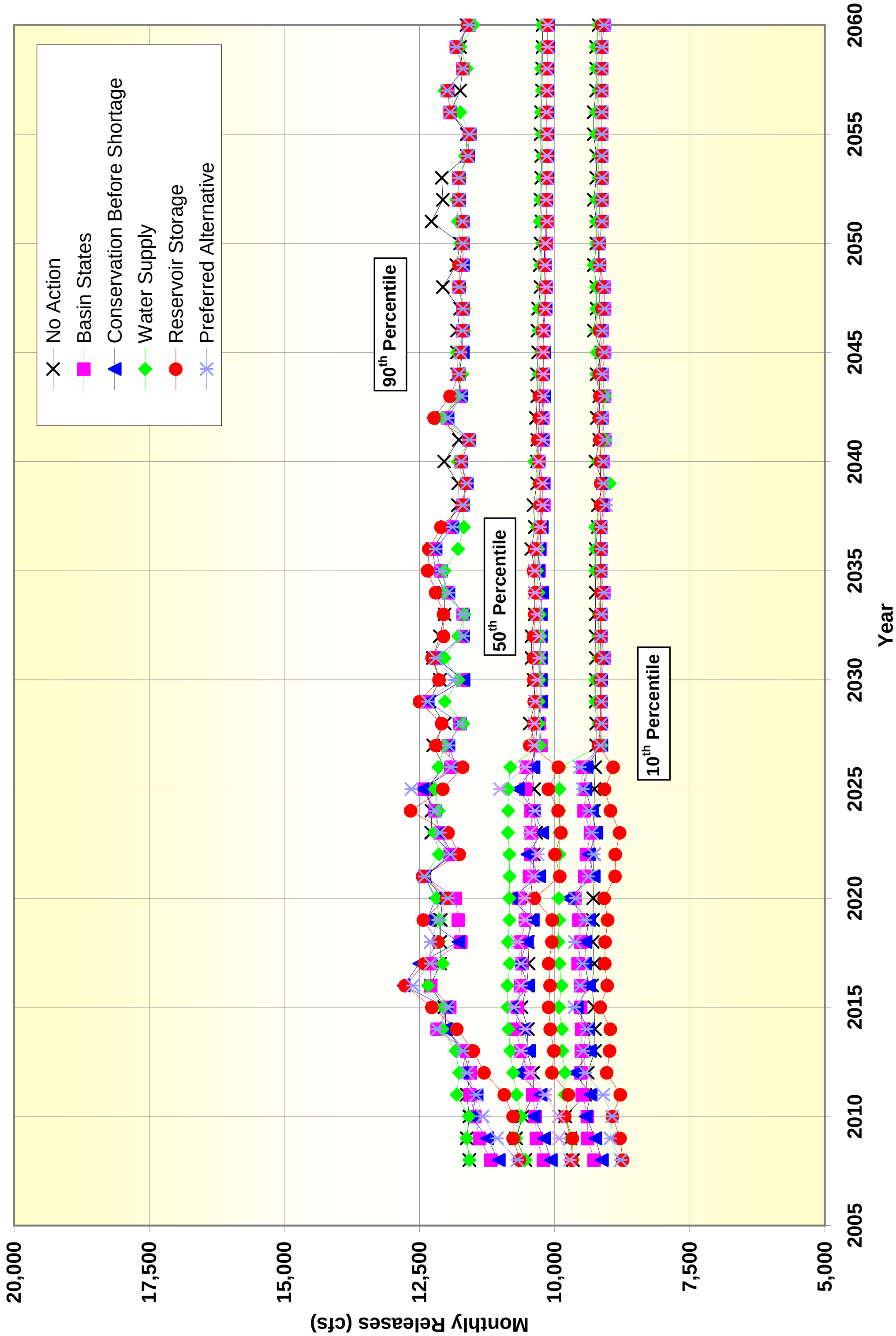


Figure P- BCR-29
Hoover Dam October Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

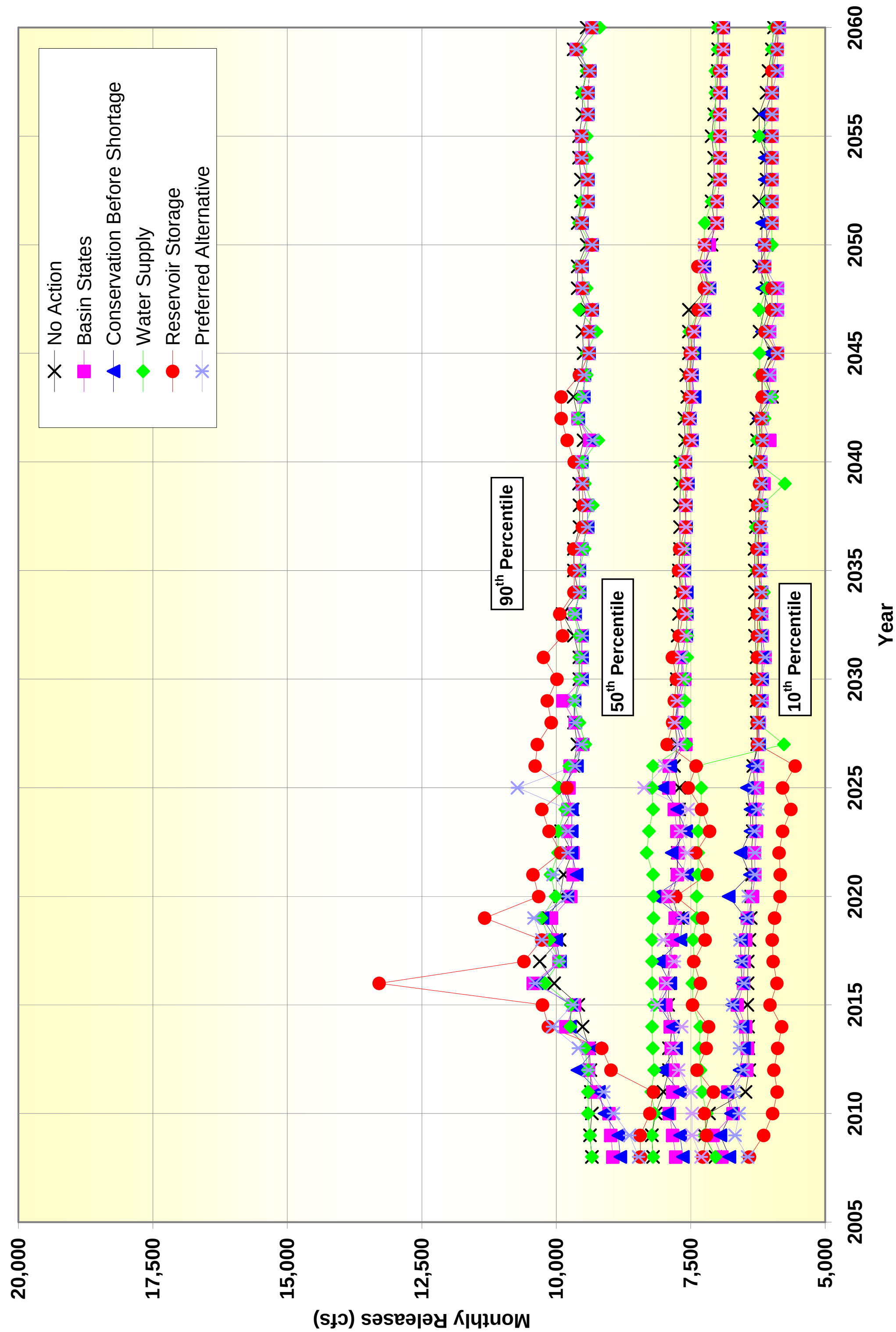


Figure P- BCR-30
Hoover Dam November Releases
Comparison of Action Alternatives to No Action Alternative
90^{th}, 50^{th}, and 10^{th} Percentile Values

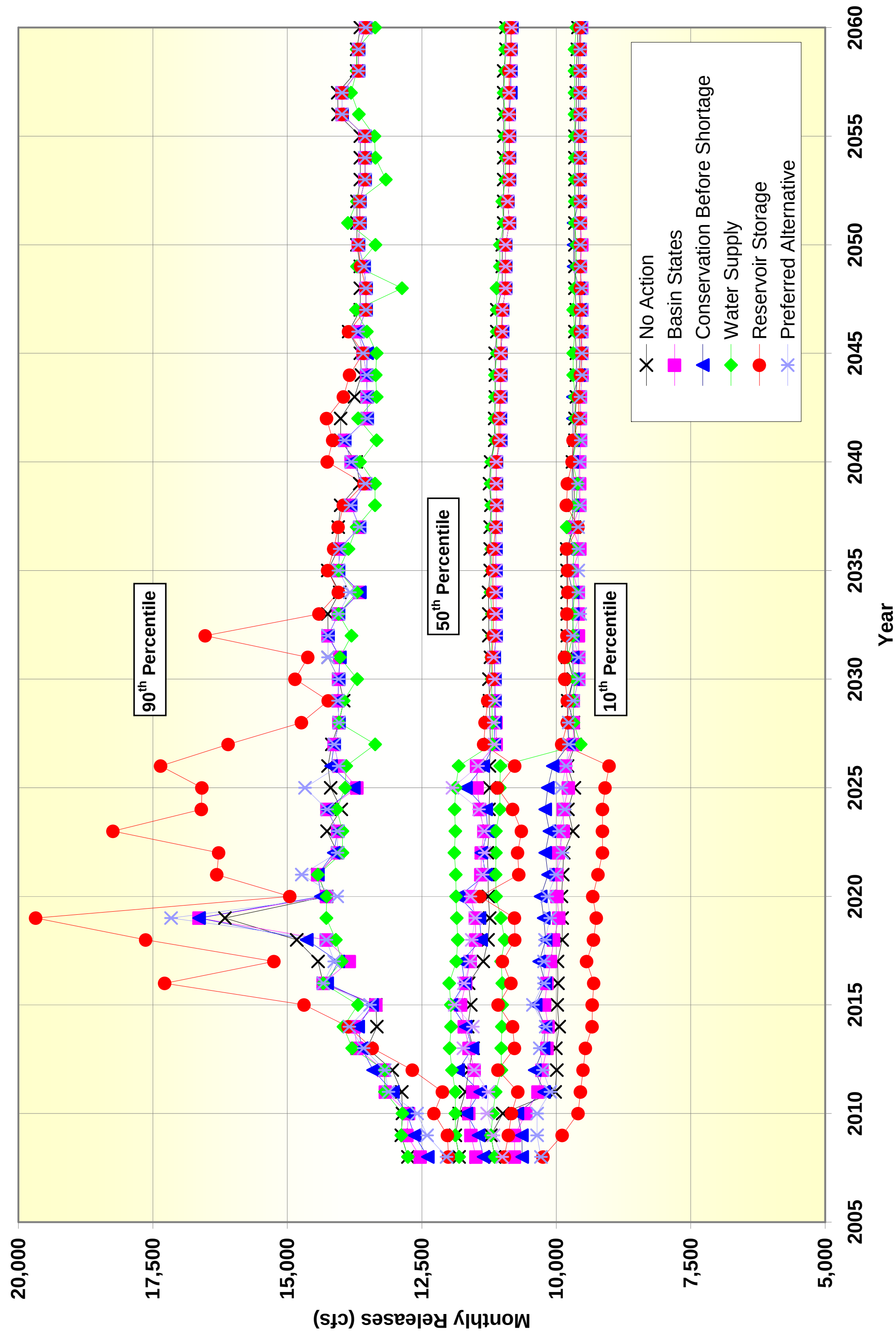


Figure P- BCR-31
Hoover Dam December Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

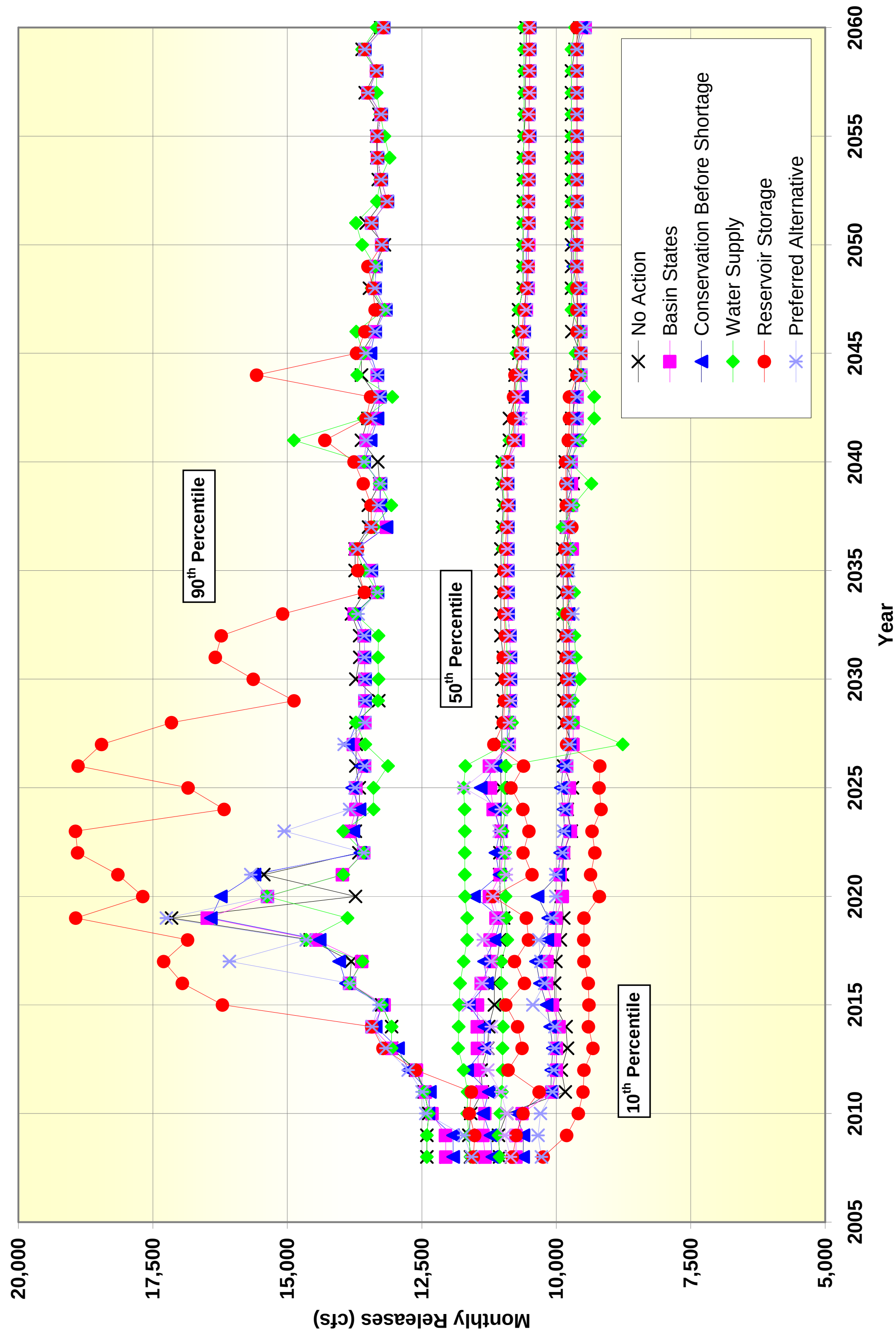


Figure P- BCR-32
Davis Dam January Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

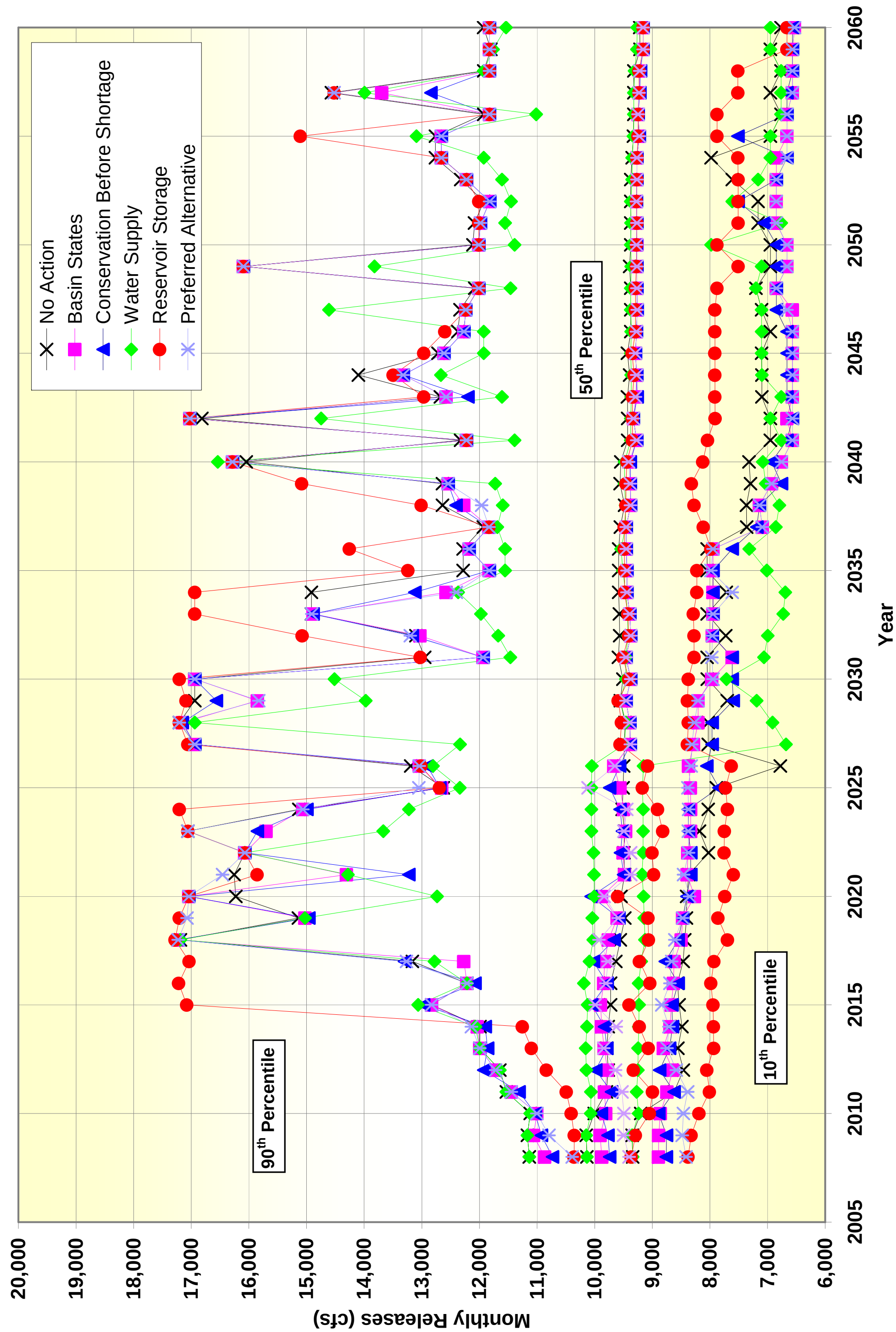


Figure P- BCR-33
Davis Dam February Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

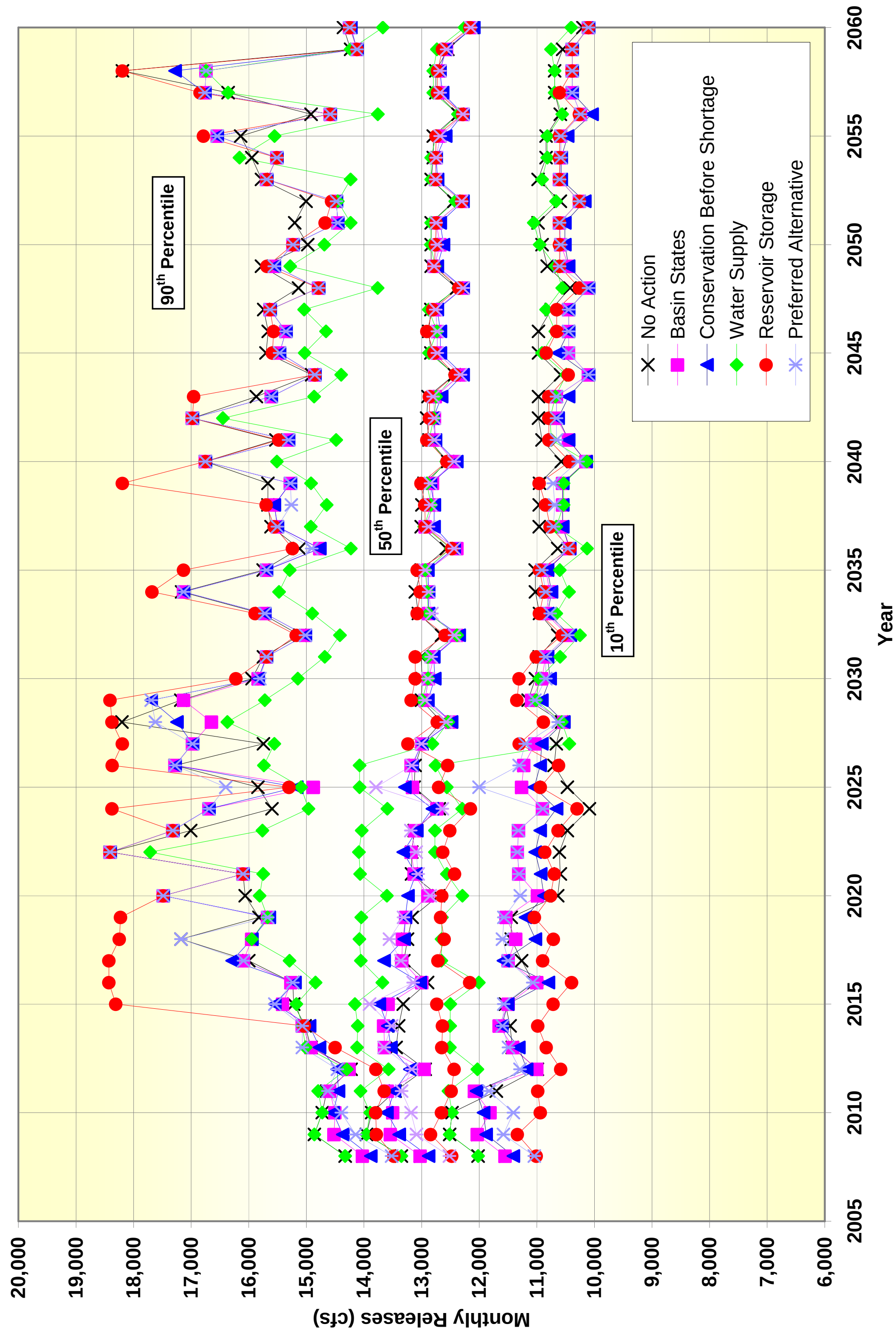


Figure P- BCR-34
Davis Dam March Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

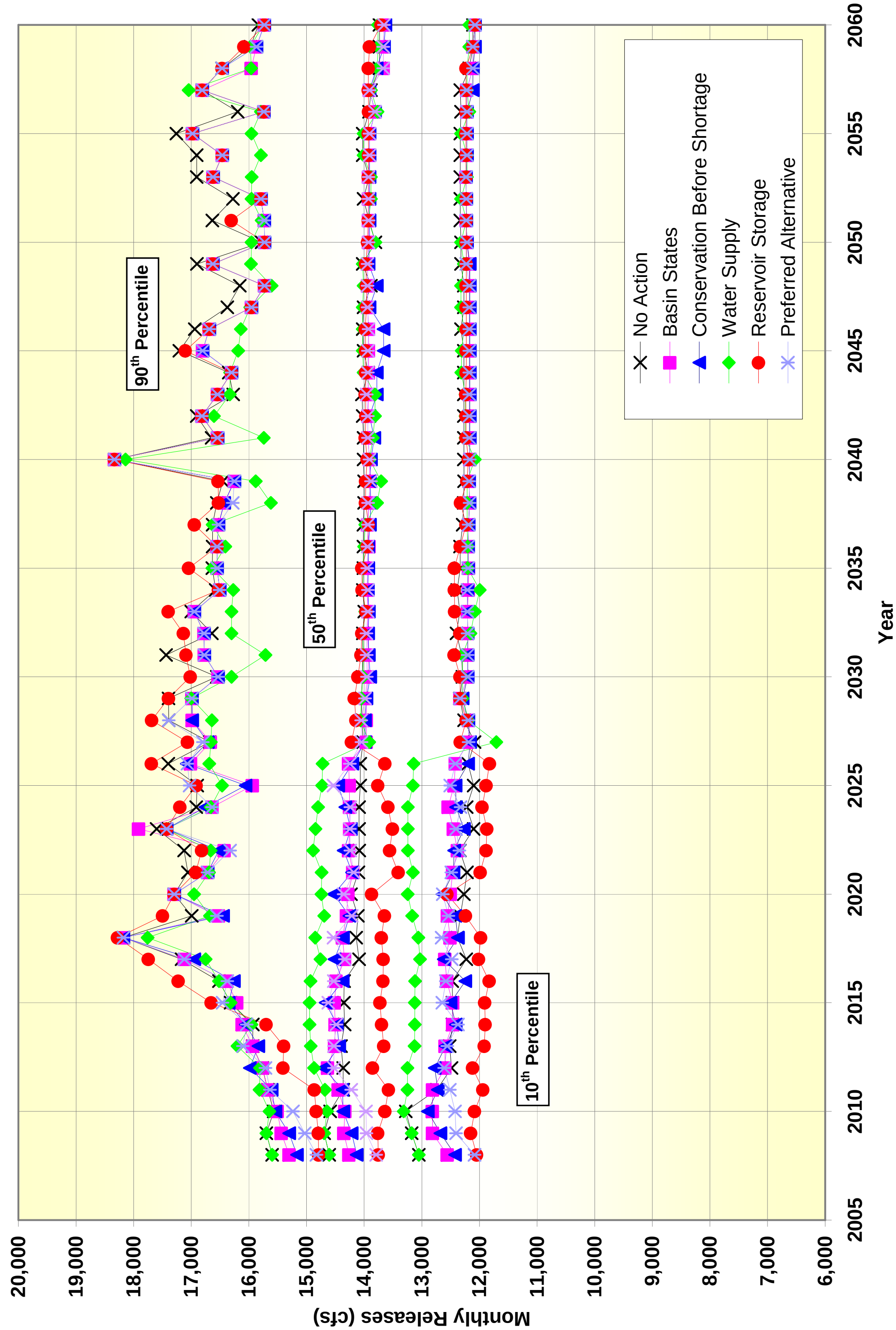


Figure P- BCR-35
Davis Dam April Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

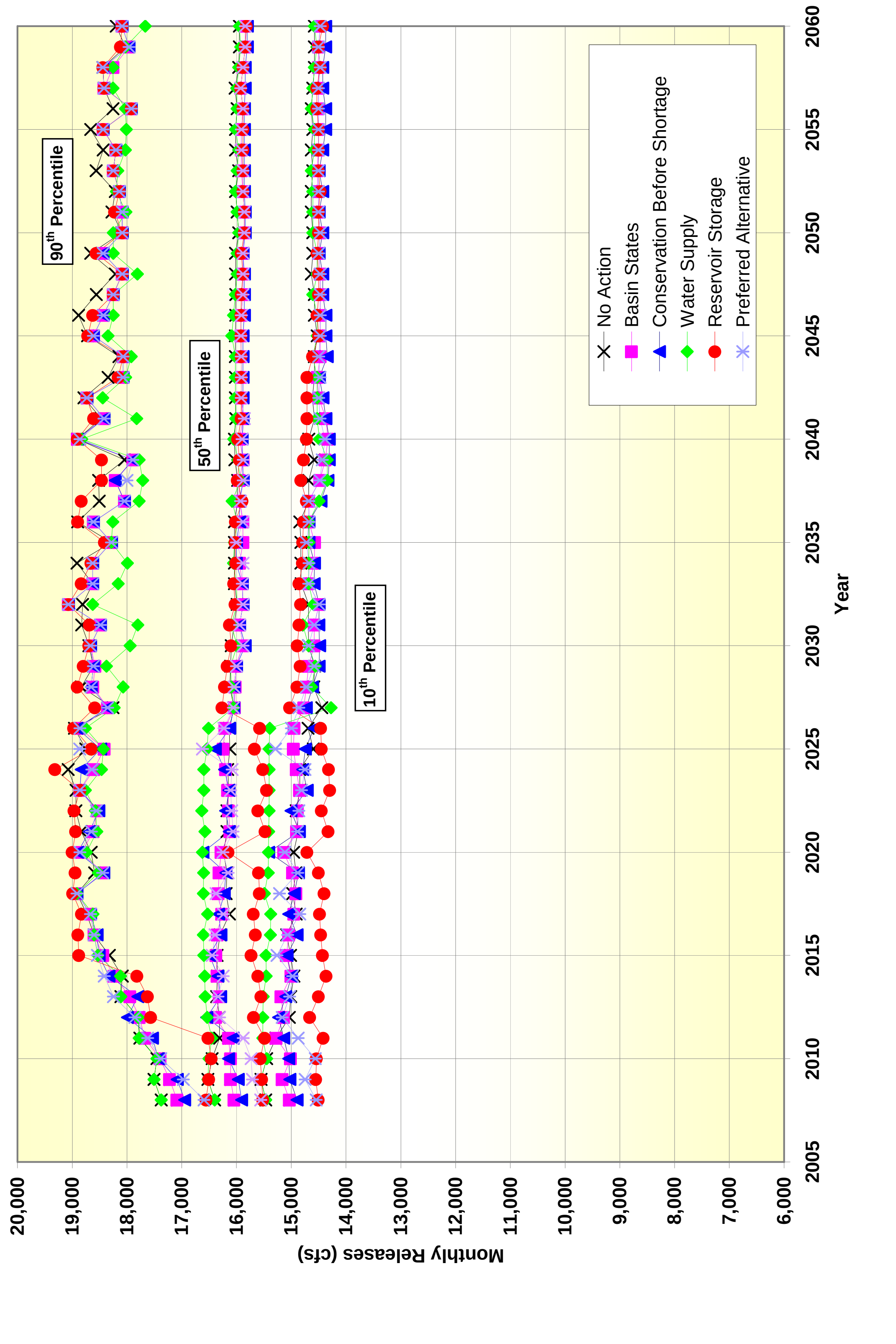


Figure P- BCR-36
Davis Dam May Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

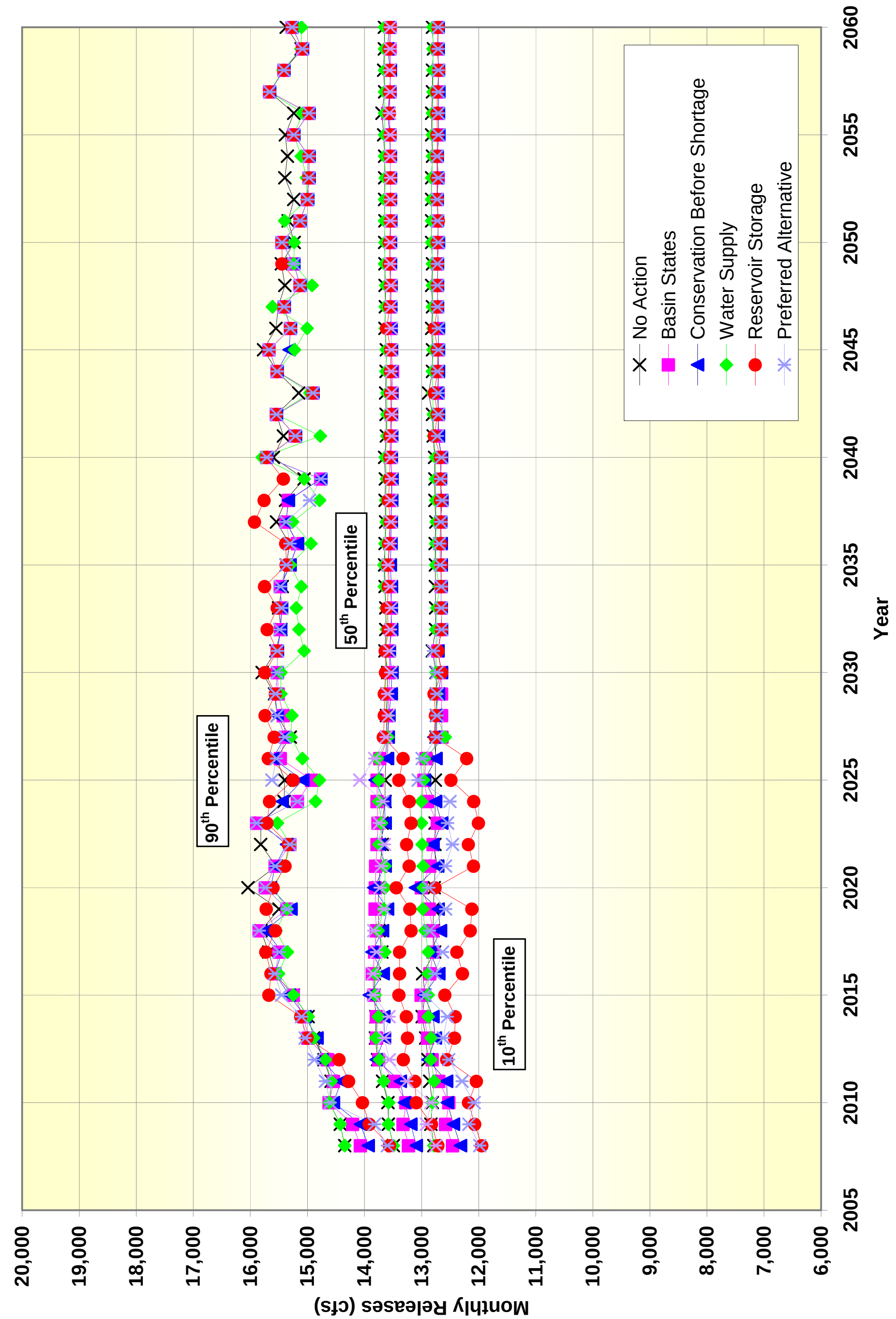


Figure P- BCR-37
Davis Dam June Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

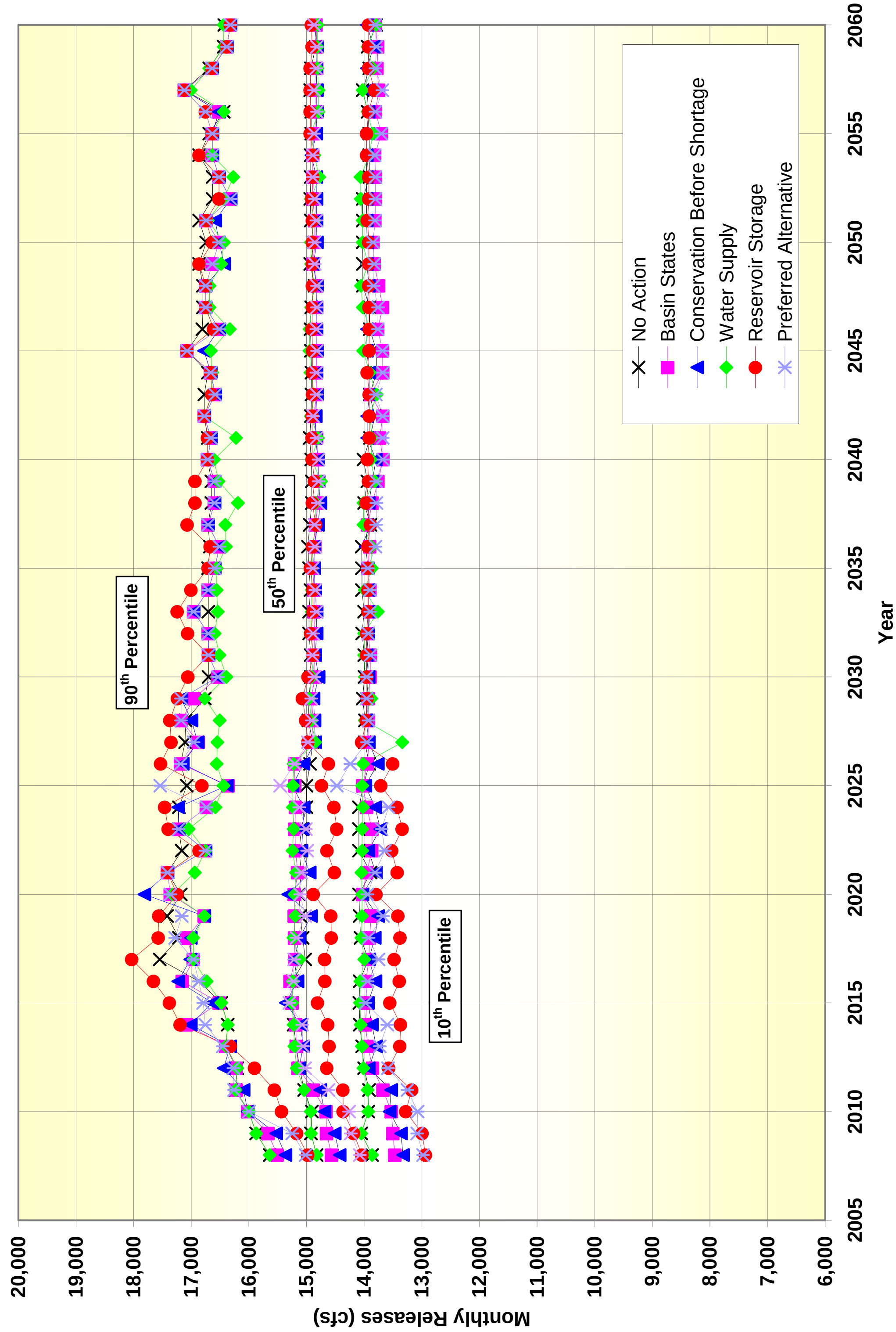


Figure P- BCR-38
Davis Dam July Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

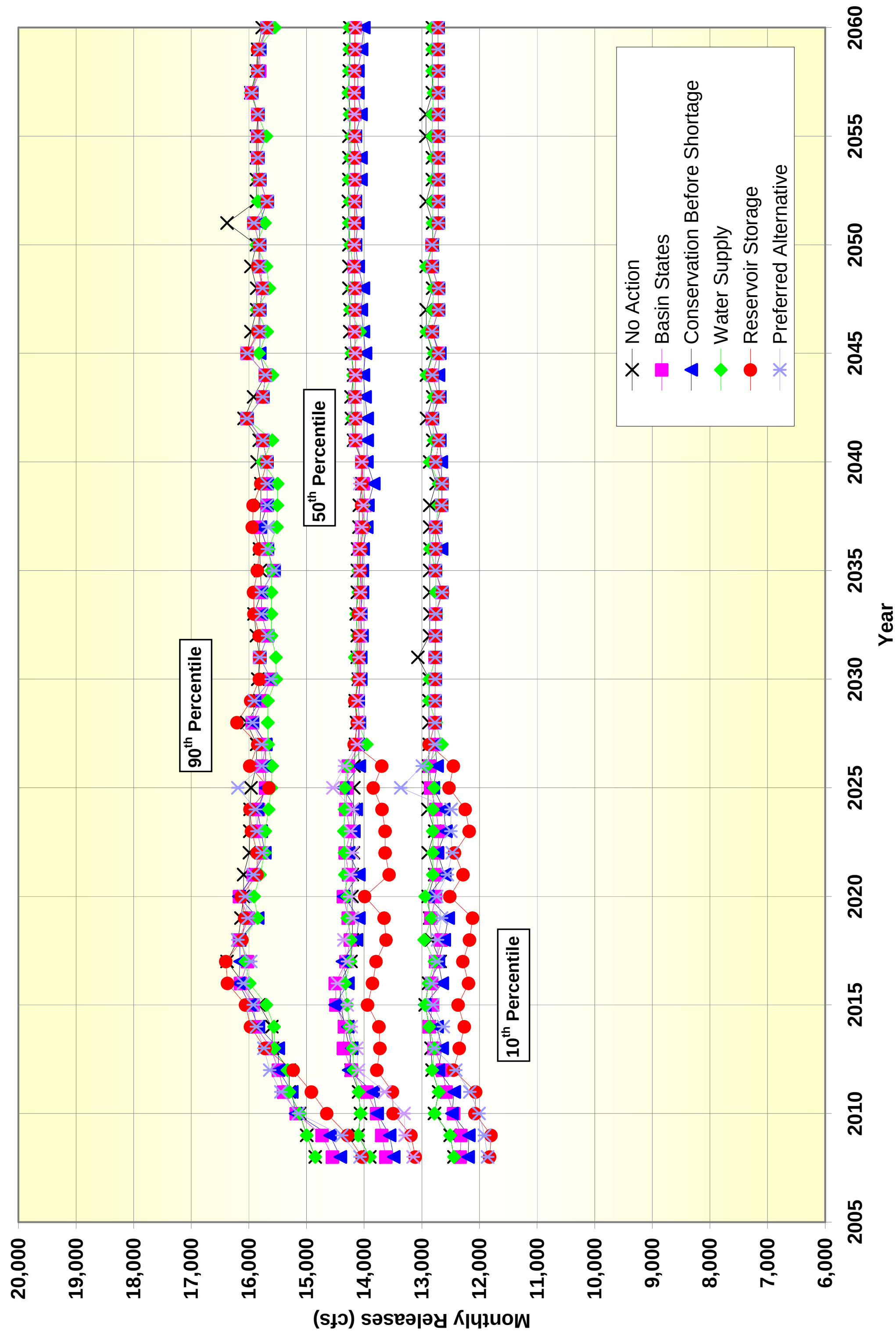


Figure P- BCR-39
Davis Dam August Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Figure P- BCR-40
Davis Dam September Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

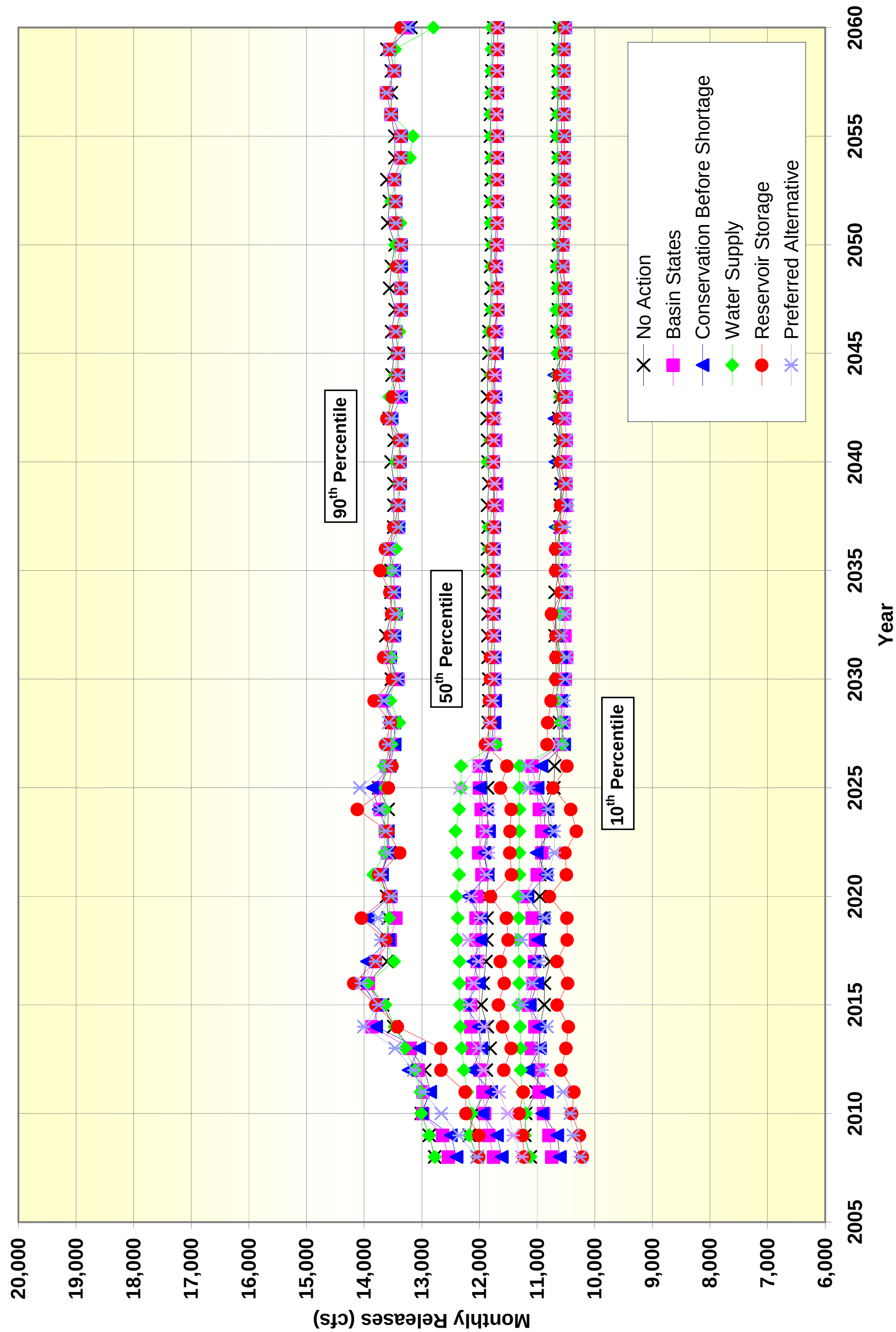


Figure P- BCR-41
Davis Dam October Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

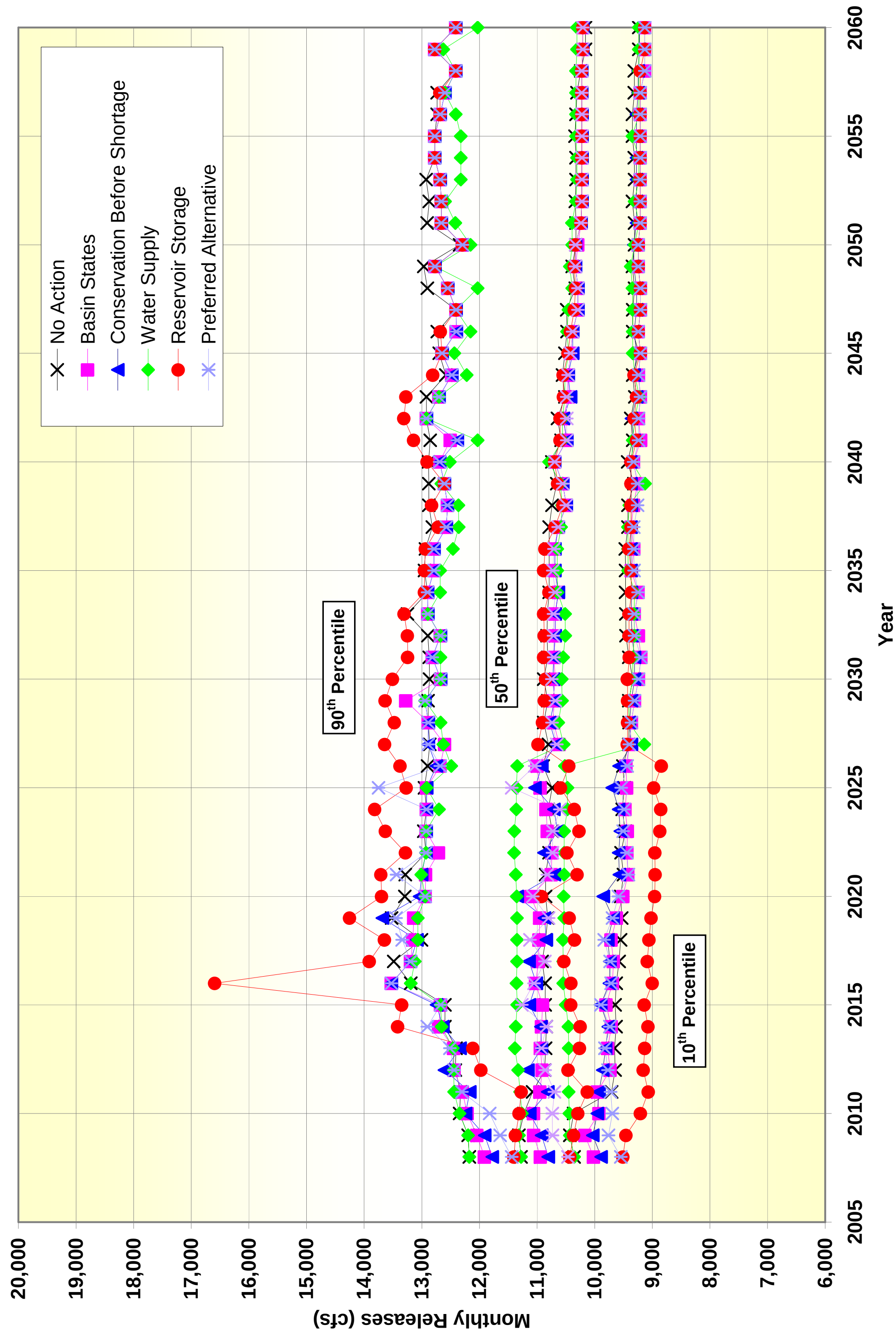


Figure P- BCR-42
Davis Dam November Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

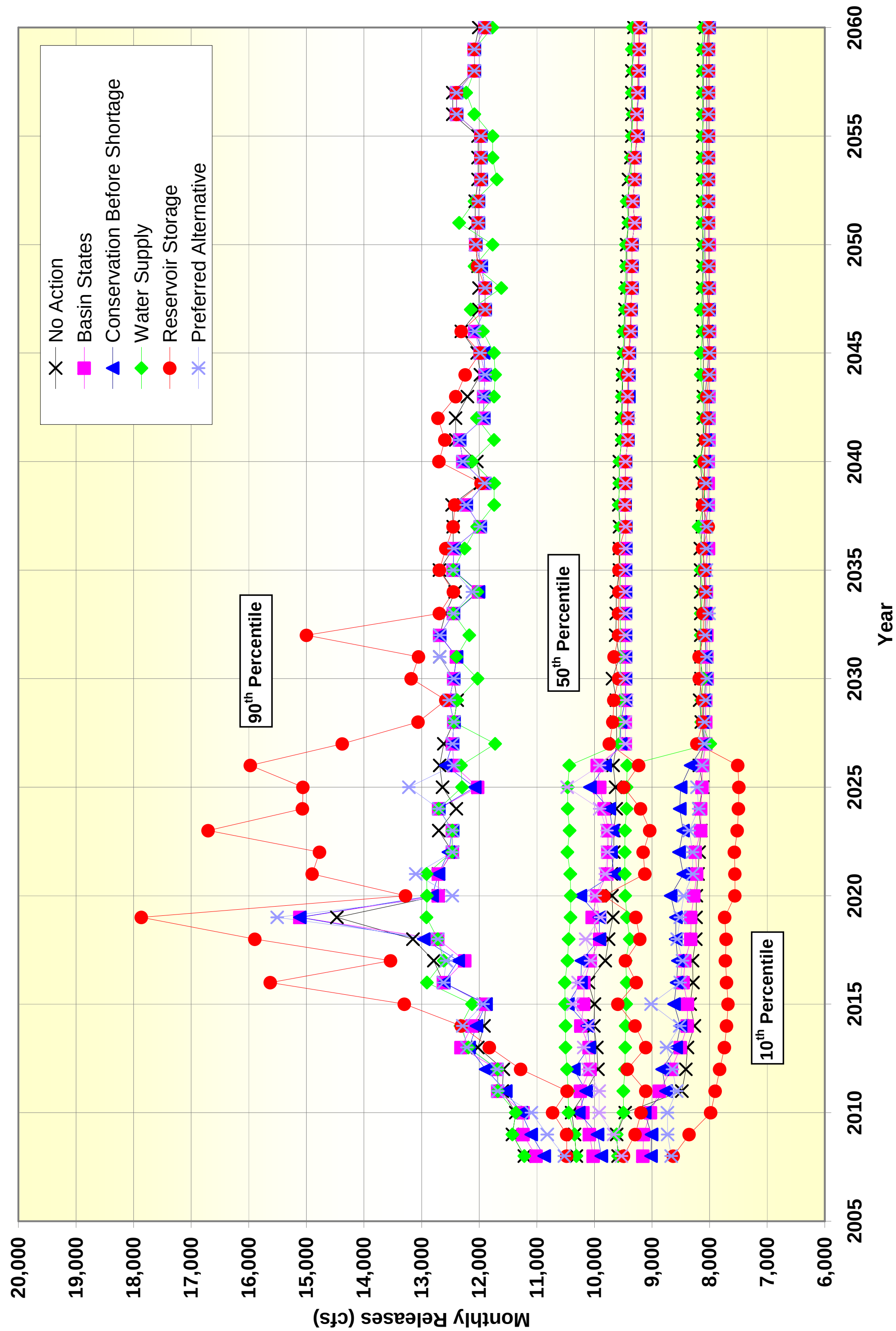


Figure P- BCR-43
Davis Dam December Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

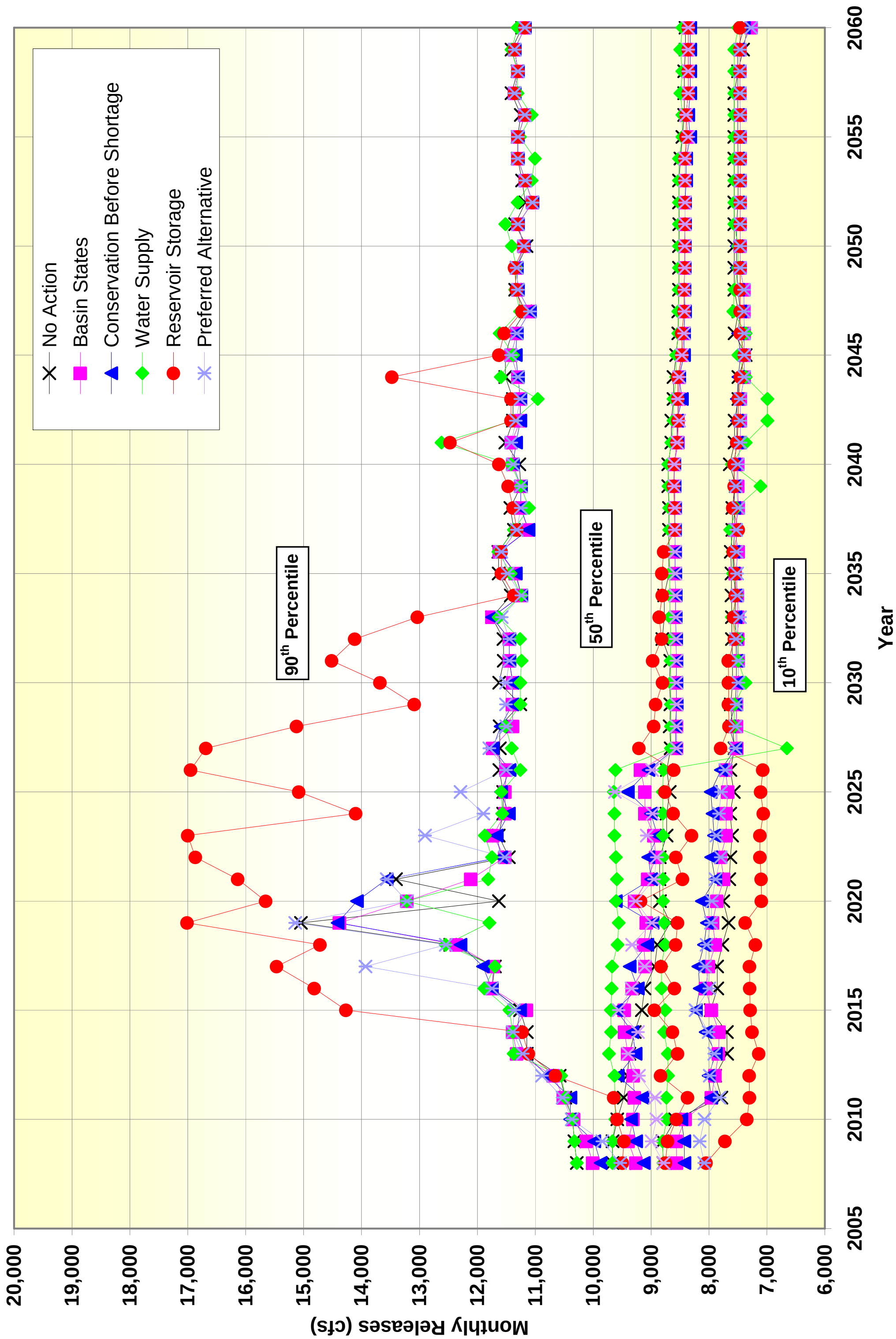


Figure P- BCR-44
Parker Dam January Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

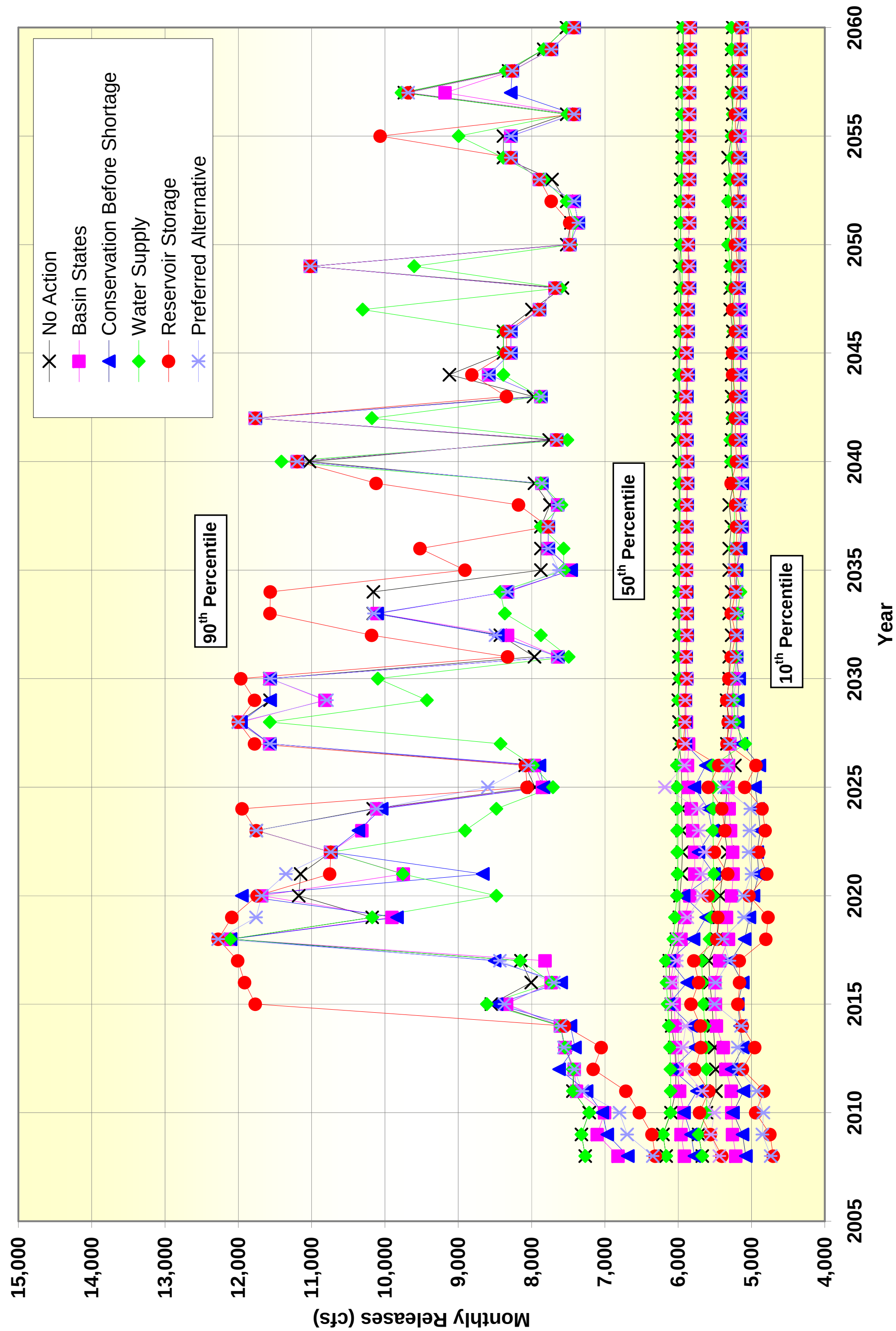


Figure P- BCR-45
Parker Dam February Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

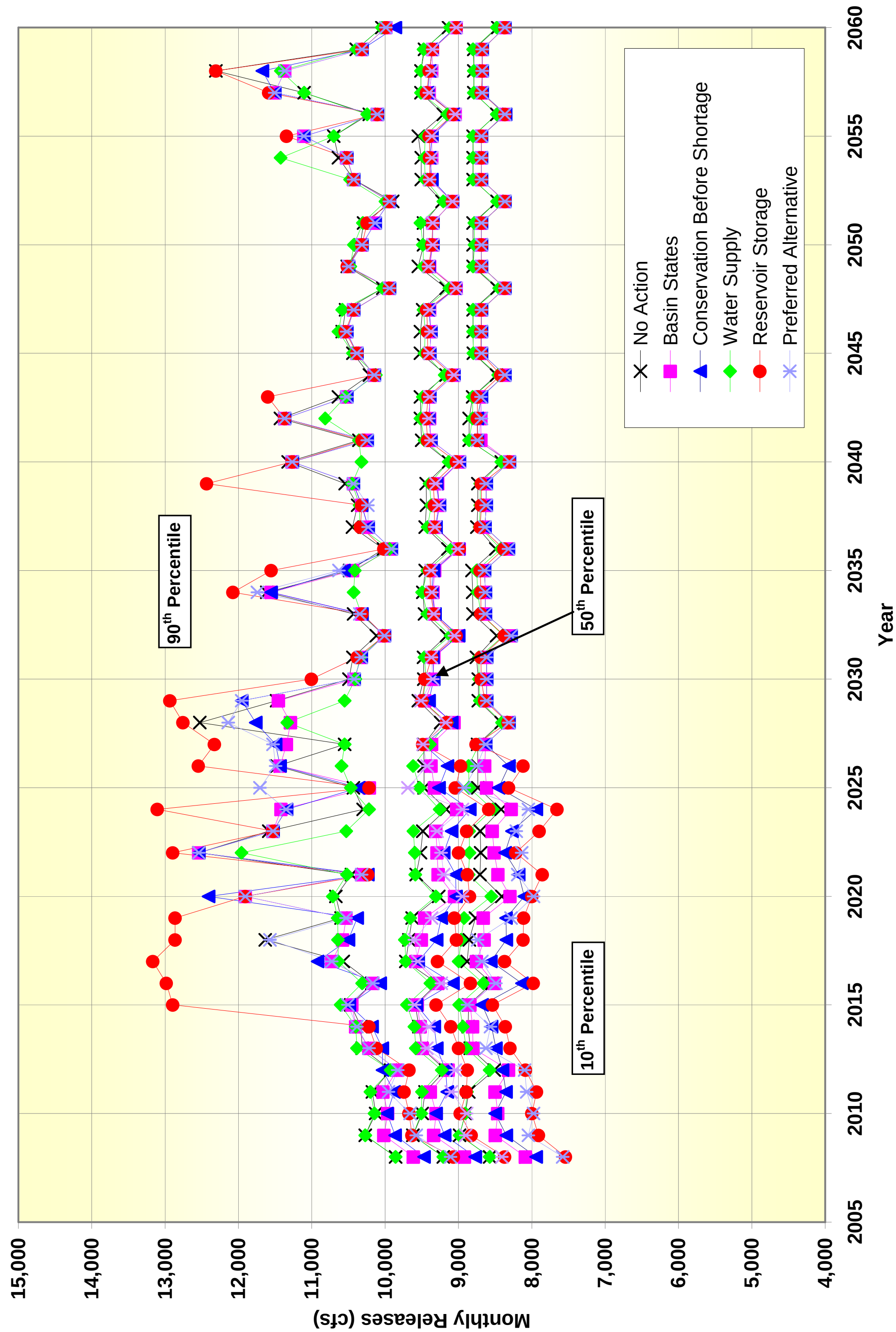


Figure P- BCR-46
Parker Dam March Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

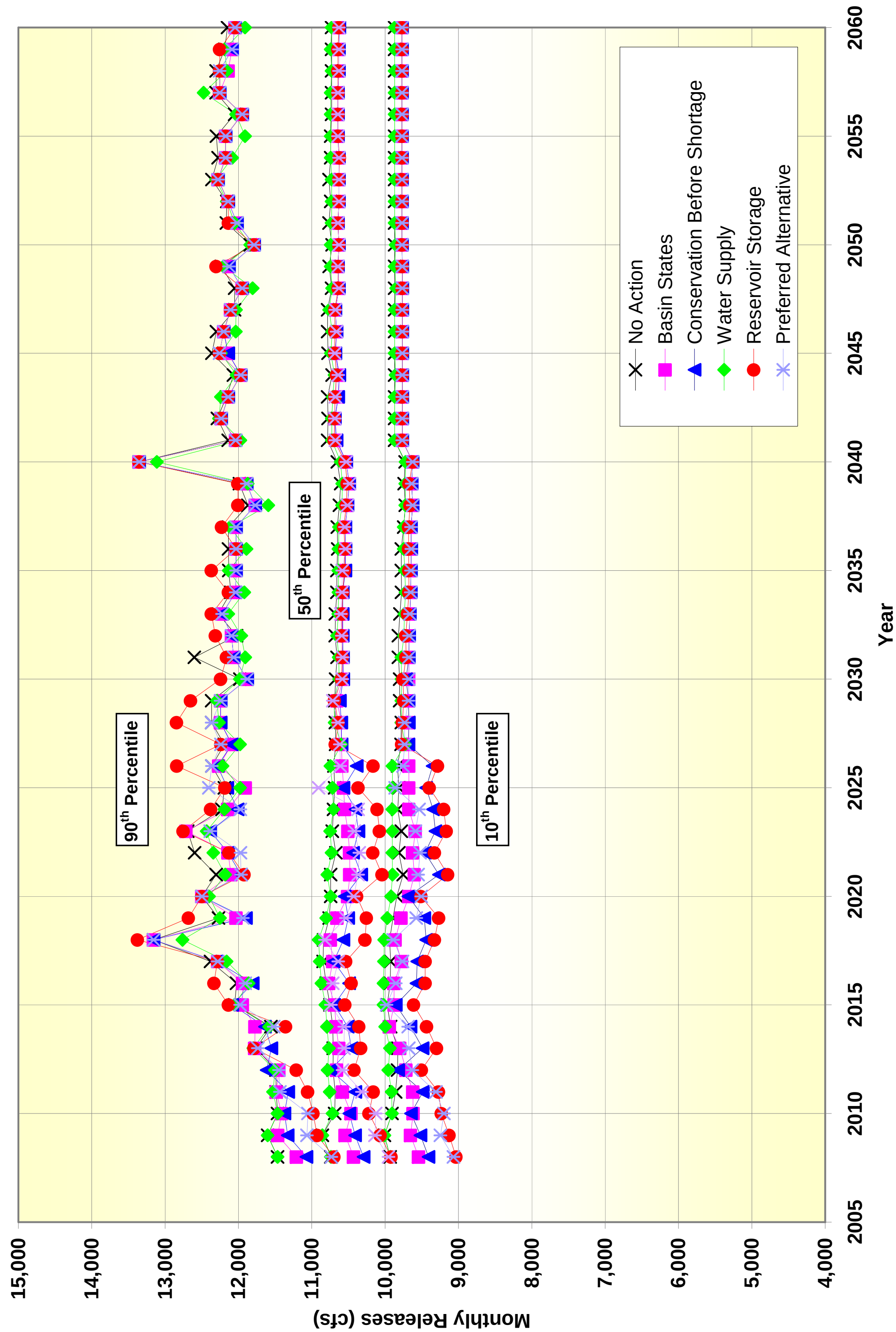


Figure P- BCR-47
Parker Dam April Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

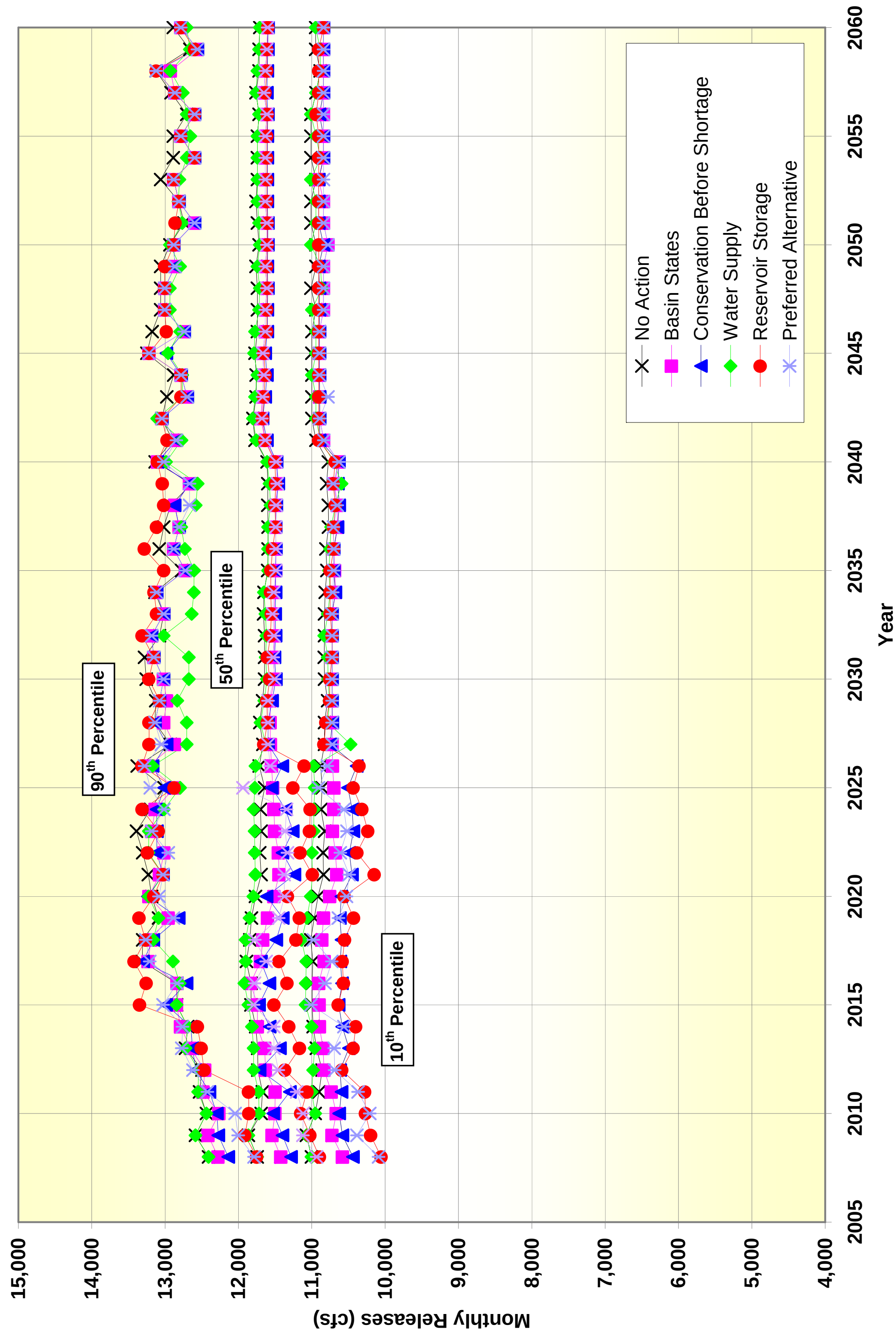


Figure P- BCR-48
Parker Dam May Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

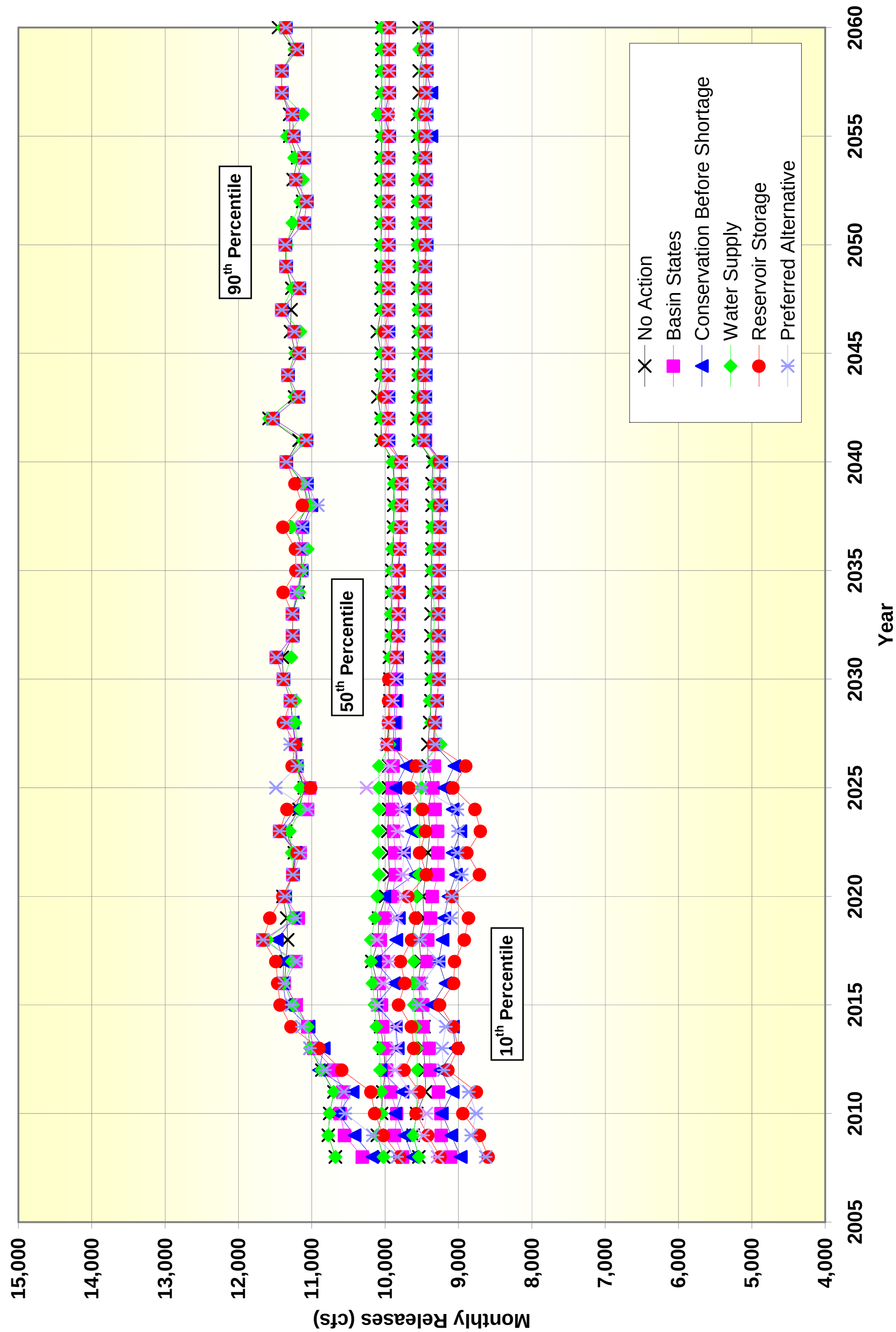


Figure P- BCR-49
Parker Dam June Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Figure P- BCR-50
Parker Dam July Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

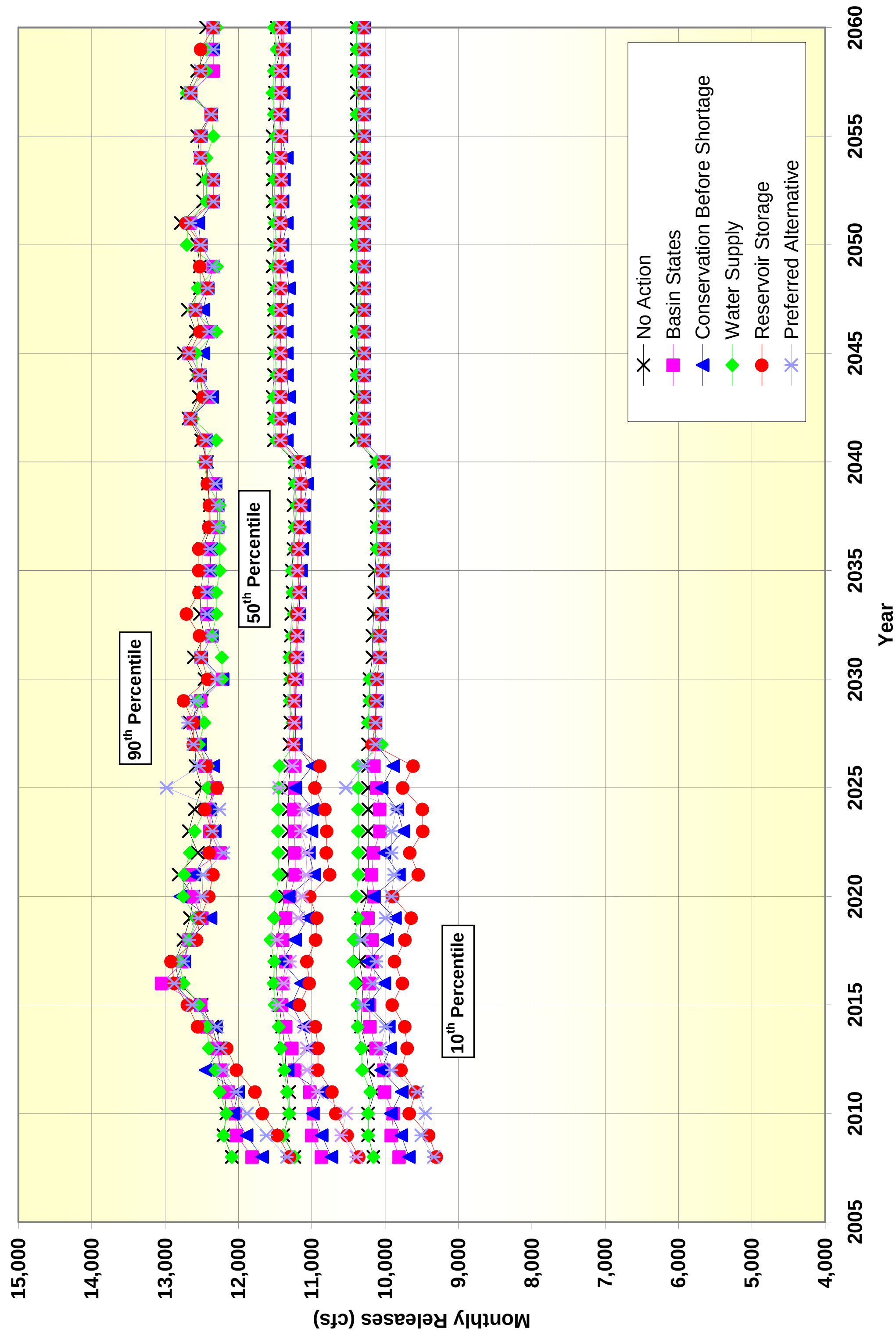


Figure P- BCR-51
Parker Dam August Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

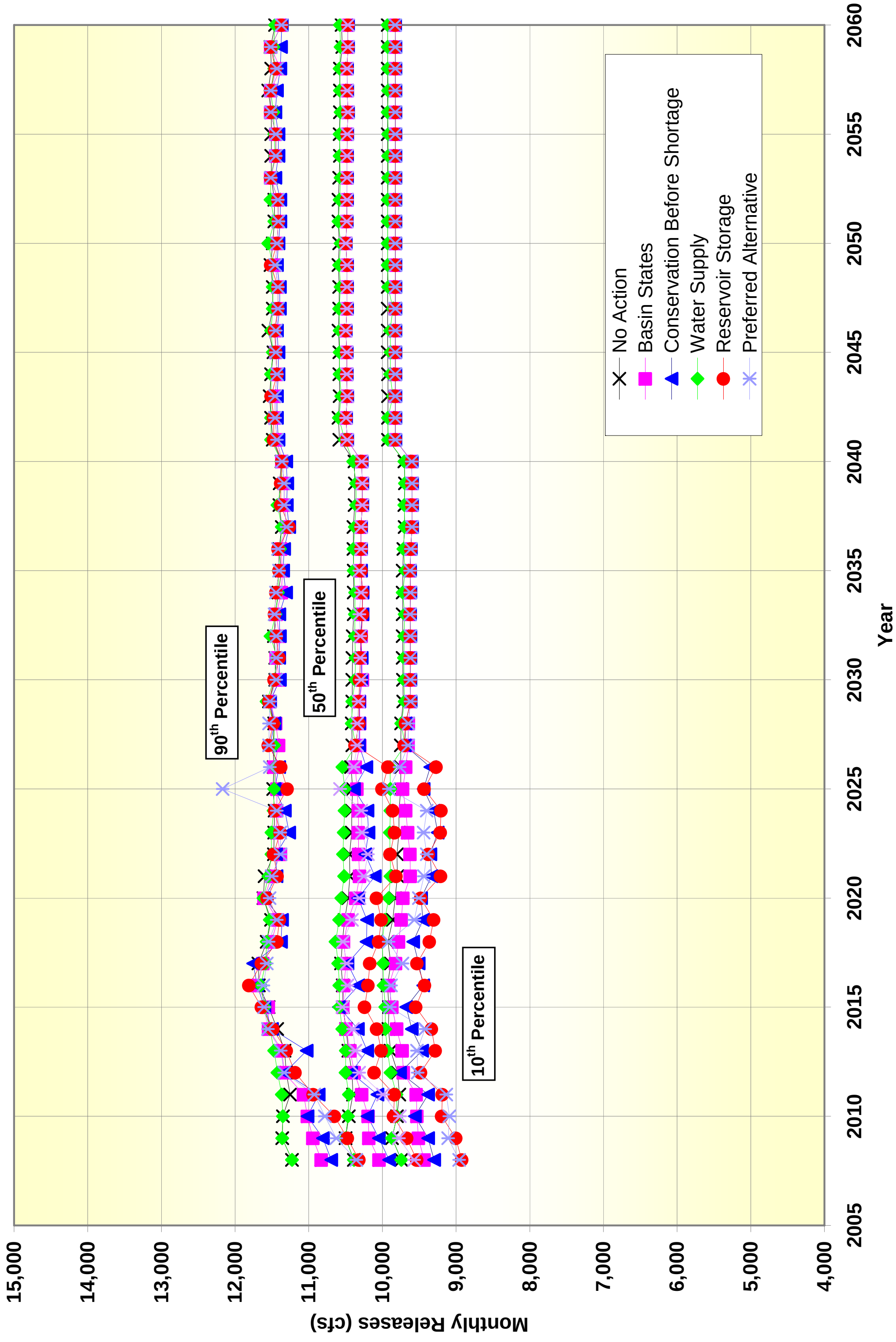


Figure P- BCR-52
Parker Dam September Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

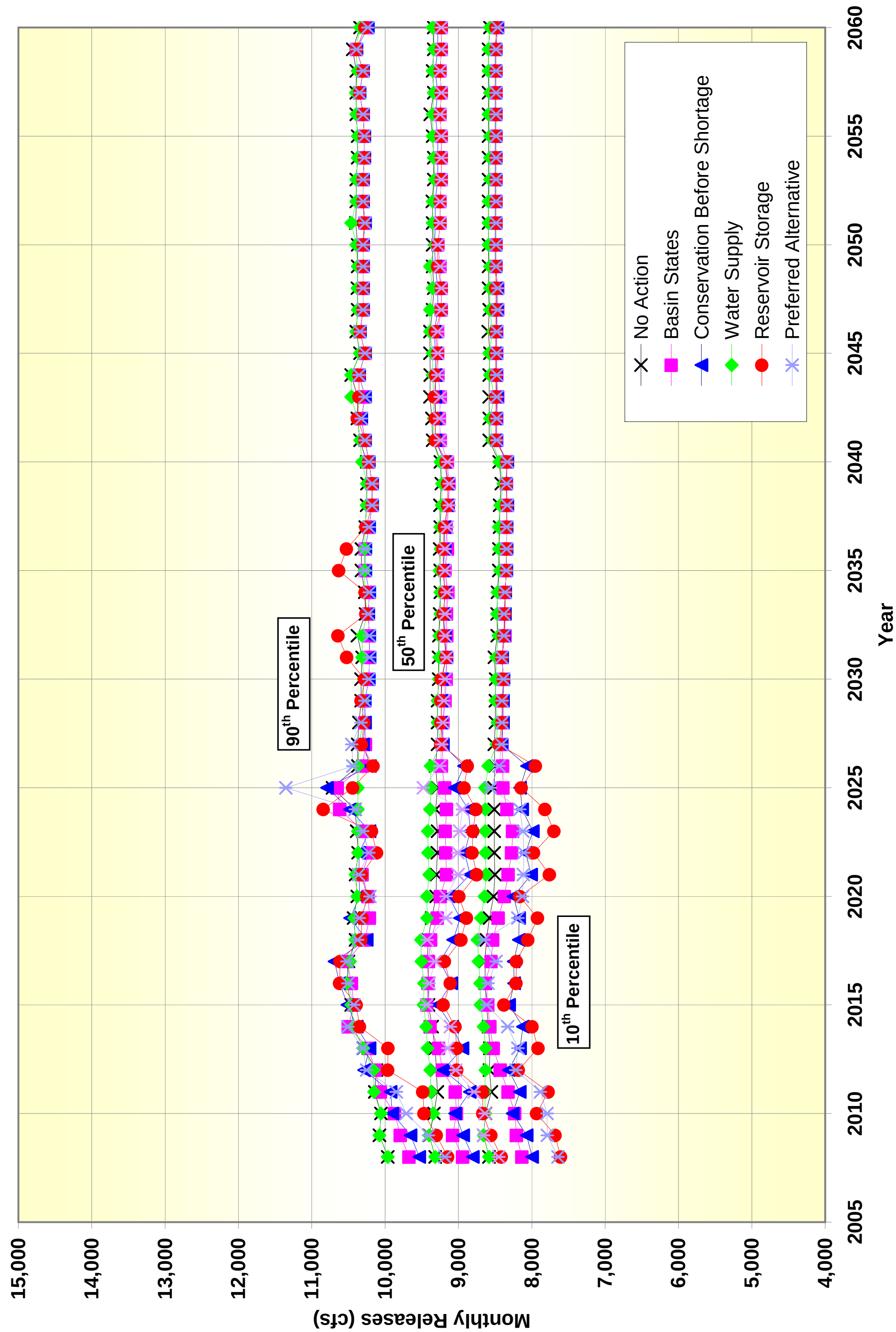


Figure P- BCR-53
Parker Dam October Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

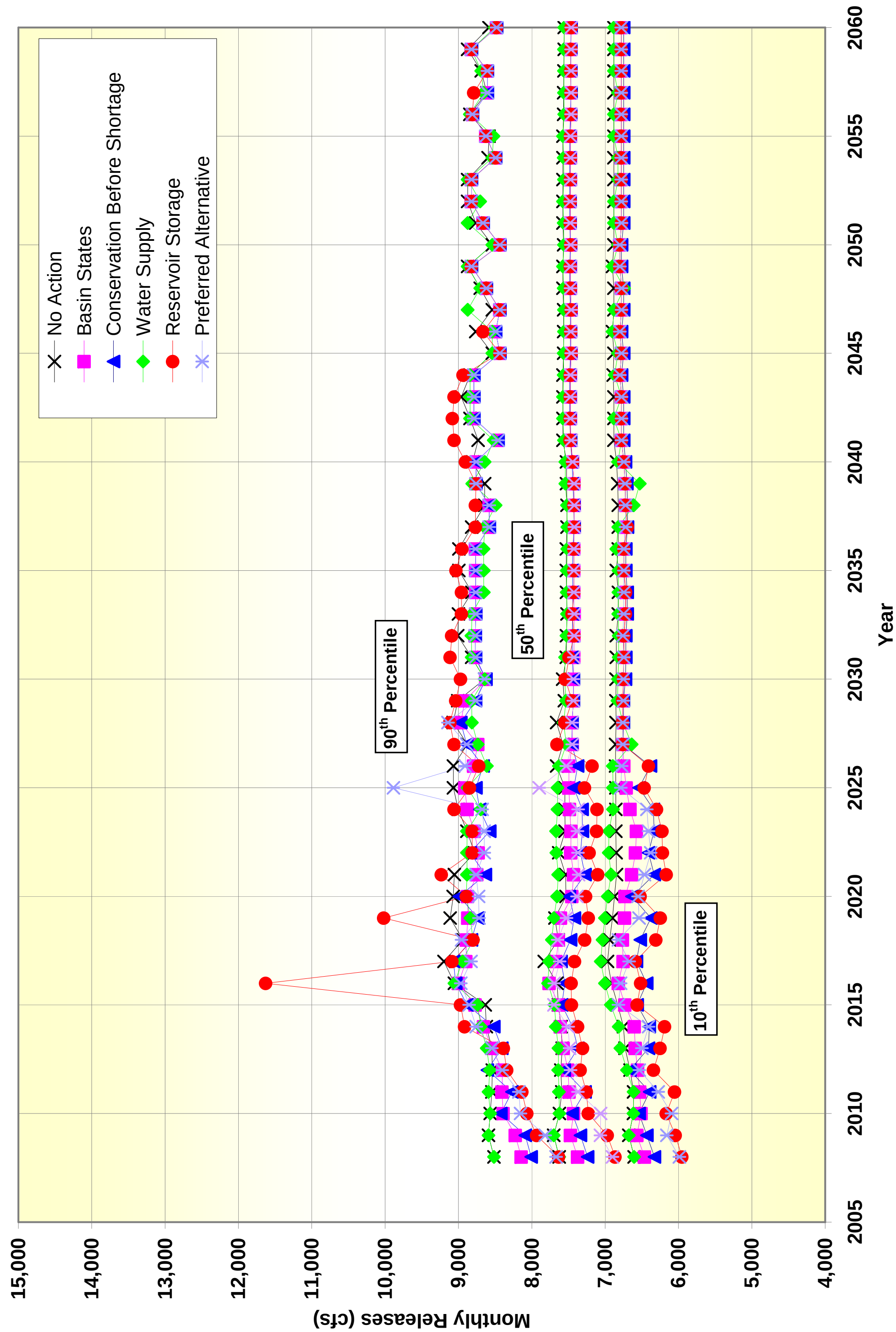


Figure P- BCR-54
Parker Dam November Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

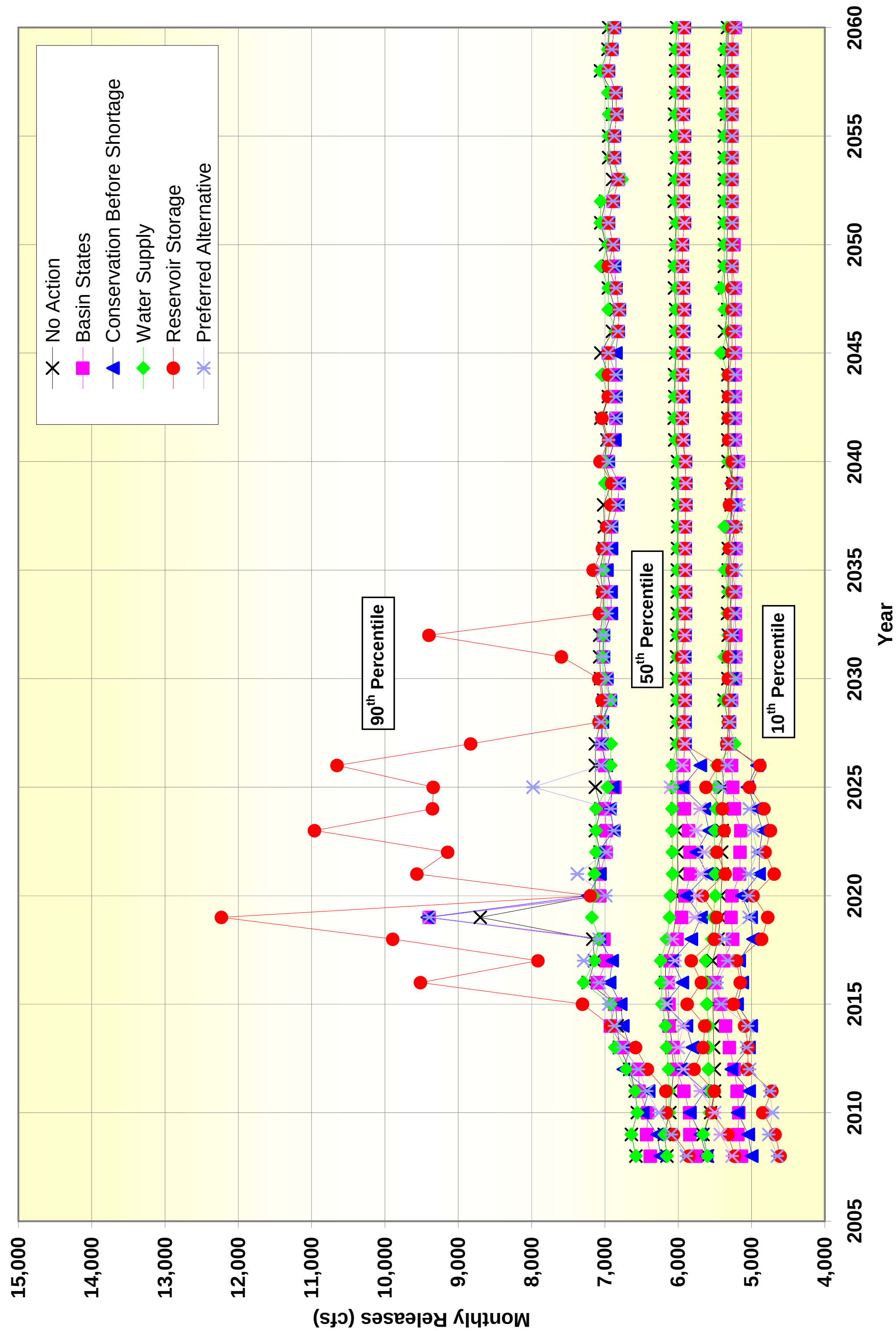


Figure P- BCR-55
Parker Dam Decembe Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

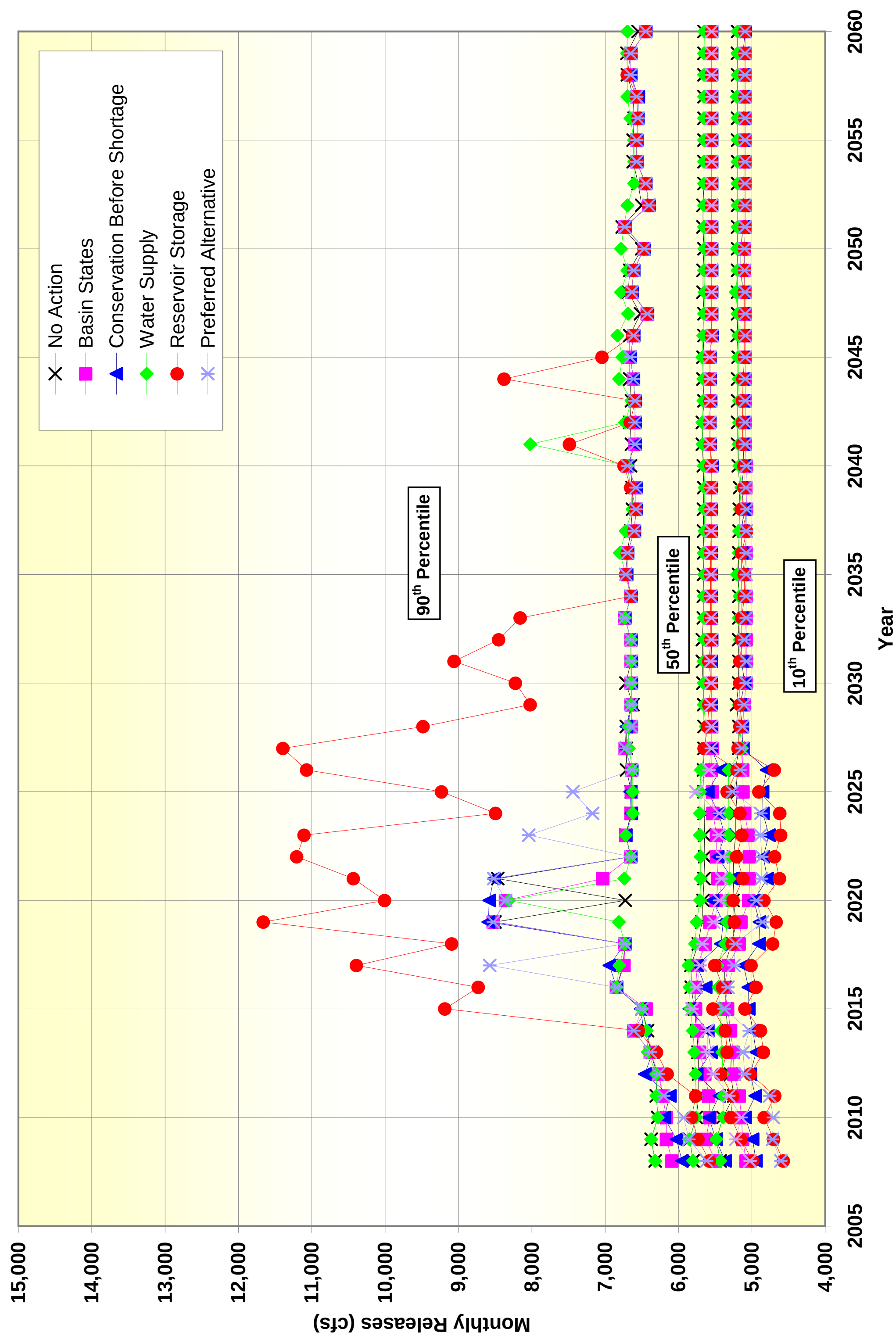


Figure P- BCR-56
Flows Downstream of Morelos Diversion Dam
Comparison of Action Alternatives to No Action Alternative
Probability of Occurrence

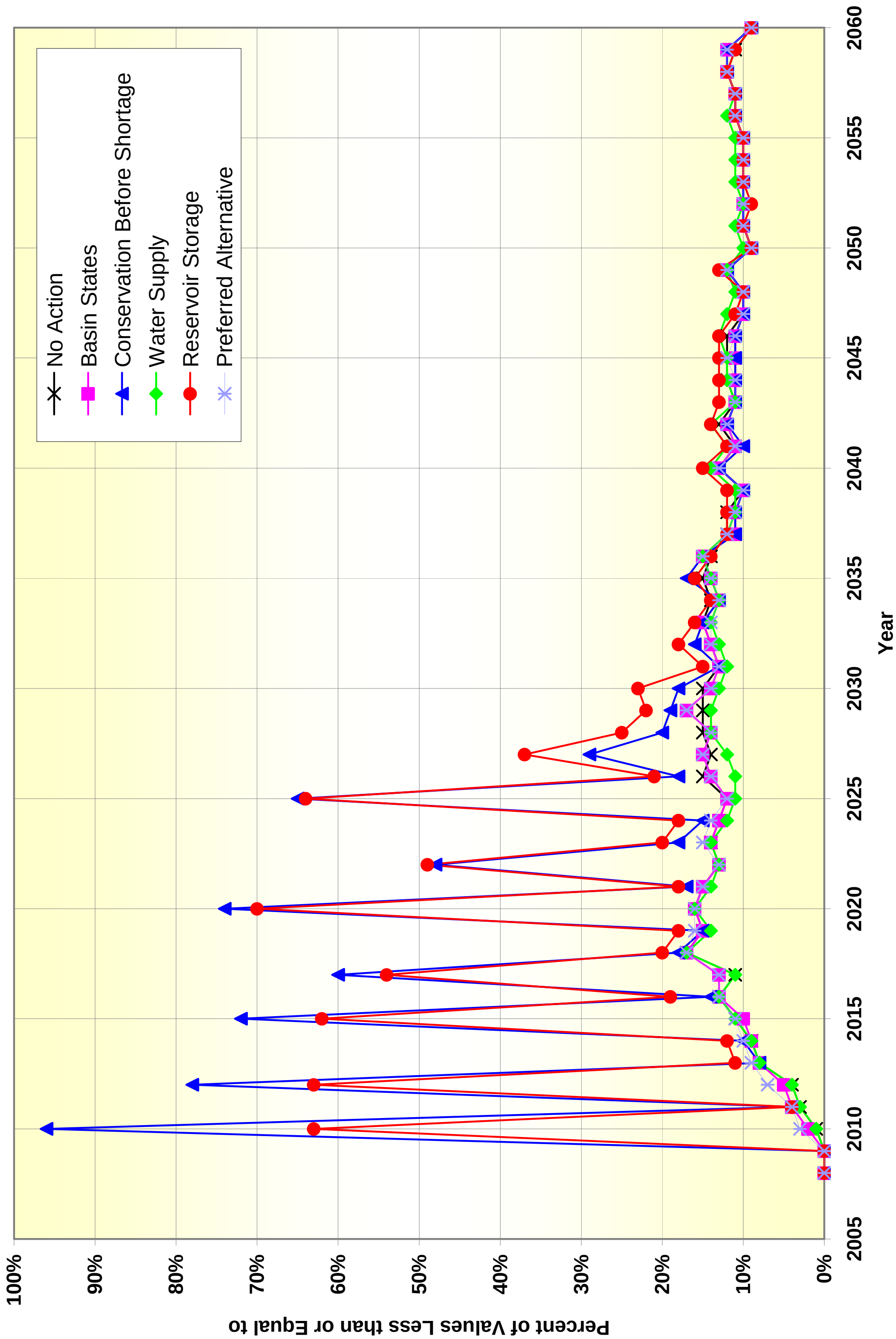


Figure P-BCR-57
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
Percent of Values Greater than or Equal to Elevation 3,660 feet msl

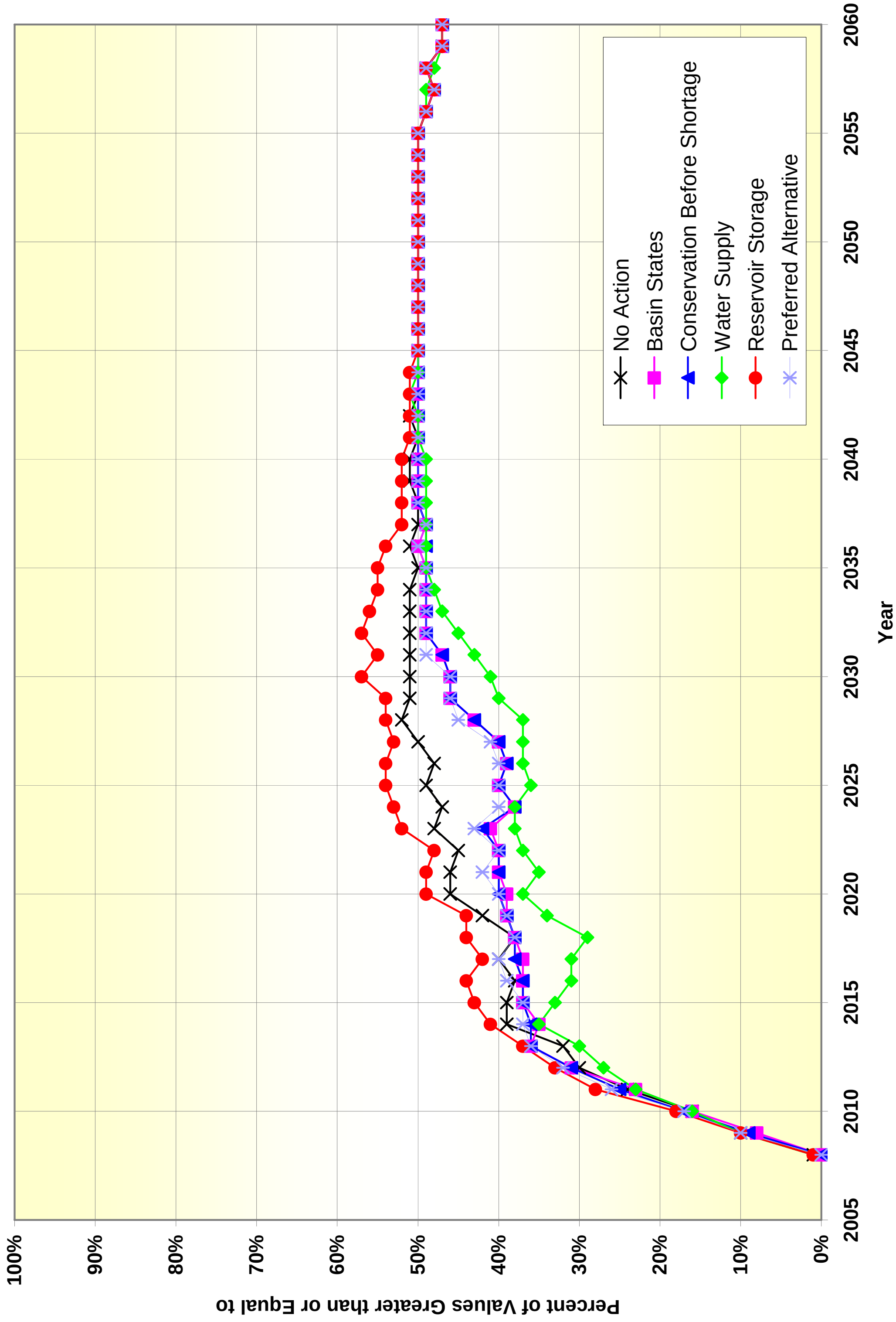
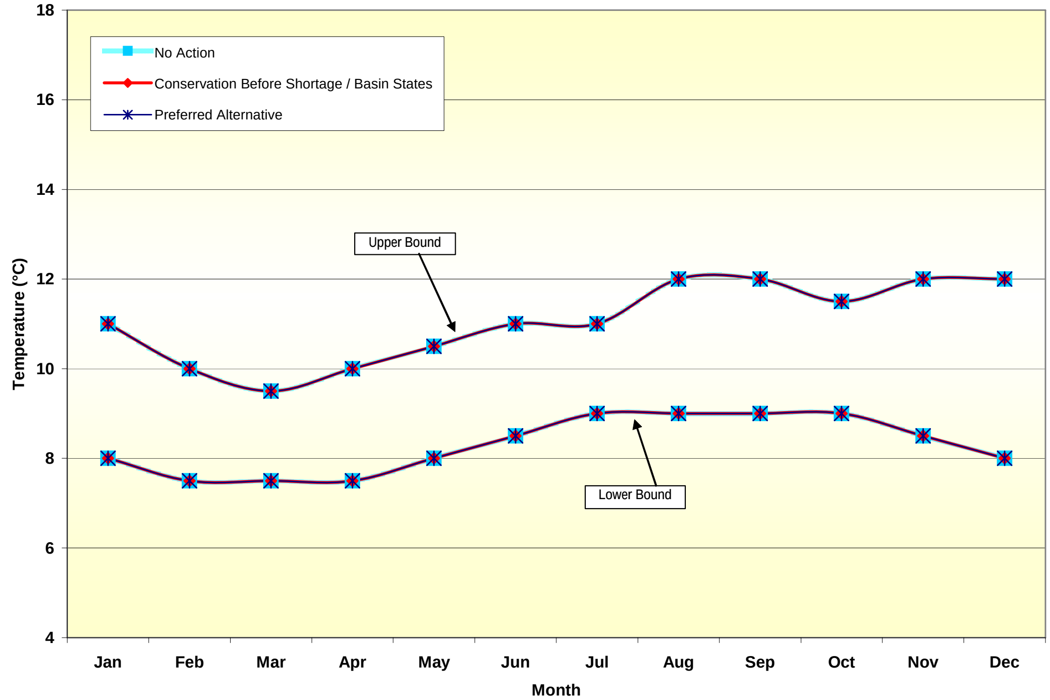


Figure P- BCR-58
Glen Canyon Dam Release Temperatures
Comparison of Action Alternatives to No Action Alternative
90th Percentile Temperatures Upper and Lower Bounds



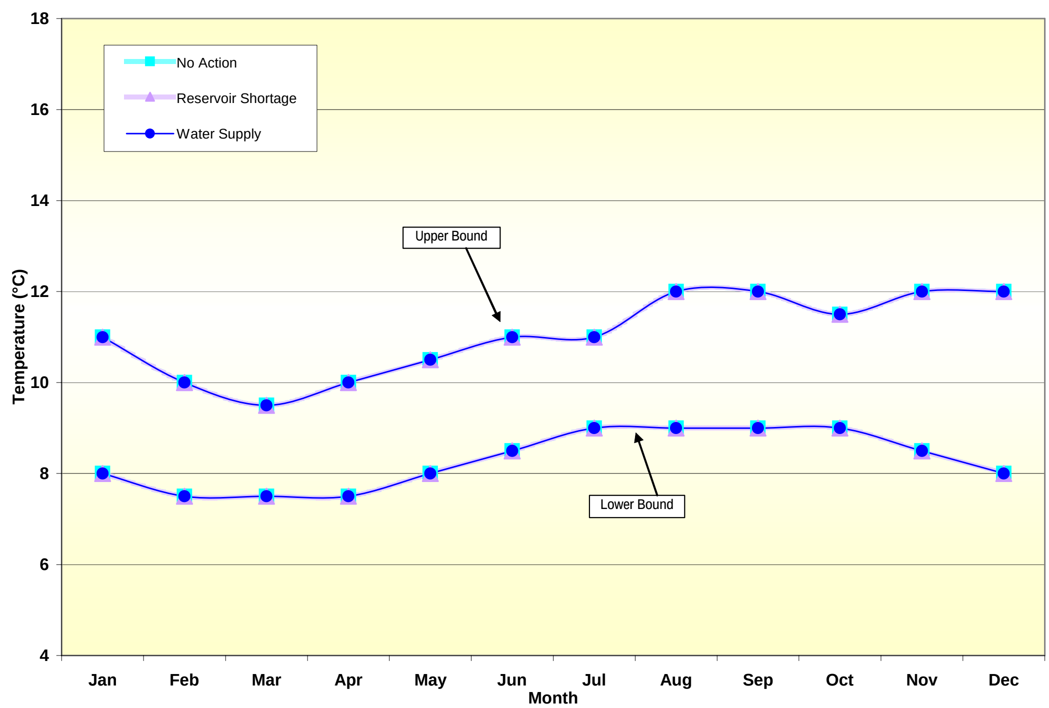
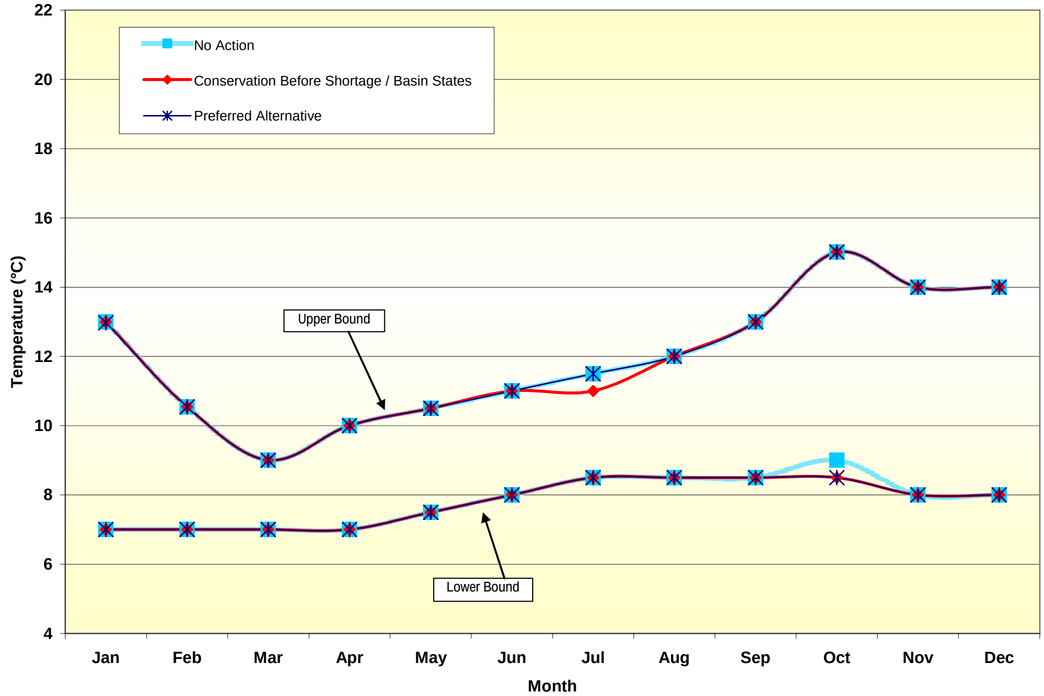


Figure P- BCR-59
Glen Canyon Dam Release Temperatures
Comparison of Action Alternatives to No Action Alternative
50th Percentile Temperatures Upper and Lower Bounds



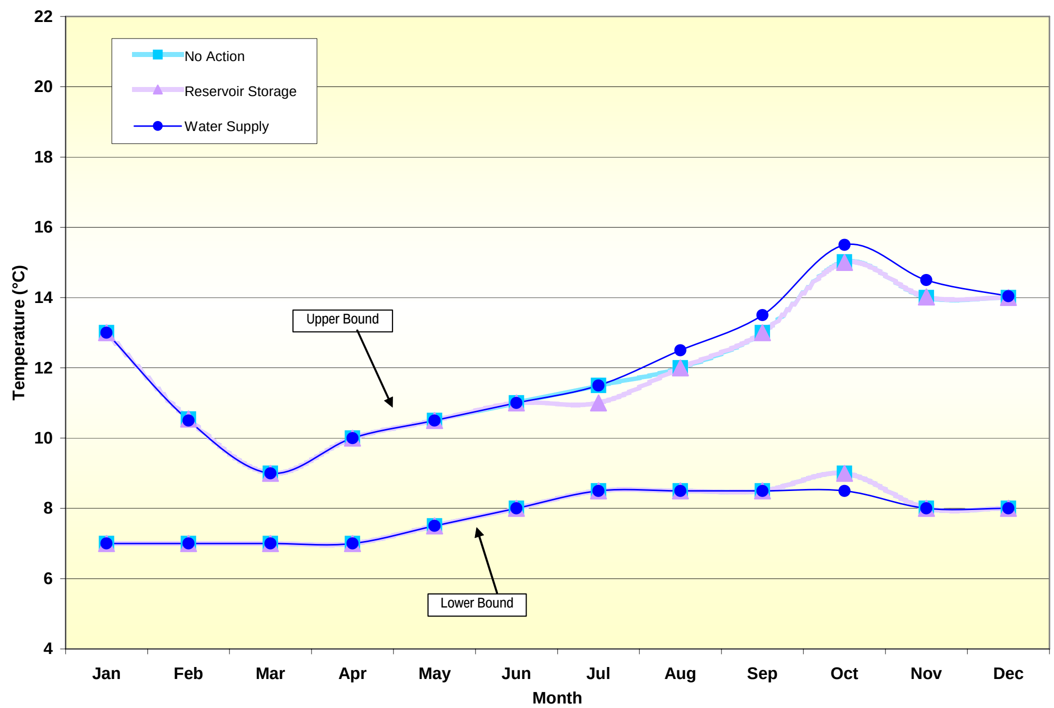
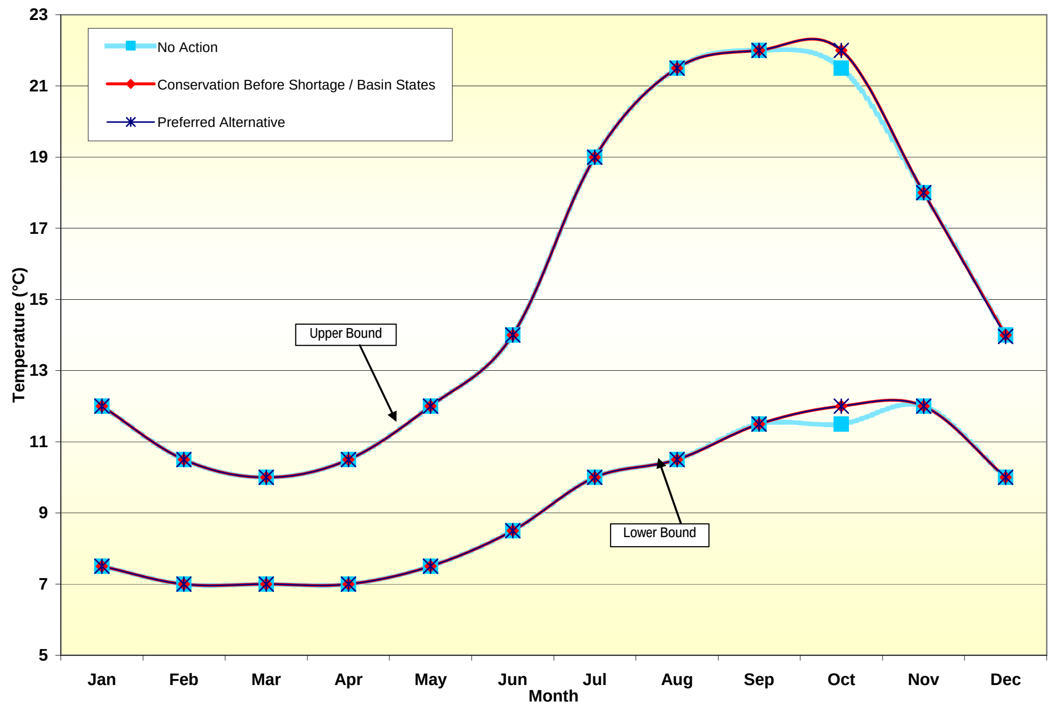


Figure P- BCR-60
Glen Canyon Dam Release Temperatures
Comparison of Action Alternatives to No Action Alternative
10th Percentile Temperatures Upper and Lower Bounds



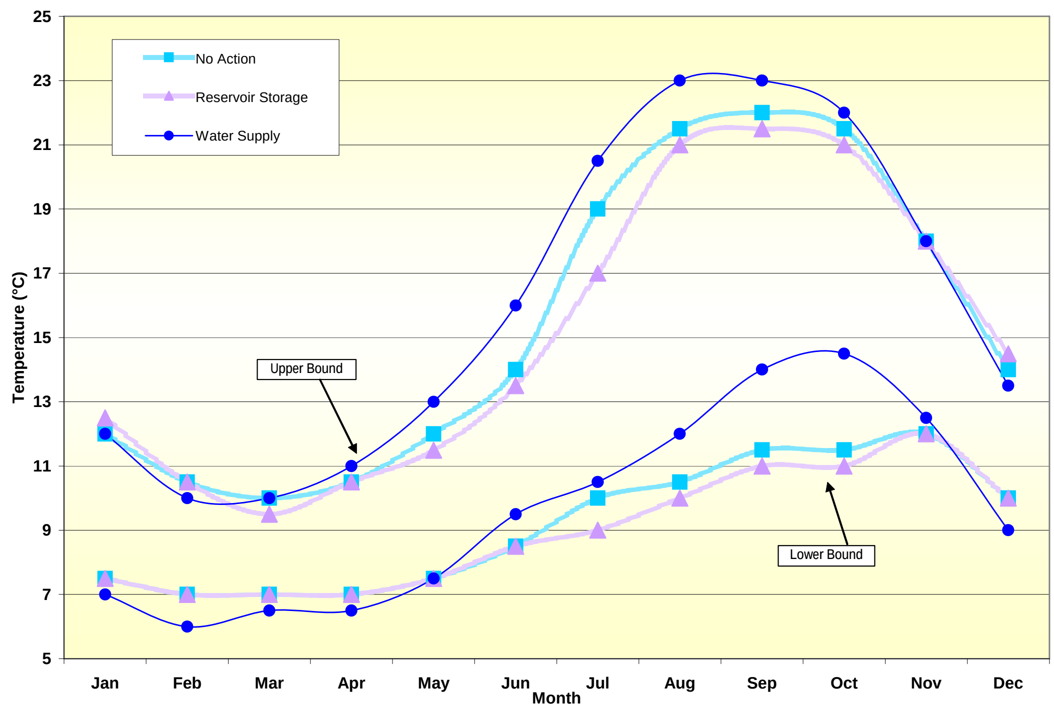
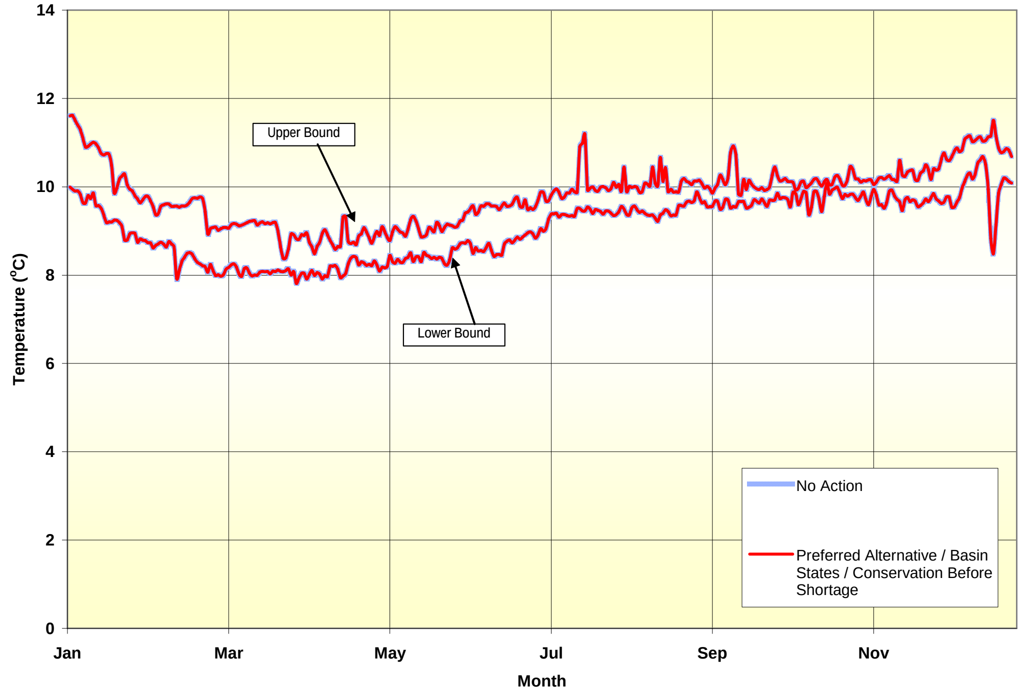


Figure P- BCR-61
Colorado River at Lees Ferry
Comparison of Action Alternatives to No Action Alternative
90th Percentile Temperatures Upper and Lower Bounds



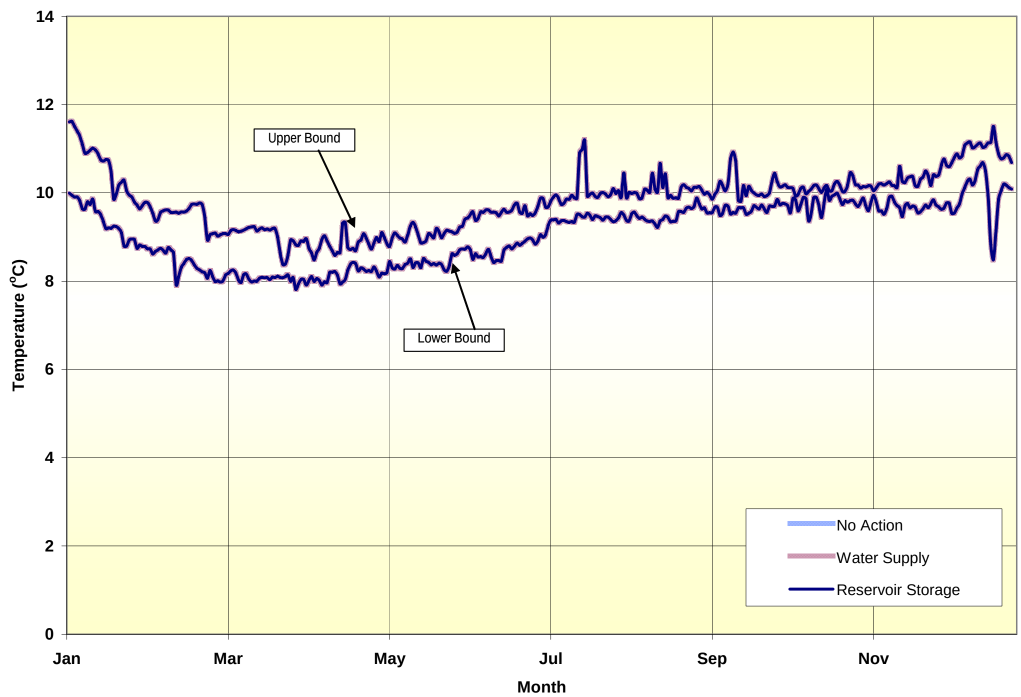
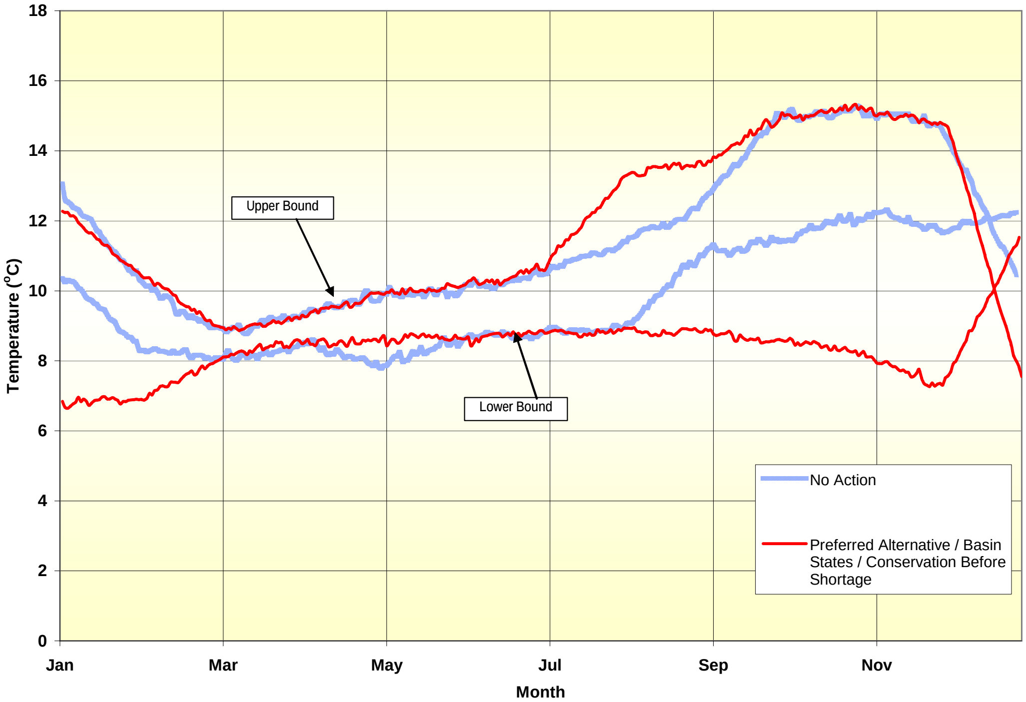


Figure P- BCR-62
Colorado River at Lees Ferry
Comparison of Action Alternatives to No Action Alternative
50th Percentile Temperatures Upper and Lower Bounds



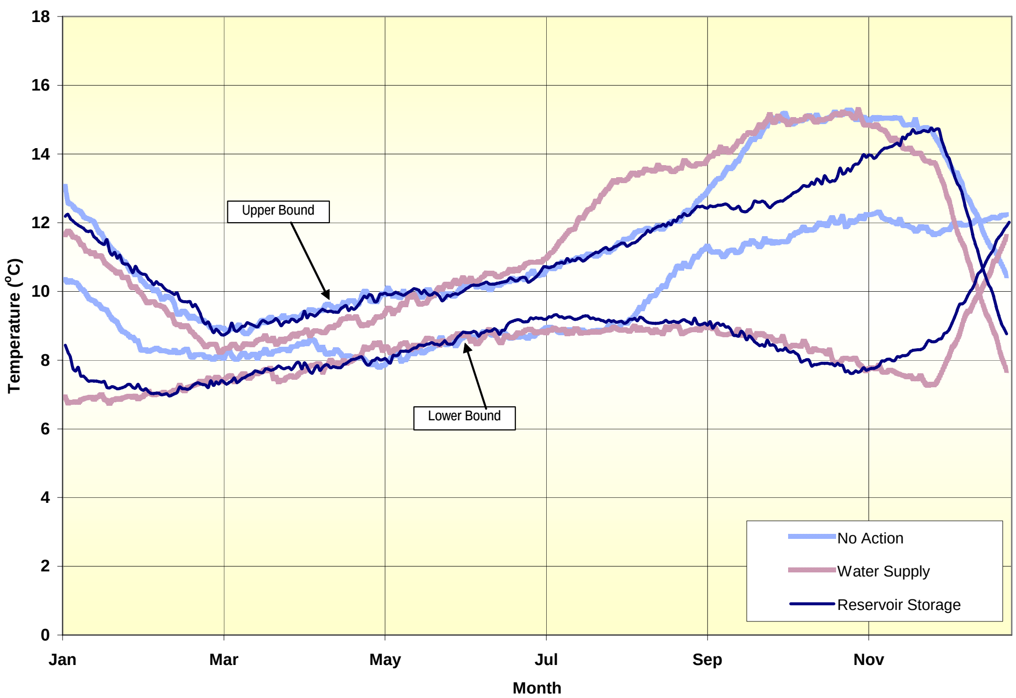
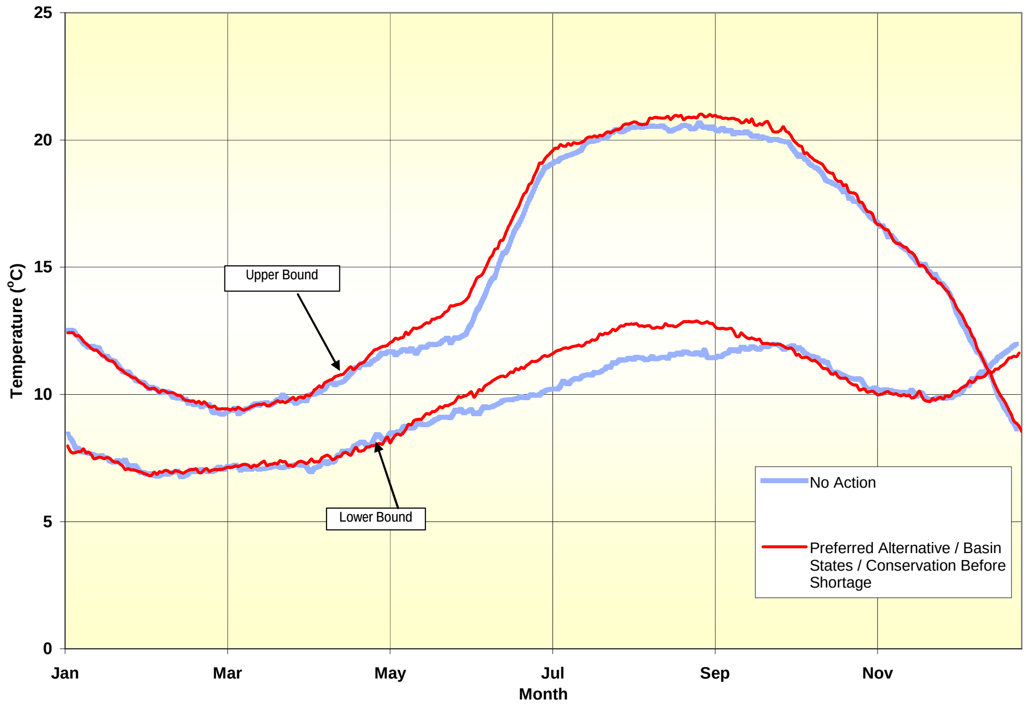


Figure P- BCR-63
Colorado River at Lees Ferry
Comparison of Action Alternatives to No Action Alternative
10th Percentile Temperatures Upper and Lower Bounds



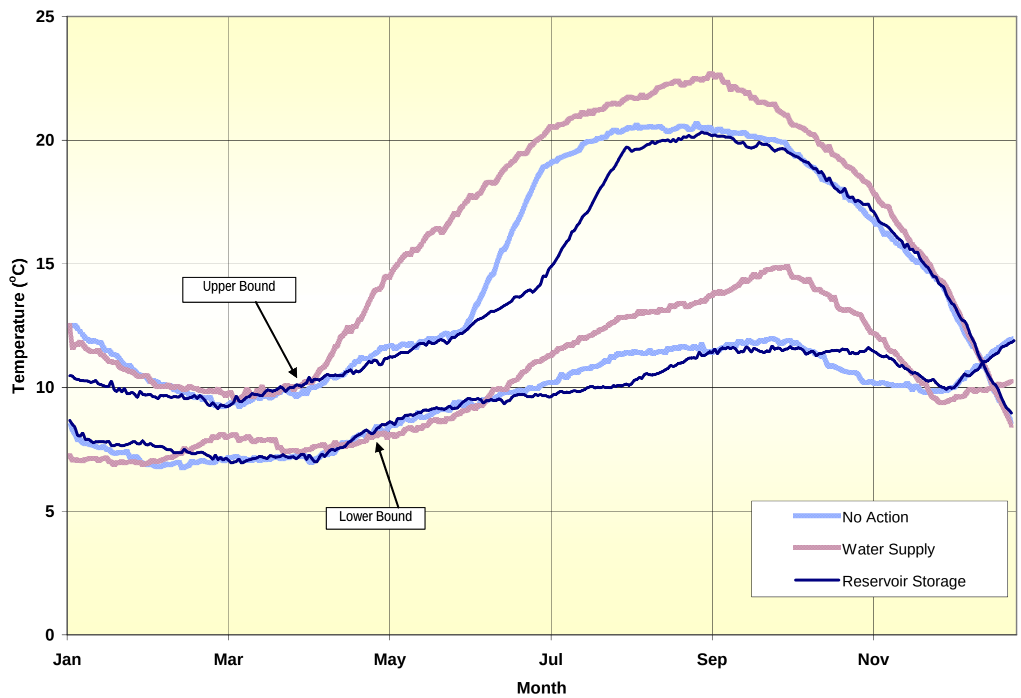
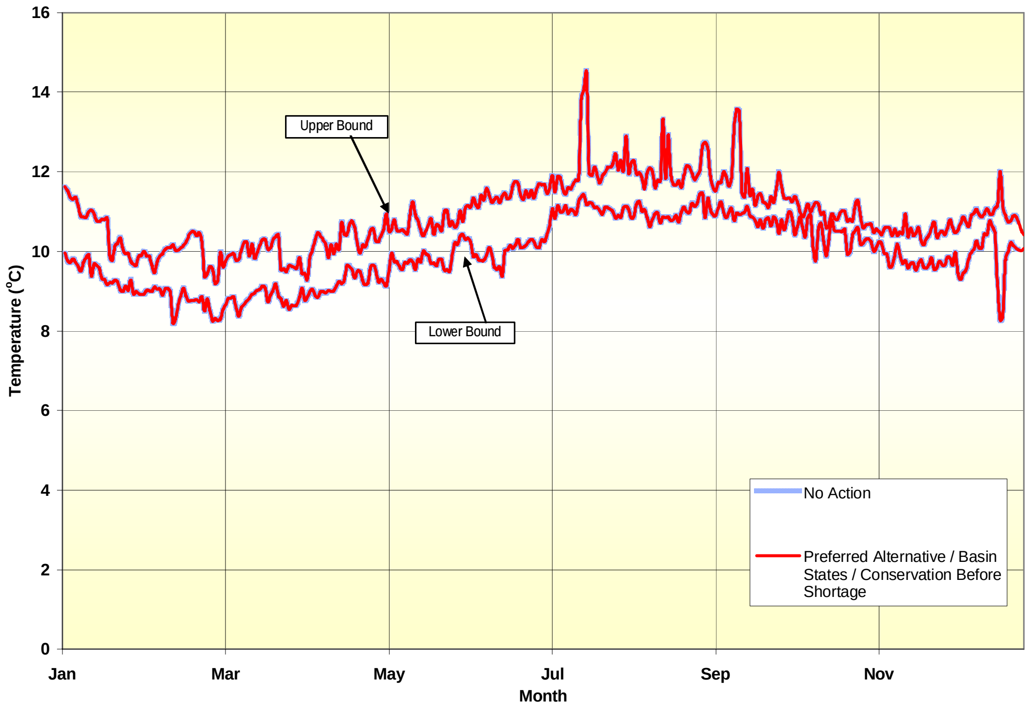


Figure P- BCR-64
Colorado River Downstream of Little Colorado River Confluence
Comparison of Action Alternatives to No Action Alternative
90th Percentile Temperatures Upper and Lower Bounds



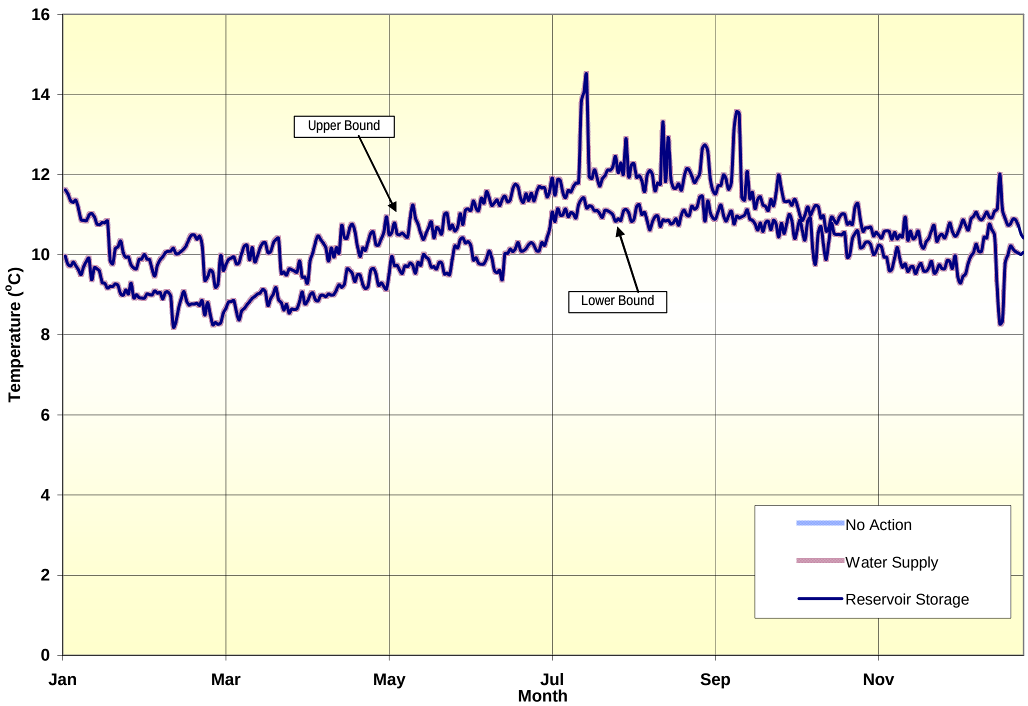


Figure P- BCR-65
Colorado River Downstream of Little Colorado River Confluence
Comparison of Action Alternatives to No Action Alternative
50th Percentile Temperatures Upper and Lower Bounds

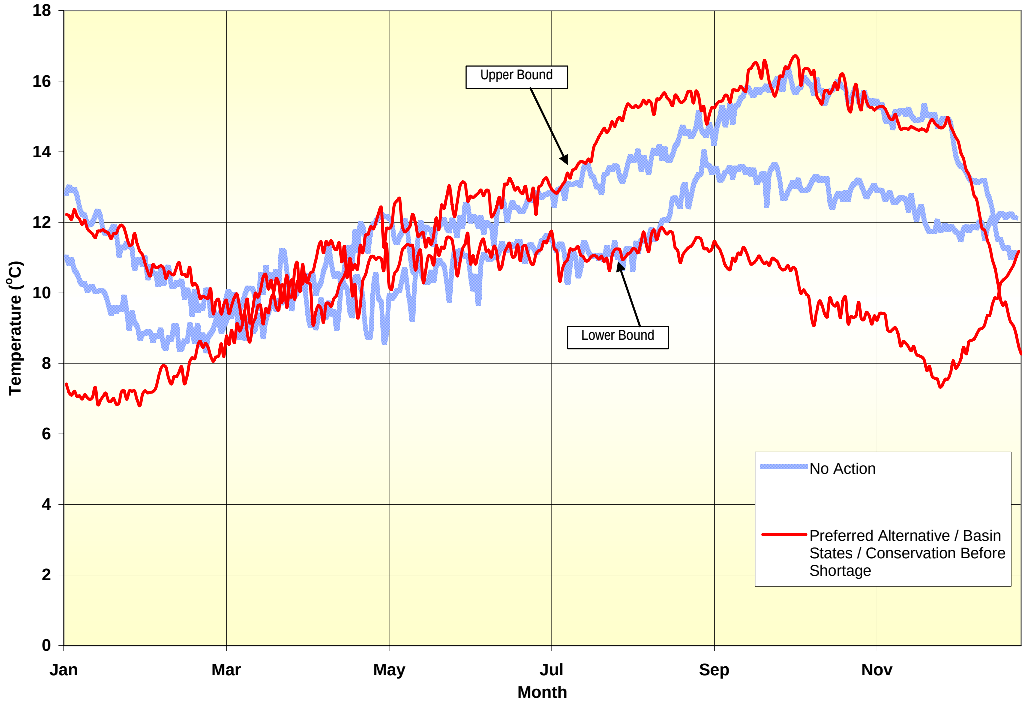
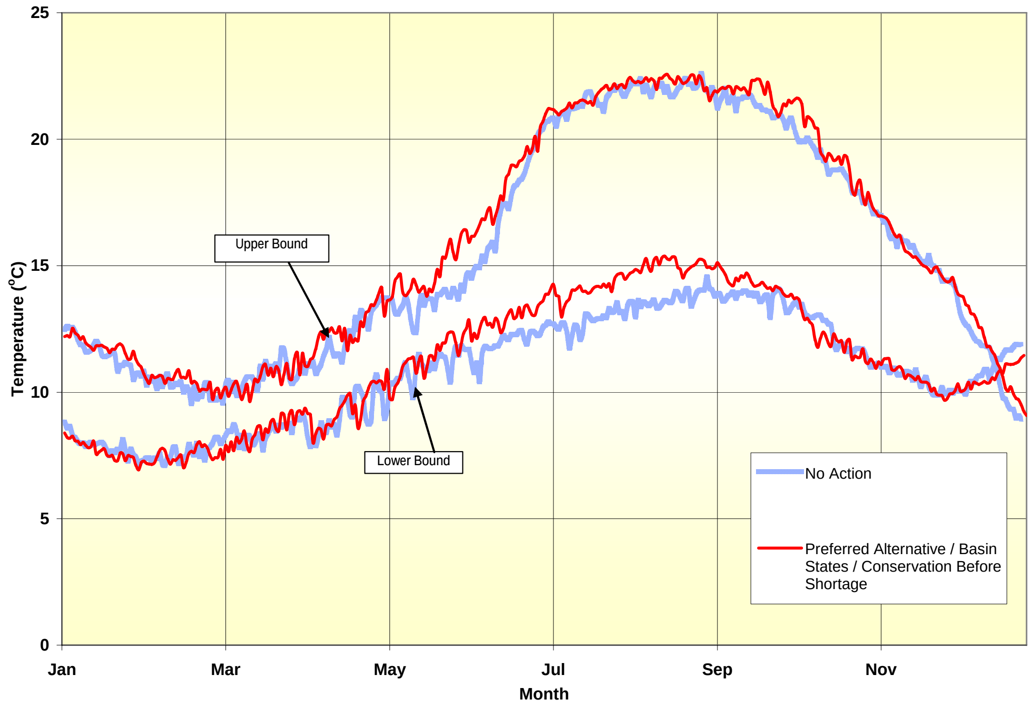


Figure P- BCR-66
Colorado River Downstream of Little Colorado River Confluence
Comparison of Action Alternatives to No Action Alternative
10th Percentile Temperatures Upper and Lower Bounds



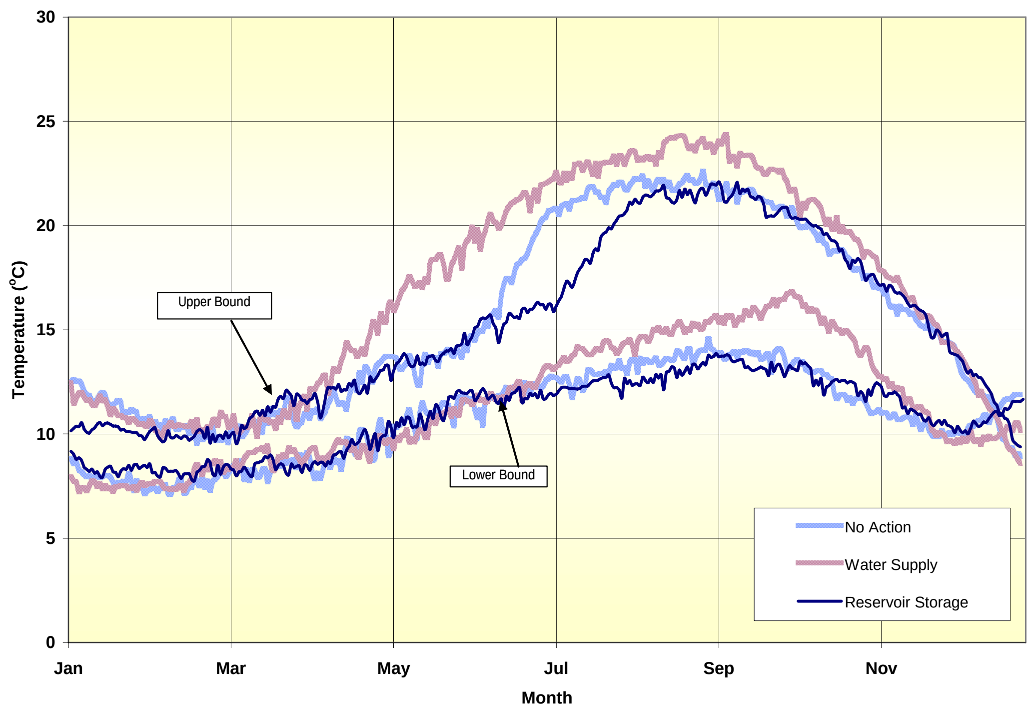
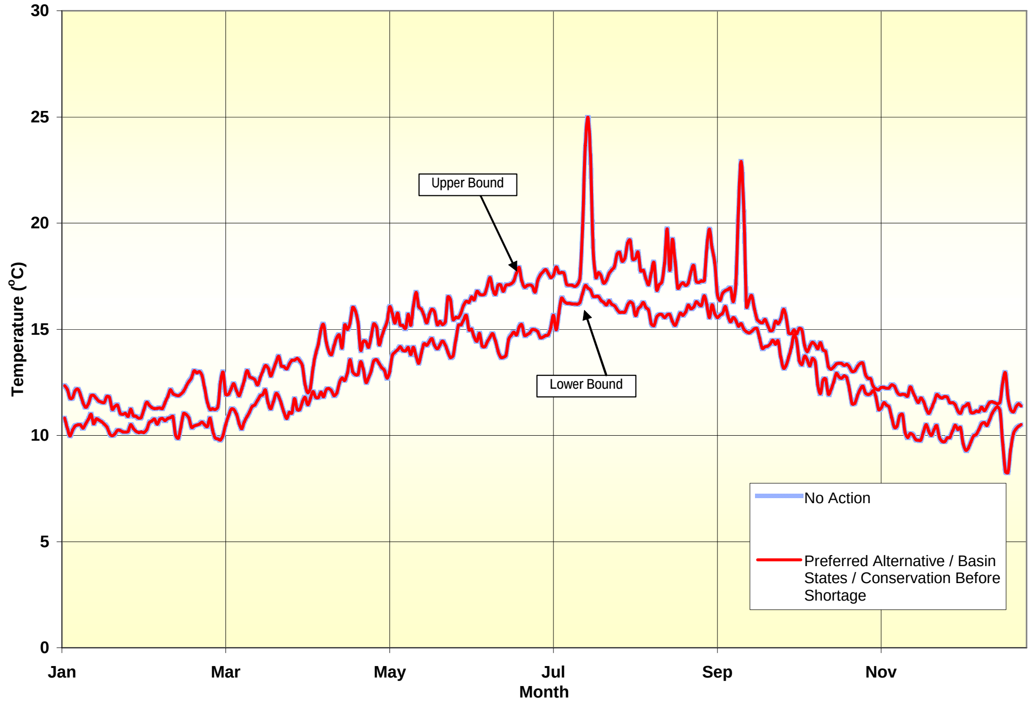


Figure P- BCR-67
Colorado River Near Diamond Creek
Comparison of Action Alternatives to No Action Alternative
90th Percentile Temperatures Upper and Lower Bounds



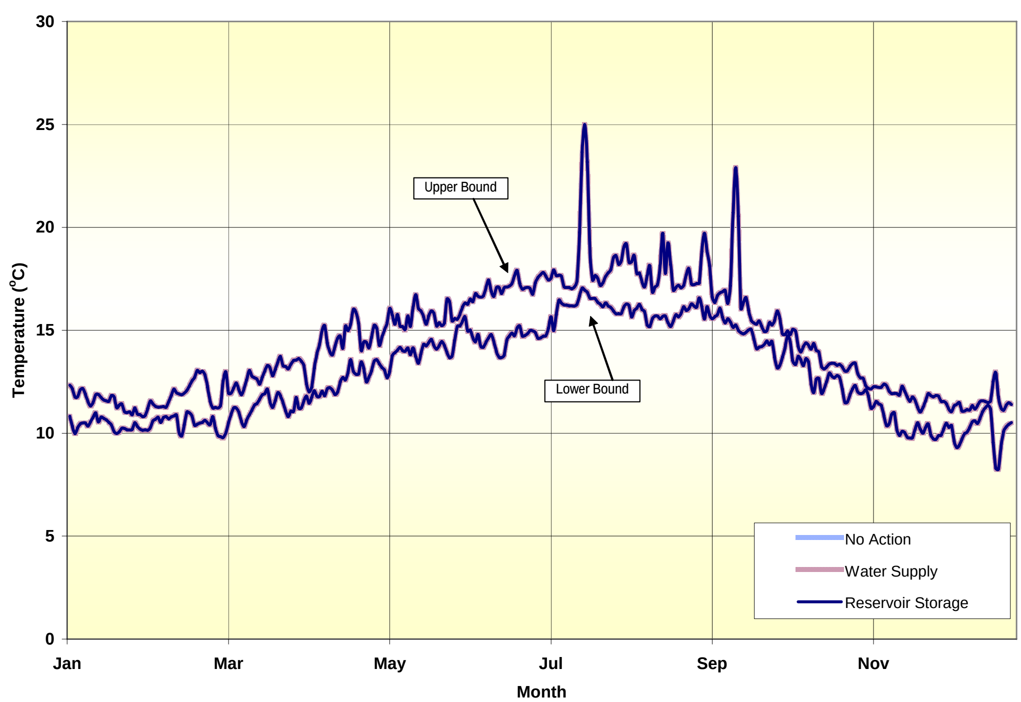
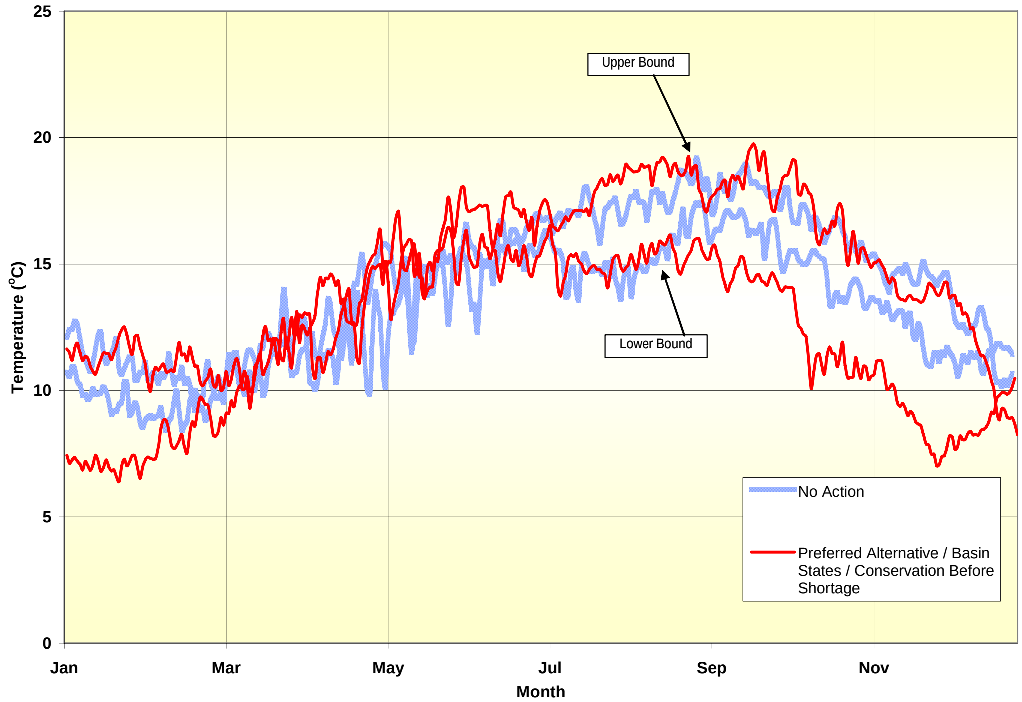


Figure P- BCR-68
Colorado River Near Diamond Creek
Comparison of Action Alternatives to No Action Alternative
50th Percentile Temperatures Upper and Lower Bounds



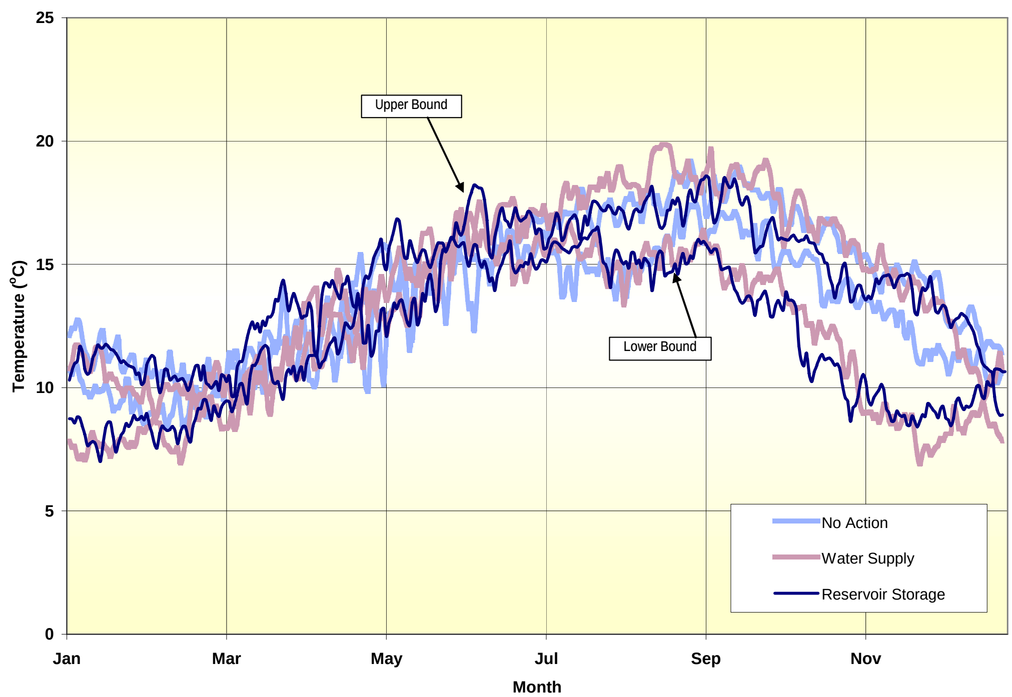
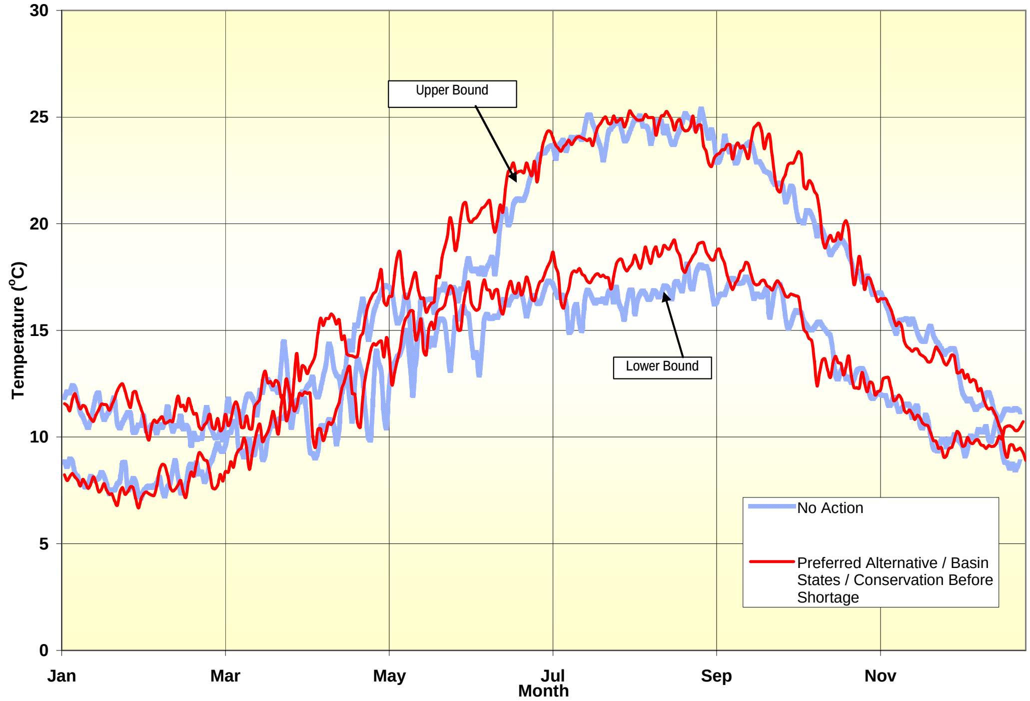


Figure P- BCR-69
Colorado River Near Diamond Creek
Comparison of Action Alternatives to No Action Alternative
10th Percentile Temperatures Upper and Lower Bounds



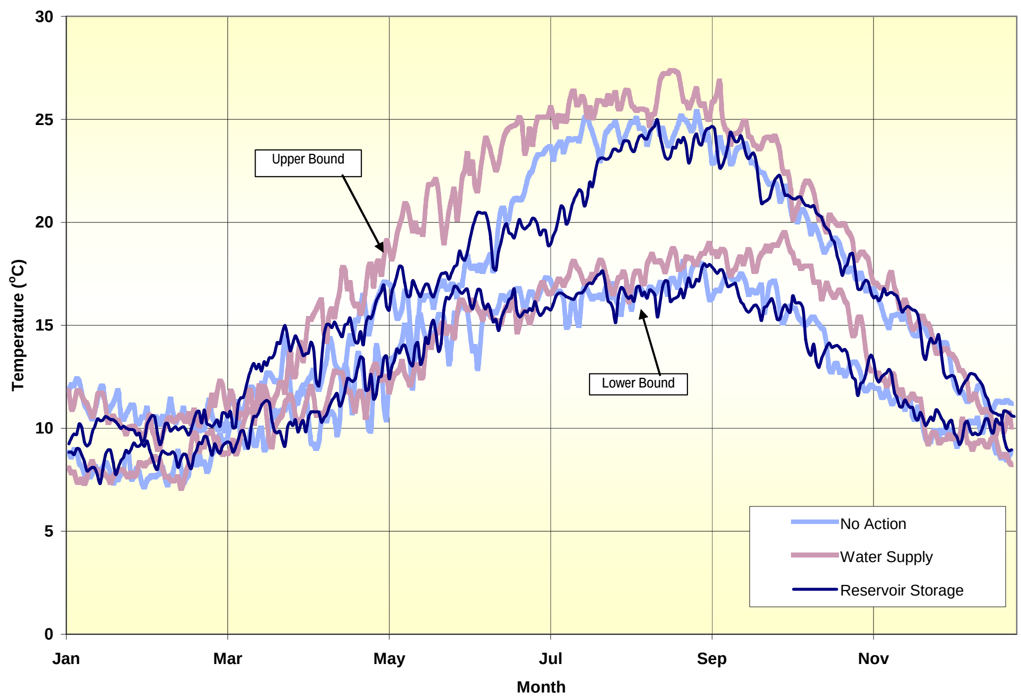


Table P-BCR-1
Average Monthly Temperature (ºC)
Colorado River at Lees Ferry

Alternative	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action												
90th Percentile	9.5	9	8.5	8.5	8.7	9	9.5	10	10.3	10.5	10.3	10
50th Percentile	10.5	8.7	8.3	8.3	8.9	9.2	9.5	10.5	11	11.5	11.5	11
10th Percentile	10	8.5	8.2	8.8	10	11.5	15	16	16.5	15.5	14	12
Basin States / Conservation Before Shortage												
90th Percentile	9.9	8.9	8.5	8.5	8.7	9.1	9.7	9.8	9.9	10.0	10.0	10.4
50th Percentile	9.1	8.6	8.7	9.0	9.3	9.5	10.3	11.2	11.5	11.8	11.3	10.4
10th Percentile	9.4	8.4	8.4	9.2	10.9	13.4	16.0	16.8	16.5	15.0	12.9	11.1
Water Supply												
90th Percentile	9.9	8.9	8.5	8.5	8.7	9.1	9.7	9.8	9.9	10.0	10.0	10.4
50th Percentile	8.9	8.1	8.0	8.5	9.1	9.6	10.4	11.2	11.6	11.7	11.0	10.0
10th Percentile	9.1	8.7	8.8	9.8	12.1	14.3	16.4	17.6	18.1	16.9	13.9	10.6
Reservoir Storage												
90th Percentile	9.9	8.9	8.5	8.5	8.7	9.1	9.7	9.8	9.9	10.0	10.0	10.4
50th Percentile	9.4	8.4	8.3	8.7	9.1	9.6	10.1	10.5	10.6	10.5	11.2	11.0
10th Percentile	8.9	8.5	8.4	9.1	10.3	11.4	13.3	15.3	15.7	15.1	13.5	11.2
Preferred Alternative												
90th Percentile	9.5	9	8.5	8.5	8.7	9	9.5	10	10.3	10.5	10.3	10
50th Percentile	10.5	8.7	8.3	8.3	8.9	9.2	9.5	10.5	11	11.5	11.5	11
10th Percentile	10	8.5	8.2	8.8	10	11.5	15	16	16.5	15.5	14	12

Table P-BCR-2
Average Monthly Temperature (ºC)
Colorado River Below Little Colorado River

Alternative	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action												
90th Percentile	10.0	9.4	9.4	9.7	10.2	10.7	11.5	11.5	11.4	10.7	10.2	10.4
50th Percentile	10.8	9.4	9.8	10.3	11.0	11.7	12.1	13.0	14.4	14.4	13.8	12.4
10th Percentile	9.7	8.9	9.5	10.5	12.2	14.4	18.0	17.8	17.6	16.0	13.3	11.2
Basin States / Conservation Before Shortage												
90th Percentile	10.0	9.4	9.4	9.7	10.2	10.7	11.5	11.5	11.4	10.7	10.2	10.4
50th Percentile	9.4	9.1	9.7	10.7	11.5	12.0	12.4	13.4	13.4	12.9	11.8	10.5
10th Percentile	9.7	9.0	9.4	10.8	12.8	15.4	17.8	18.7	18.2	16.1	13.3	11.2
Water Supply												
90th Percentile	10.0	9.4	9.4	9.7	10.2	10.7	11.5	11.5	11.4	10.7	10.2	10.4
50th Percentile	9.2	8.7	8.9	10.1	11.1	12.0	12.6	13.3	13.6	13.0	11.5	10.2
10th Percentile	9.3	9.2	9.8	11.4	13.9	16.3	18.3	19.3	19.5	17.9	14.2	10.7
Reservoir Storage												
90th Percentile	9.9	9.4	9.4	9.7	10.2	10.7	11.5	11.5	11.4	10.7	10.2	10.4
50th Percentile	9.8	9.0	9.6	10.3	11.2	11.9	12.3	12.6	12.6	11.7	11.5	11.2
10th Percentile	9.3	9.1	9.7	10.7	12.3	13.7	15.2	17.1	17.3	16.0	13.8	11.4
Preferred Alternative												
90th Percentile	10.0	9.4	9.4	9.7	10.2	10.7	11.5	11.5	11.4	10.7	10.2	10.4
50th Percentile	9.4	9.1	9.7	10.7	11.5	12.0	12.4	13.4	13.4	12.9	11.8	10.5
10th Percentile	9.7	9.0	9.4	10.8	12.8	15.4	17.8	18.7	18.2	16.1	13.3	11.2

Table P-BCR-3
Average Monthly Temperature (ºC)
Colorado River Near Diamond Creek

Alternative	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action												
90th Percentile	10.9	11.2	12.0	13.4	14.8	15.8	17.2	16.8	16.0	13.4	11.3	10.8
50th Percentile	10.6	9.8	11.2	12.4	14.2	15.5	16.5	16.6	17.3	15.6	13.7	11.8
10th Percentile	9.6	9.3	11.0	12.6	15.2	17.7	20.2	20.7	20.0	16.9	13.3	10.8
Basin States / Conservation Before Shortage												
90th Percentile	10.9	11.2	12.0	13.4	14.8	15.8	17.2	16.8	16.0	13.4	11.3	10.8
50th Percentile	9.3	9.6	11.0	13.2	15.2	16.1	16.2	17.1	16.5	14.5	11.9	10.1
10th Percentile	9.6	9.4	10.9	13.4	16.3	19.1	20.9	21.6	20.5	17.2	13.2	10.7
Water Supply												
90th Percentile	10.9	11.2	12.0	13.4	14.8	15.8	17.2	16.8	16.0	13.4	11.3	10.8
50th Percentile	9.1	9.2	10.2	12.7	14.5	16.2	16.6	17.0	16.7	14.7	11.7	9.9
10th Percentile	9.3	9.5	11.0	13.9	16.8	19.6	21.4	22.0	21.5	18.9	14.1	10.4
Reservoir Storage												
90th Percentile	10.9	11.2	12.0	13.4	14.8	15.8	17.2	16.8	16.0	13.4	11.3	10.8
50th Percentile	9.7	9.5	11.3	12.8	14.7	16.0	16.1	16.1	15.9	13.5	11.7	10.7
10th Percentile	9.3	9.5	11.4	13.0	15.7	17.7	18.9	20.2	19.9	17.1	13.7	10.8
Preferred Alternative												
90th Percentile	10.9	11.2	12.0	13.4	14.8	15.8	17.2	16.8	16.0	13.4	11.3	10.8
50th Percentile	9.3	9.6	11.0	13.2	15.2	16.1	16.8	17.1	16.5	14.5	11.9	10.1
10th Percentile	9.6	9.4	10.9	13.4	16.3	19.1	20.9	21.6	20.5	17.2	13.2	10.7

Electrical Power Resources Information

This section contains additional information used in the electrical power resources impact analyses (Section 4.11 of this Final EIS). This information consists of three groups of graphs. The initial group of graphs provide a comparison of the energy production at Glen Canyon, Hoover, Davis, and Parker Powerplants. The second group of graphs provide a comparison of the Lake Powell and Lake Mead elevations under the modeled action alternatives to those under the modeled No Action Alternative. These graphs compare Lake Powell end-of-July and Lake Mead end-of-December elevations. The last group of graphs provide a comparison of the Headgate Rock Dam annual releases and energy production values under the modeled action alternatives to those under the modeled No Action Alternative.

Figure P-EP-1
Glen Canyon Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

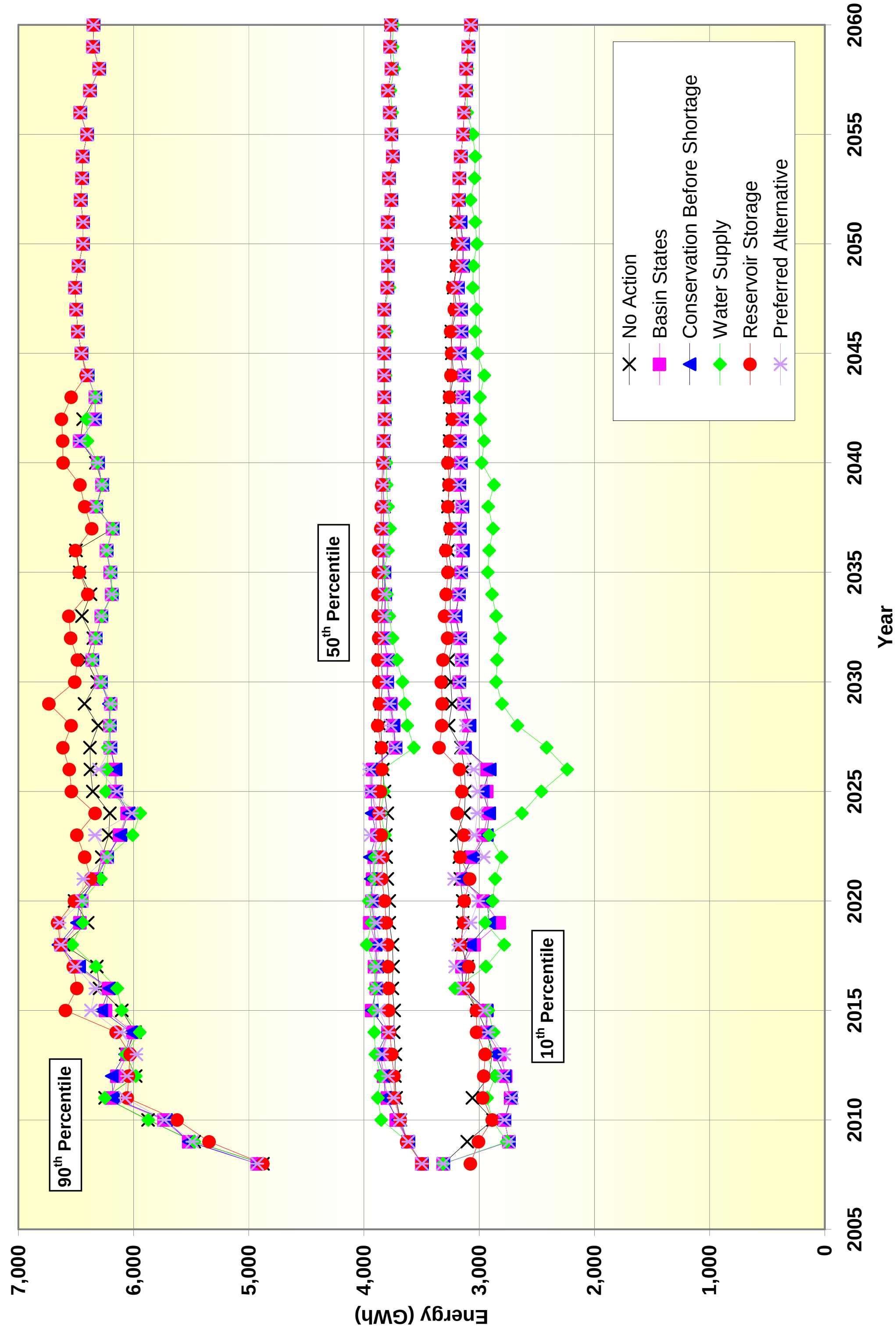


Figure P- EP-2
Hoover Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

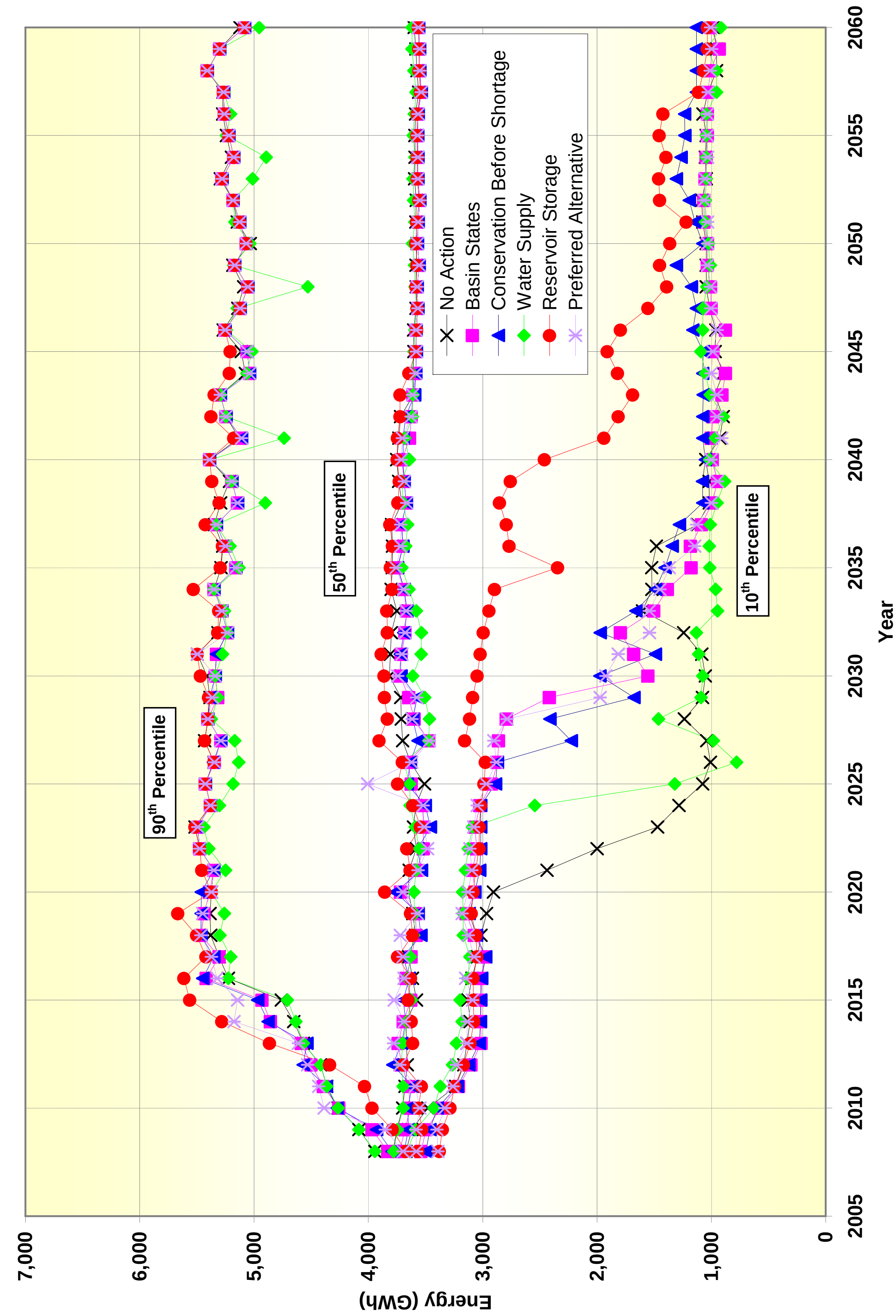


Figure P- EP-3
Davis Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

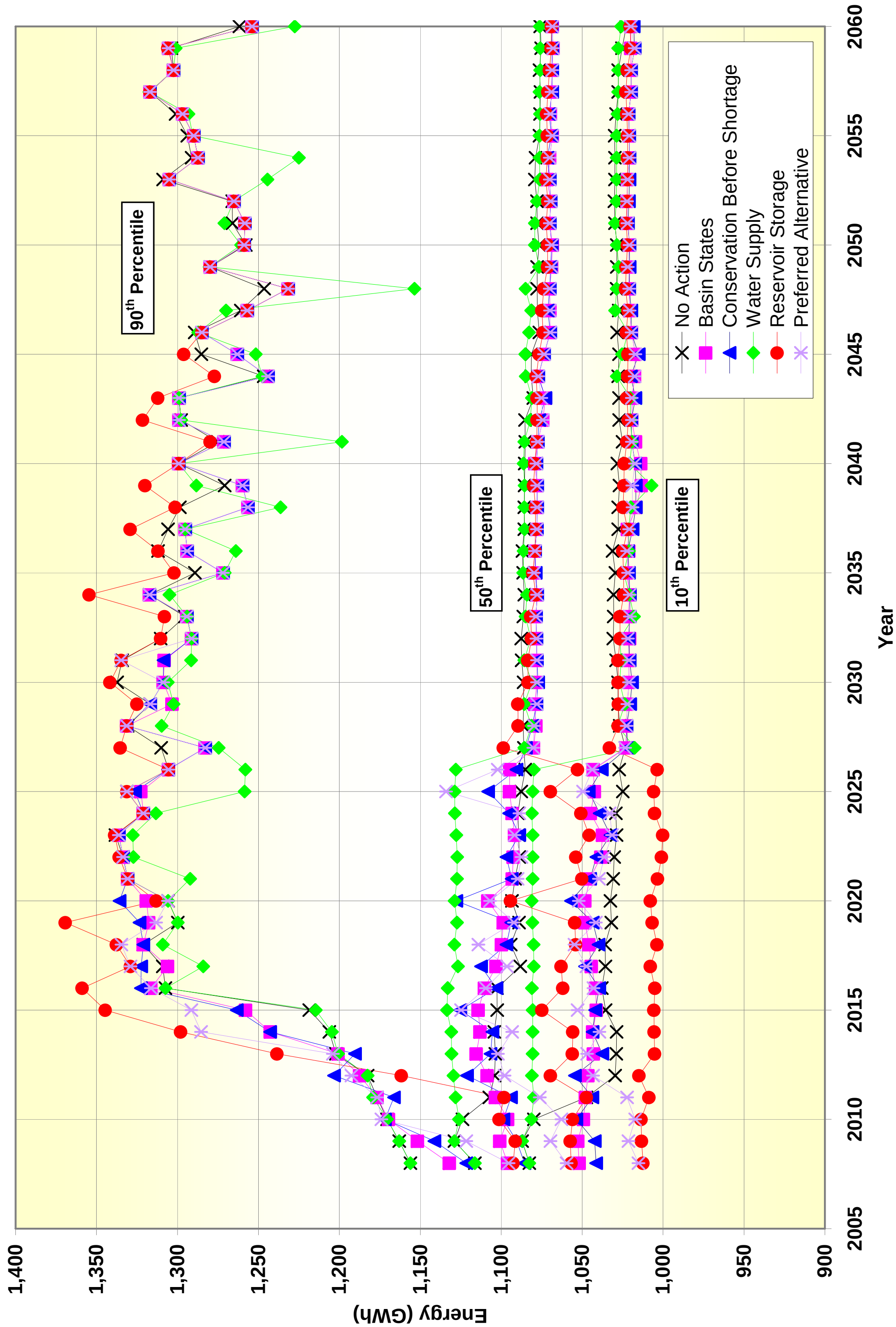


Figure P- EP-4
Parker Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Figure P- EP-5
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
50th and 10th Percentile Values

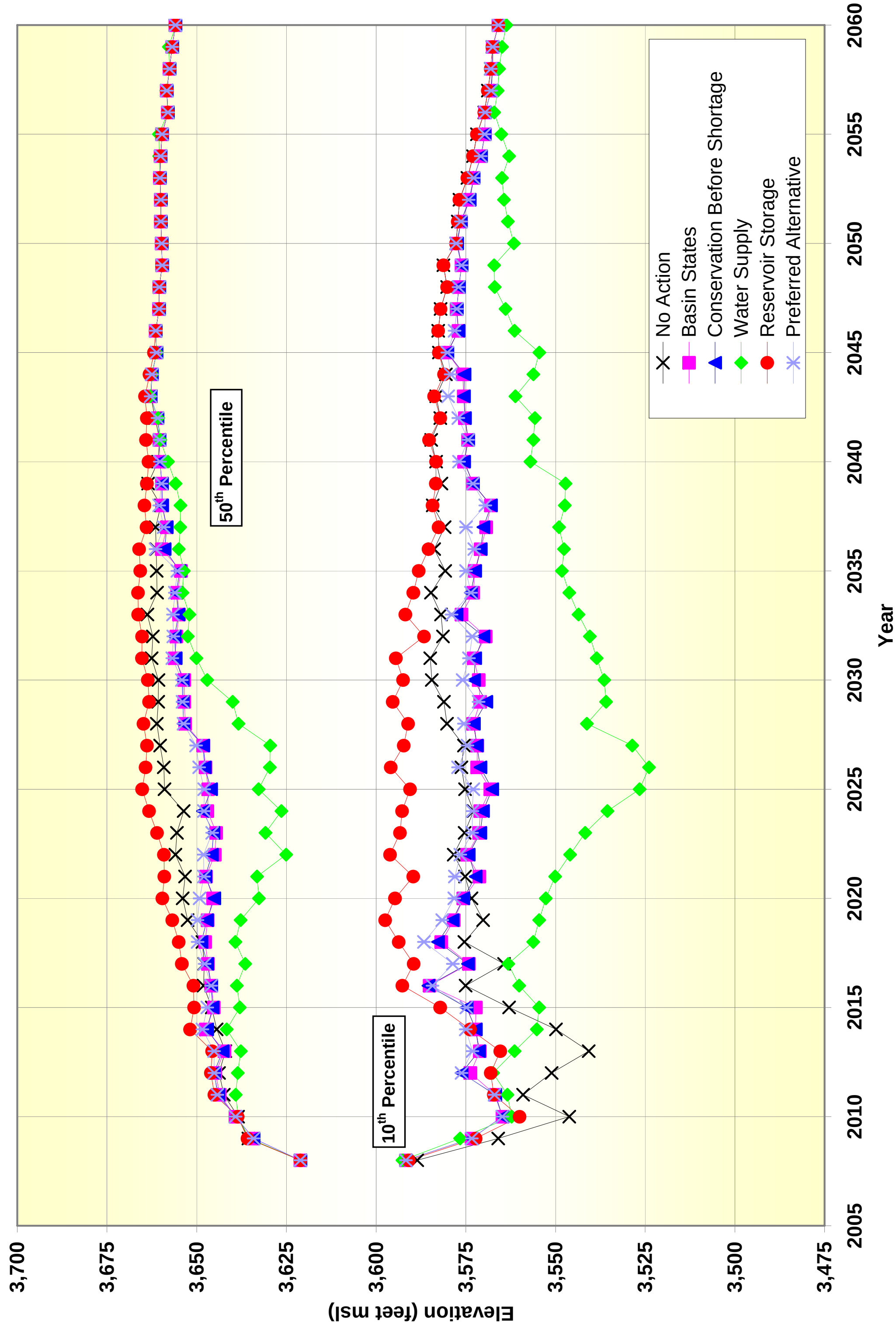


Figure P- EP-6
Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative
50th and 10th Percentile Values

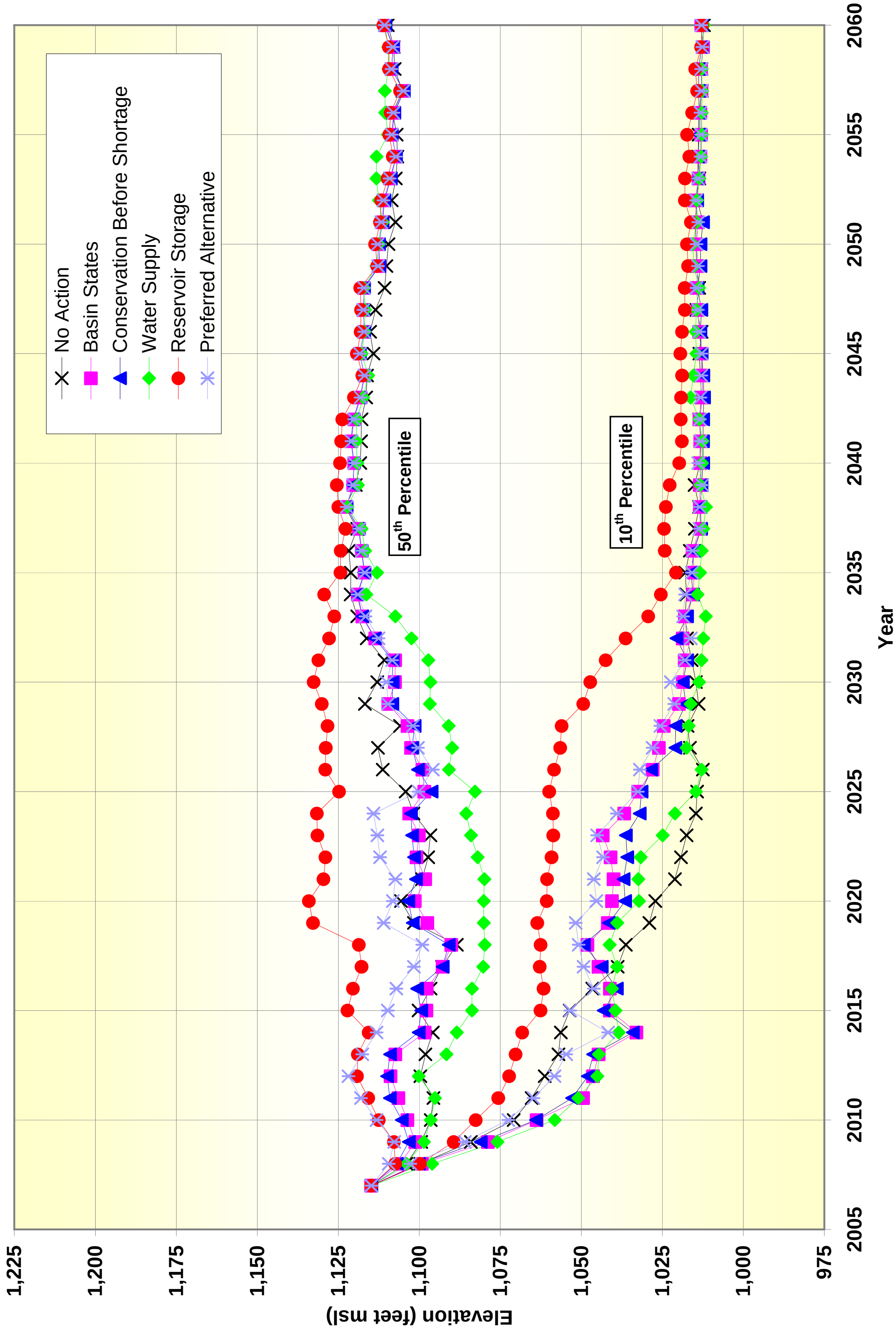


Figure P- EP-7
Headgate Rock Dam Annual Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

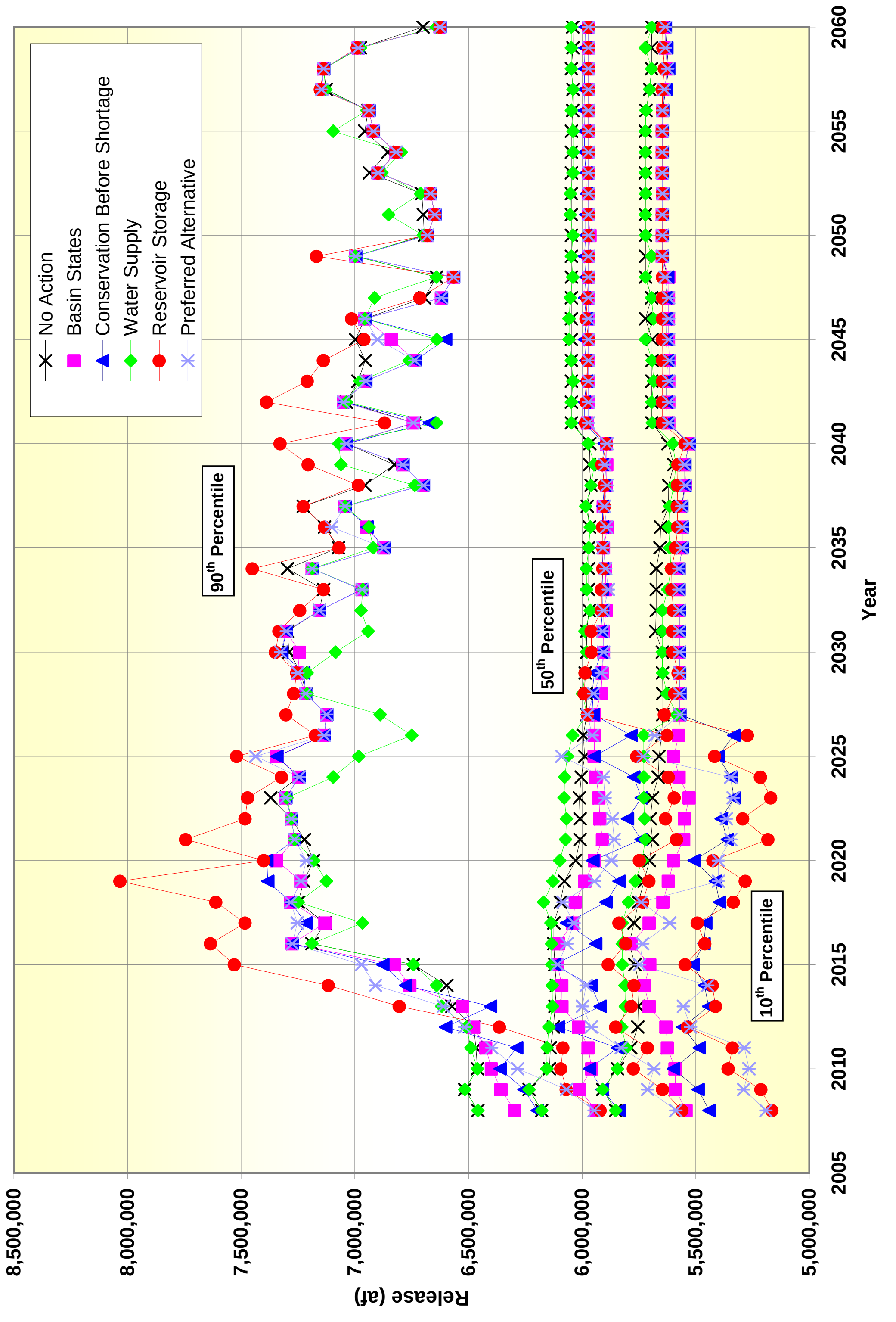


Figure P- EP-8
Headgate Rock Dam Annual Releases
Comparison of Action Alternatives to No Action Alternative
Average Values

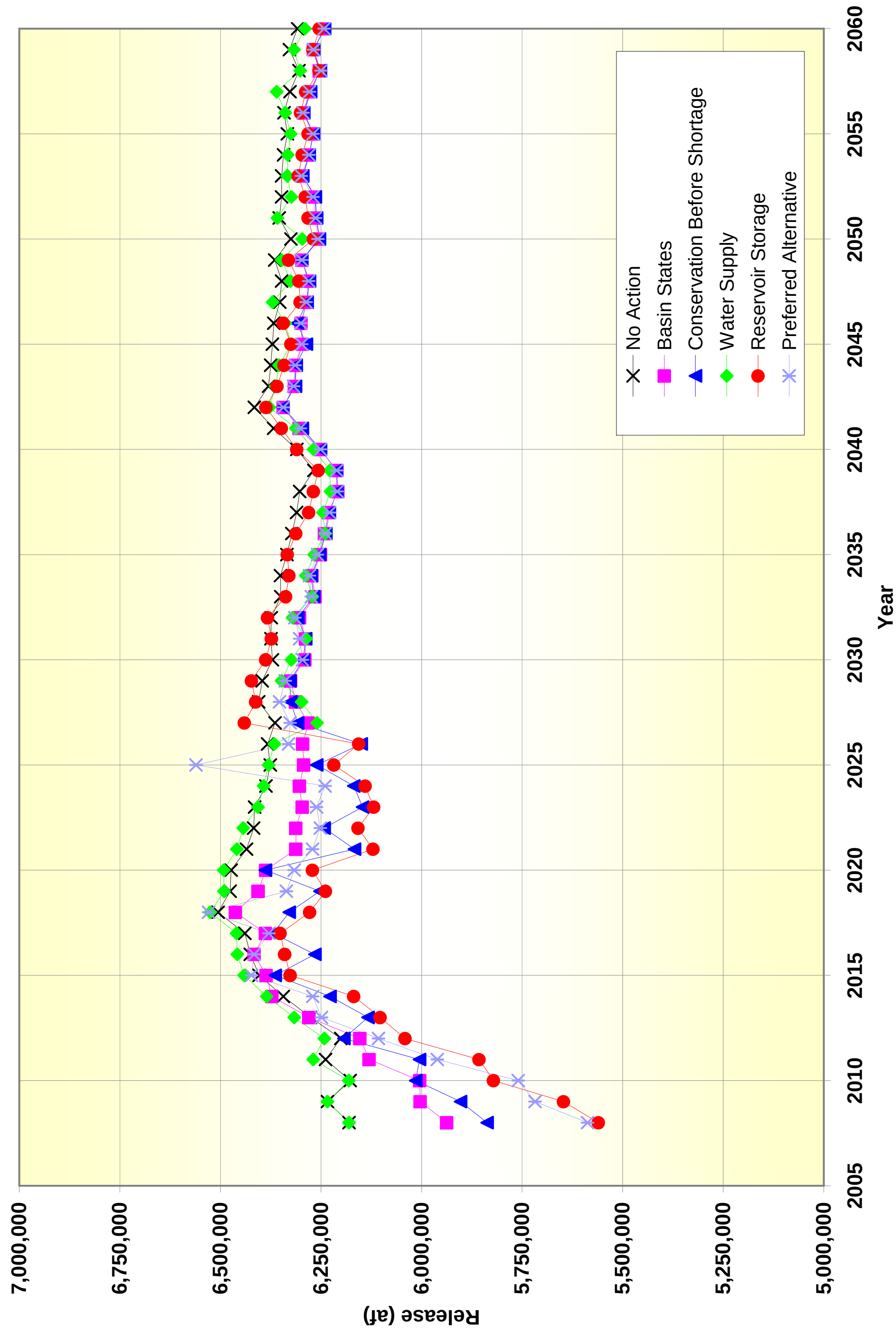


Figure P- EP-9
Headgate Rock Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

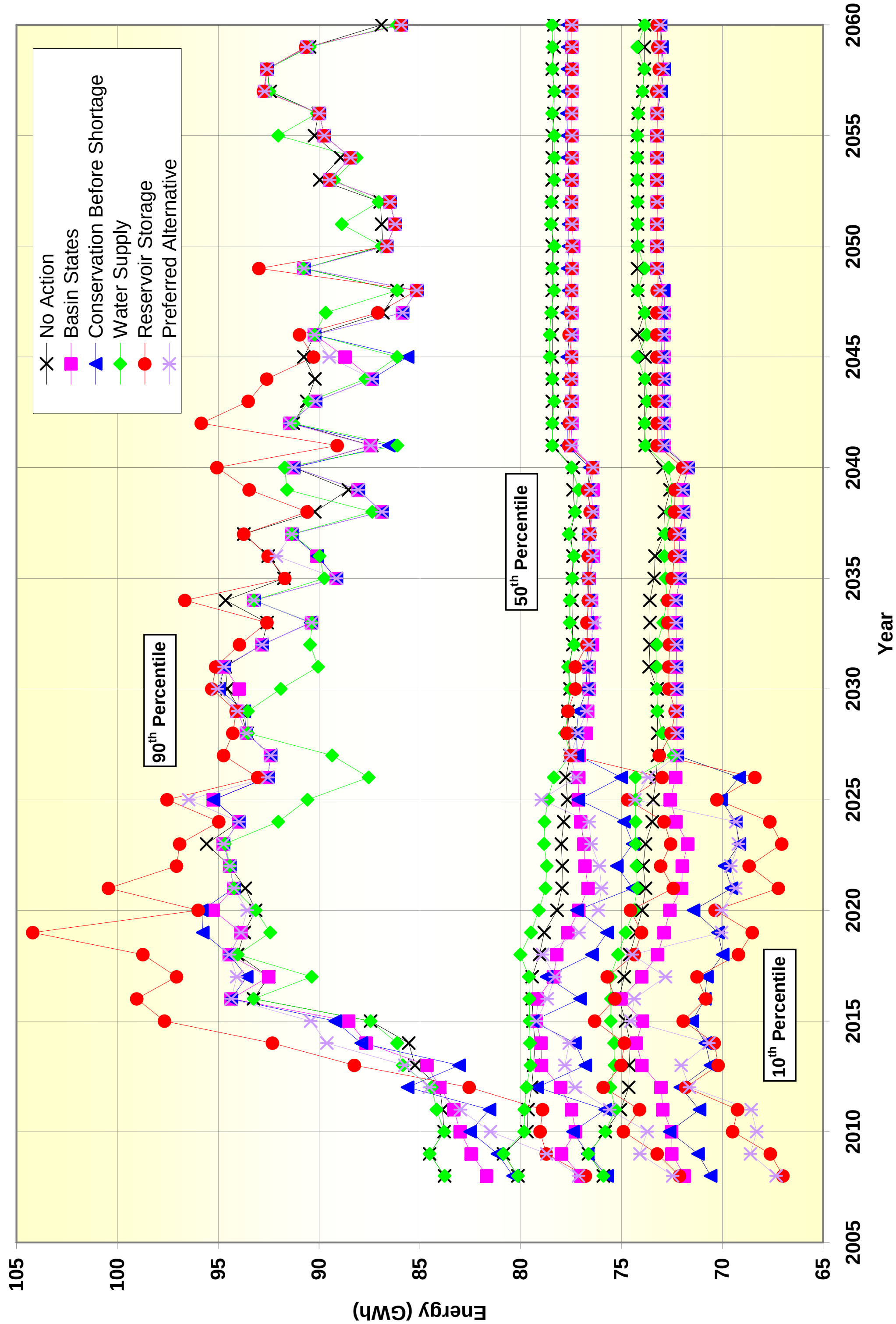
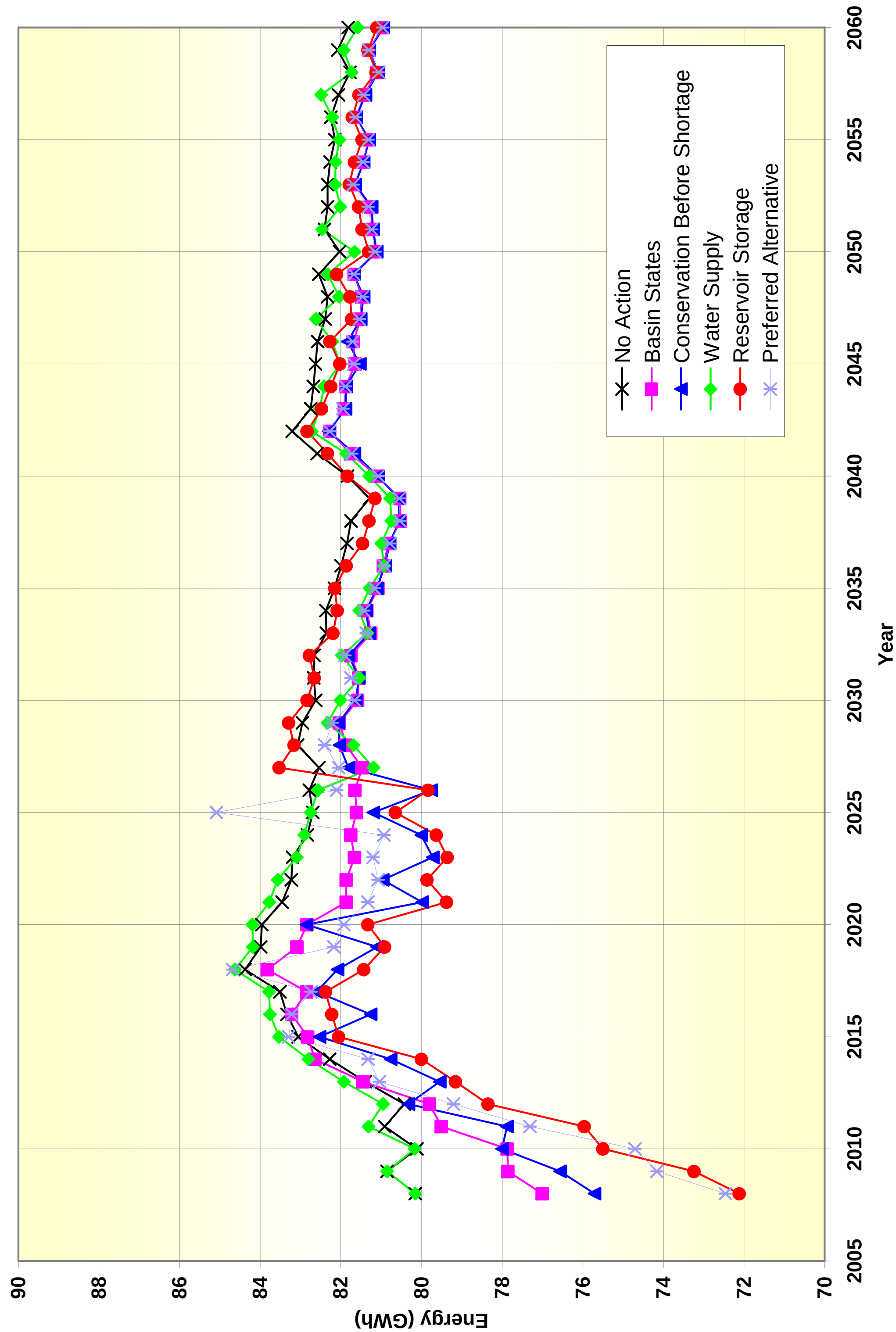


Figure P- EP-10
Headgate Rock Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
Average Values



Appendix Q

Modeling Assumptions with Regard to Future Water Deliveries to Mexico Sensitivity Analysis

This appendix provides a comparative analysis of the sensitivity of the hydrologic resources to different modeling assumptions with regard to how Mexico may incur future water delivery reductions. Two methodologies for determining future water delivery reductions to Mexico are described. The modeling assumptions used to implement the methodologies are also presented.

Table of Contents

List of Attachments

List of Figures

List of Tables

Q.1 Introduction

The proposed federal action includes the adoption of specific interim guidelines for Lower Basin shortages. The interim guidelines would be used by the Secretary to determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) (Section 1.7) below 7.5 million acre-feet (maf) (a ‘‘Shortage’’) pursuant to Article II(B)(3) of the Consolidated Decree. The determination of deliveries to Mexico is not a part of the proposed federal action. Any such determination would be made in accordance with the 1944 Treaty. Nevertheless, modeling assumptions with respect to the distribution of shortages for the Lower Division states include water delivery reductions to Mexico in order to analyze potential impacts to hydrologic and other environmental resources (Section Q.2.2.1 and Appendix A)[1]. These modeling assumptions were applied to the No Action Alternative as well as the action alternatives, i.e., the modeling assumptions with regard to the distribution of shortages to the Lower Division states include water delivery reductions to Mexico and are identical in all alternatives.

This appendix provides a comparative analysis of the sensitivity of the hydrologic resources to different modeling assumptions with regard to how Mexico would be impacted by future water delivery reductions. Two methodologies for determining future water delivery reductions to Mexico are described. The modeling assumptions used to implement the methodologies are also presented.

Q.2 Description of Methodologies

Although many possible methodologies exist that would result in different volumes of potential future water delivery reductions to Mexico, two methodologies were considered in this analysis in order to assess the sensitivity of the hydrologic resources to a wide range of possible water delivery reductions. Both methodologies are similar and both assume that the water deliveries to Mexico would be reduced in the same proportion as reductions in consumptive uses in the United States (shortages). The difference between the methodologies is whether shortages in both the Upper Basin and Lower Basin in the United States are considered when applying water delivery reductions to Mexico. Methodology A applies water delivery reductions to Mexico only when shortages to United States users in the Lower Basin occur, and water deliveries to Mexico are reduced in the same proportion as the reduction to United States users in the Lower Basin. This is the methodology that was used for the resource analyses in Volume I of this Final EIS. Methodology B applies water delivery reductions to Mexico when shortages to United States

[1] Reclamation’s modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

users in either the Upper Basin or Lower Basin or both occur, and water deliveries to Mexico are reduced in the same proportion as the reduction to United States users in both the Upper and Lower Basins. These methodologies are described below along with comparisons of the results of the methodologies.

Q.2.1 Methodology A

Under Methodology A, water delivery reductions to Mexico are triggered only when deliveries to United States users in the Lower Basin are reduced. When triggered, the water deliveries to Mexico are reduced in the same proportion as the reduction to the United States users in the Lower Basin. The methodology is as follows:

1) Determine the shortage to be applied to United States users in the Lower Basin. Under the Preferred Alternative, shortages of specific magnitudes are triggered by specific Lake Mead elevations.

   - Example: for the Preferred Alternative, if Lake Mead elevation is below 1,025 feet msl, the shortage to United States users in the Lower Basin is 500 kaf

2) Compute the proportional reduction to United States users in the Lower Basin by dividing the shortage to be applied to United States users in the Lower Basin by the total United States Lower Division states apportionments (7.5 maf).

   - Example: assuming a shortage to United States users in the Lower Basin of 500 kaf, the proportional reduction would be computed as:

     500 kaf / 7.5 maf = 6.7 percent

3) Compute the water delivery reduction to Mexico by applying the same proportional reduction to United States users in the Lower Basin to Mexico. This is computed by multiplying Mexico's annual Colorado River allotment (1.5 maf) by the proportional reduction to United States users in the Lower Basin. [2]

   - Example: assuming the proportional reduction to United States users in the Lower Basin is 6.7 percent, the water delivery reduction to Mexico would be computed as:

     *1.5 maf * 6.7 percent = 100 kaf*

A summary of shortages to United States users in the Lower Basin and water delivery reductions to Mexico for the three levels of shortages under the Preferred Alternative is provided in Table Q-1 and Table Q-2 respectively.

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[2] Alternatively, under Methodology A, the same volume of the reduction to Mexico may be computed by taking 16.7 percent of the total water reduction applied to the United States and Mexico. This percentage is computed by taking the ratio of Mexico's allotment to the sum of the Lower Basin United States apportionments and Mexico's allotment (1.5 maf/(7.5 maf + 1.5 maf) = 0.167 or 16.7 percent). This approach results in the same proportional reduction to Mexico as occurs to the United States users in the Lower Basin (see Attachment A).

Table Q-1
Examples of Shortages to United States Users in the Lower Basin for Methodology A

Lake Mead Elevation (feet msl)	Reduction to United States Lower Basin users (kaf)	Delivery to United States Lower Basin Users (kaf)	Percent Reduction to United States Lower Basin Users
1,075 to 1,050	333	7,167	4.4
1,050 to 1,025	417	7,083	5.6
Less than 1,025	500	7,000	6.7

Table Q-2
Examples of Water Delivery Reductions to Mexico for Methodology A

Mead Elevation (feet msl)	Reduction to Mexico (kaf)	Delivery to Mexico (kaf)	Percent Reduction to Mexico
1,075 to 1,050	67	1,433	4.4
1,050 to 1,025	83	1,417	5.6
Less than 1,025	100	1,400	6.7

Q.2.2 Methodology B

Under Methodology B, water delivery reductions to Mexico are triggered by shortages to United States users in the Upper Basin, by shortages to United States users in the Lower Basin, or both. When triggered, the water deliveries to Mexico are reduced in the same proportion as the reduction to United States users in both the Upper and Lower Basins. The methodology is as follows:

1) Determine the shortage to be applied to United States users in the Lower Basin.

    - Example: for the Preferred Alternative, if Lake Mead elevation is below 1,050 feet msl, the shortage to United States users in the Lower Basin is 417 kaf

2) Determine the shortage to be applied to United States users in the Upper Basin. Shortages to United States users in the Upper Basin are assumed to occur when the delivery to those users is less than their scheduled use. Shortage is calculated as Upper Basin scheduled use minus Upper Basin actual use.

    - Example: in the year 2016, the Upper Basin scheduled use is 4.779 maf and under one hydrologic sequence, the model computed a delivery of 4.355 maf, resulting in a shortage to United States users in the Upper Basin of 424 kaf, in addition to the shortage to United States users in the Lower Basin of 417 kaf

3) Compute the proportional reduction to United States users in both the Upper and Lower Basins as the sum of shortages to United States users in the Upper and Lower Basins

divided by the sum of the Upper Basin scheduled use and the total United States Lower Basin apportionments (7.5 maf).

- Example: the proportional reduction to the United States users would be computed as:

  (417 kaf + 424 kaf) / (7.5 maf + 4.779 maf) = 6.8 percent

4) Compute water delivery reduction to Mexico by applying the same proportional reduction to United States users in both the Upper and Lower Basins to Mexico. This is computed by multiplying Mexico's annual Colorado River allotment (1.5 maf) by the proportional reduction to United States users in both the Upper and Lower Basins.

   - Example: given the proportional reduction to United States users in both the Upper and Lower Basins is 6.8 percent, the water delivery reduction to Mexico would be computed as:

     *1.5 maf * 6.8 percent = 102 kaf*

Since Upper Basin scheduled use varies each year (Section 3.4.1 and Appendix C) and the computed shortages in the Upper Basin vary for each hydrologic sequence, a wide range of possible proportional reductions are simulated by Methodology B (from zero to approximately 11.7 percent resulting in water reductions to Mexico of zero to approximately 175 kafy as shown in Figure Q-9 and Q-7 respectively).

Table Q-3 shows some examples taken from the modeling results for year 2016. The scheduled Upper Basin uses in 2016 are 4.779 maf, resulting in the proportional reduction to the United States equal to the sum of Upper and Lower Basin United States shortages divided by 12.279 maf (7.5 maf plus 4.779 maf).

Table Q-3
Examples of Shortages to the United States Users for Methodology B

Example	Shortage to Upper Basin (kaf)	Shortage to Lower Basin (kaf)	Total Shortage to United States (kaf)	Total Use in the United States (kaf)	% Reduction to United States*
a) Upper and Lower Basin Shortage	424	417	841	11,438	6.8
b) Upper and Lower Basin Shortage	100	417	517	11,762	4.2
c) Upper Basin Shortage only	21	0	21	12.258	0.2
d) Lower Basin Shortage only	0	333	333	11.946	2.7

** Percent reduction on total delivery to United States of 7.5 maf + 4.779 maf = 12.279 maf*

Given the shortages examples in the United States in Table Q-3, the resulting equal proportional water delivery reductions to Mexico under Methodology B are provided In Table Q-4.

Table Q-4
Examples of Water Delivery Reductions to Mexico for Methodology B

Example	Reduction to Mexico Delivery (kaf)	Total Delivery to Mexico (kaf)	% Reduction to Mexico
a) Upper and Lower Basin Shortage	102	1,398	6.8
b) Upper and Lower Basin Shortage	63	1,437	4.2
c) Upper Basin Shortage only	3	1,497	0.2
d) Lower Basin Shortage only	41	1,459	2.7

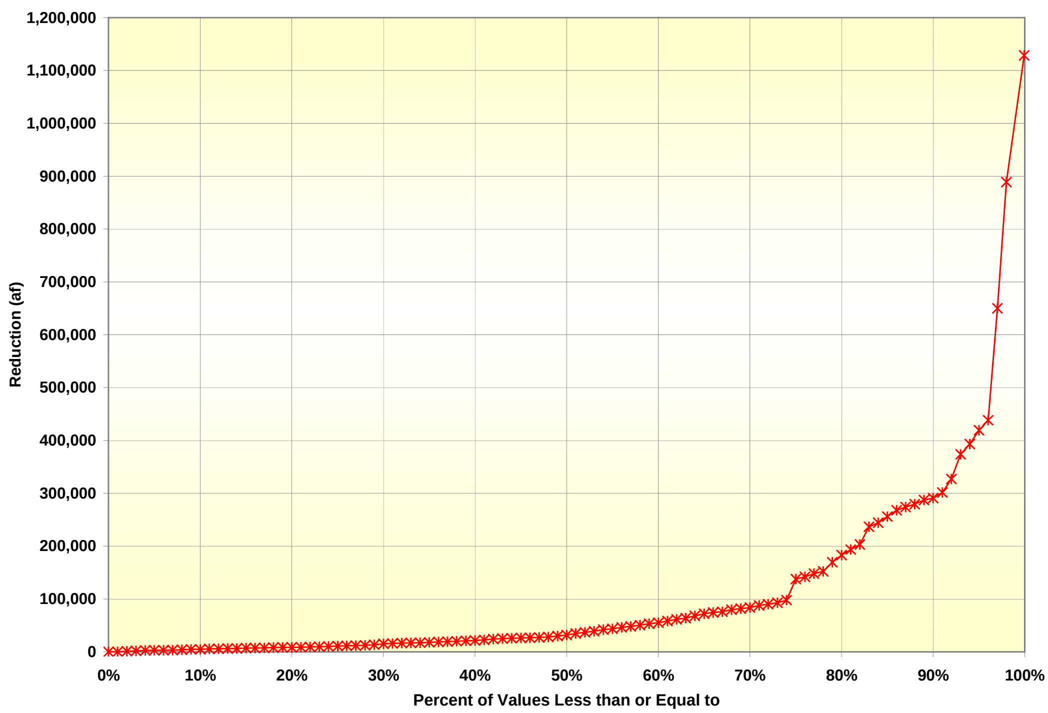
Q.3 Modeling Results

An analysis was performed to test the sensitivity of the hydrologic resources to these two sets of modeling assumptions (Methodology A and B). The Colorado River Simulation System (CRSS) model was used to simulate water deliveries to Mexico under these two methodologies with all other modeling assumptions held constant. The modeling assumptions under the Preferred Alternative were used for this assessment with one major exception. It was assumed that there was no storage and delivery mechanism in place in order to isolate the effects of each methodology. Also, the sensitivity analysis also only considers the interim period (years 2008 through 2026).

Q.3.1 Upper Basin Shortages

CRSS assumes that shortages in the Upper Basin occur only when there is not sufficient water within a given reach to meet a user’s demand. As described previously, the total Upper Basin shortage for any year is computed as the total Upper Basin delivery subtracted from the Upper Basin scheduled use for that year. Figure Q-1 provides a cumulative distribution of Upper Basin shortage amounts generated by CRSS over the period 2008 through 2026. The computed shortages to the Upper Basin users are dependent solely upon the hydrologic sequences and are therefore identical under Methodology A and Methodology B.

Figure Q-1
Upper Basin Shortages
Years 2008 to 2026



From this figure, it can be seen that modeled Upper Basin shortages range from approximately 1.05 kaf to 1,130 kaf and are frequent, occurring approximately 98 percent of the time. Approximately 75 percent of the shortages are of magnitudes less than 100 kaf. Shortages of magnitudes between 100 kaf and 400 kaf occur about 20 percent of the time and shortages of magnitudes above 400 kaf occur about five percent of the time. As a point of reference, Upper Basin shortages of 100 kaf and 400 kaf represent about two percent and eight percent of the average scheduled Upper Basin depletion over the interim period, respectively.

Q.3.2 Lake Powell and Lake Mead Water Surface Elevations

Figure Q-2 compares the 10th, 50th and 90th percentile elevations at Lake Powell under Methodology A and B.

The effect of the Methodology B water delivery reduction assumption on elevations at Lake Powell is negligible. The elevations of Lake Powell under Methodology B are higher than for Methodology A by approximately 0.001 feet at the 10th percentile and lower than under Methodology A by approximately 0.1 feet at the 50th percentile.

Figure Q-2
Lake Powell End-of-December Elevations
Comparison of Methodologies A and B
90th, 50th and 10th Percentile Values

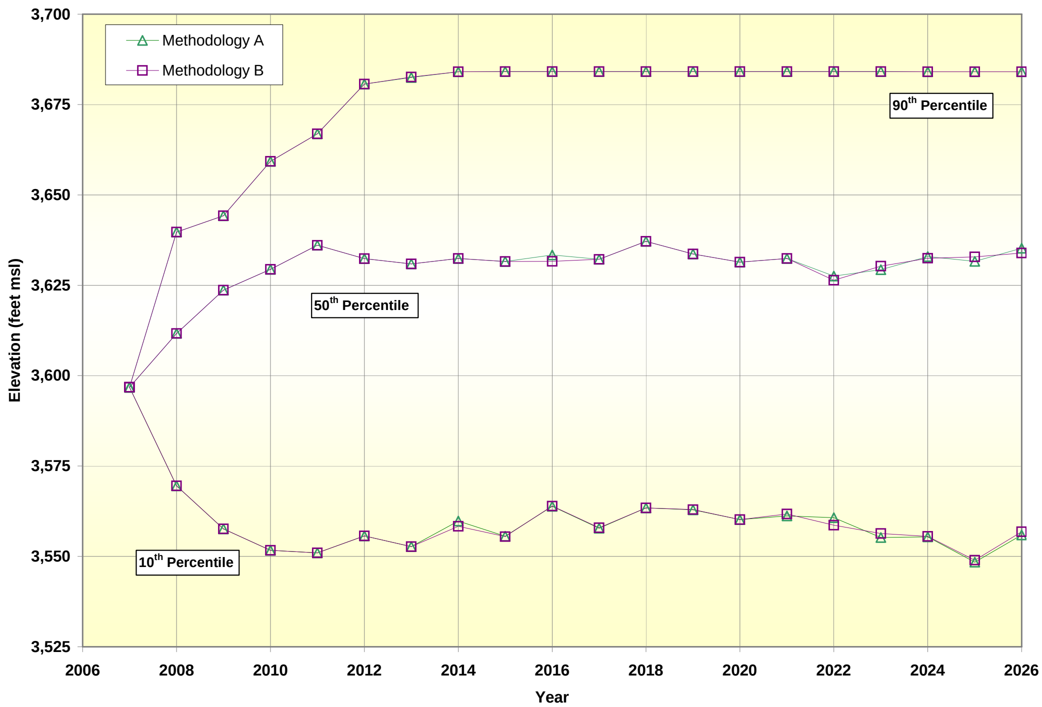
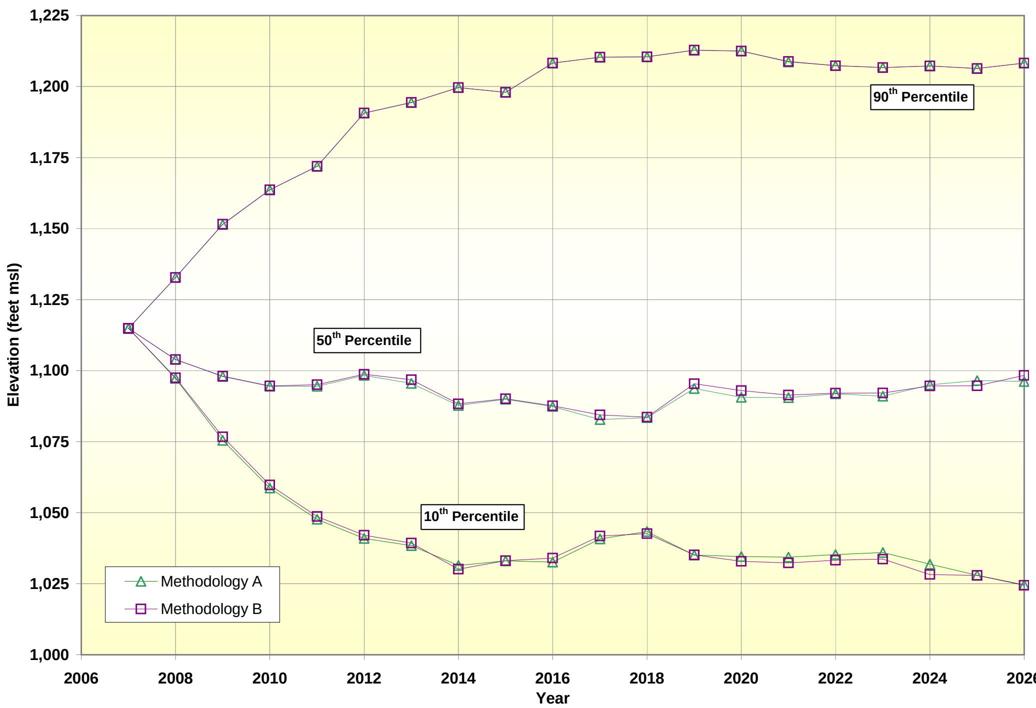


Figure Q-3 compares the 10th, 50th and 90th percentile elevations at Lake Mead under Methodology A and B. Methodology B results in somewhat lower elevations at the 10th percentile (a maximum of 3.6 feet in 2024) and slightly higher elevations at the 50th percentile (a maximum of 2.4 feet in 2020). Because the majority of the Upper Basin shortages are relatively small, Mexico may incur smaller water delivery reductions under Methodology B as compared to those observed under Methodology A when Lake Mead is relatively low (i.e., when United States users in the Lower Basin incur shortages), resulting in lower elevations at the 10th percentile. However, due to the higher frequency of Upper Basin shortages, Mexico experiences more frequent water delivery reductions under Methodology B, resulting in slightly higher Lake Mead elevations at the 50th percentile.

Figure Q-3
Lake Mead End-of-December Elevations
Comparison of Methodologies A and B
90th, 50th and 10th Percentile Values



Q.3.3 Comparison of Water Deliveries to Mexico

As described in Section 4.2, water deliveries to Mexico are assumed to be 1.5 mafy, except when the model assumes that additional deliveries of up to 200 kaf have been scheduled or a water delivery reduction has been incurred. Additional deliveries to Mexico of up to 200 kaf are assumed to occur when Lake Mead is in flood control operations. Reductions in the water deliveries to Mexico are simulated consistent with the modeling assumptions described previously under each methodology. Consequently, simulated water deliveries to Mexico are expected to fluctuate throughout the interim period (2008 through 2026) reflecting variations in hydrologic conditions under these assumptions.

Figure Q-4 displays the 10th, 50th and 90th percentile values for Mexico's water deliveries under Methodology A and Methodology B. At the 90th percentile, the results are essentially the same.

Water deliveries are 1.5 mafy at the 50th percentile under Methodology A. Water deliveries are less than 1.5 mafy at the 50th percentile under Methodology B, with an average reduction of approximately 25 kafy over the interim period. The more frequent reductions under Methodology B are due to the fact that Upper Basin shortages occur frequently and are included in the calculation of the proportional reduction under Methodology B.

At the 10th percentile, water deliveries to Mexico are higher under Methodology B after 2010, averaging approximately 16 kafy higher compared to Methodology A over the interim period. This result can be explained as follows. For a specific shortage to Lower Basin United States users, Upper Basin shortages are often small enough in magnitude to result in a proportional reduction to United States users (and to Mexico) under Methodology B that is less than the proportional reduction computed under Methodology A for the same shortage to Lower Basin United States users. These occurrences result in higher water deliveries to Mexico under Methodology B at the 10th percentile.

This occurrence is illustrated in Table Q-1 through Table Q-4. As shown in Table Q-1, a shortage of 417 kaf to Lower Basin United States users results in a proportional reduction of 5.6 percent under Methodology A. As shown in Table Q-2, applying the same proportional reduction to Mexico would result in a reduction of 83 kaf. The same shortage to Lower Basin United States users (417 kaf), coupled with shortages to Upper Basin United States users of 100 kaf (Example (b) in Table Q-3), results in a smaller proportional reduction of 4.2 percent under Methodology B. As shown in Table Q-4, applying the same proportional reduction to Mexico would result in a reduction of 63 kaf.

Figure Q-4
Mexico Modeled Annual Depletions
Comparison of Methodologies A and B
90th, 50th and 10th Percentile Values

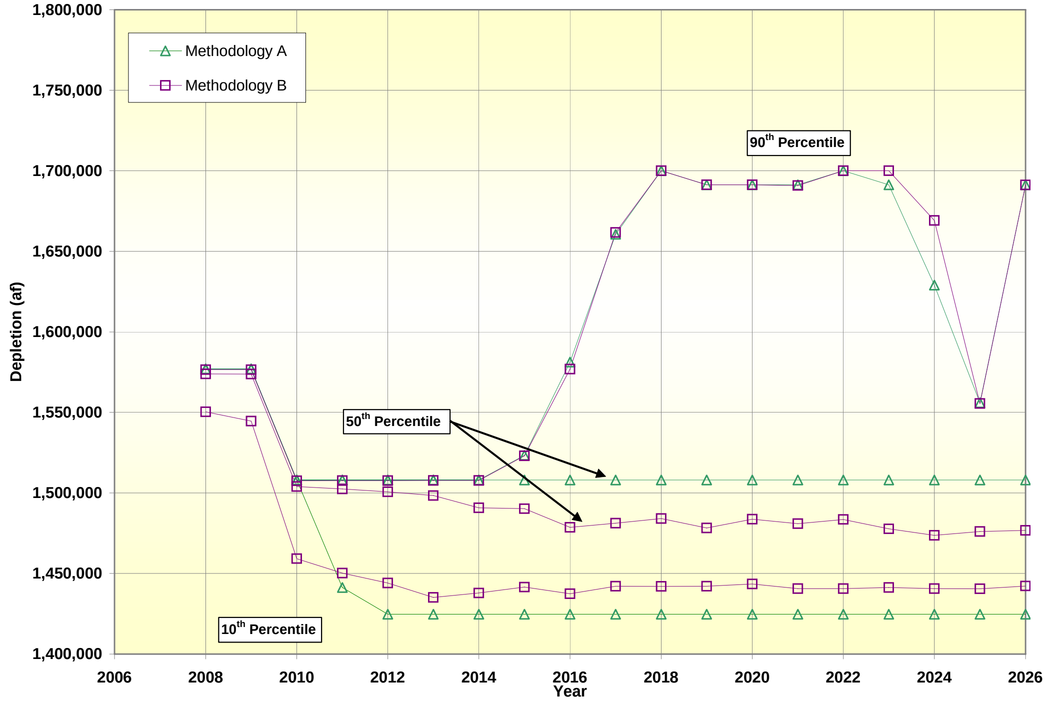


Table Q-5 provides a comparison of the information presented in Figure Q-4 for specific years in the interim period.

Table Q-5
Mexico Modeled Annual Depletions
Comparison of Methodologies A and B

Year	Methodology A			Methodology B		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
2008	1,577,000	1,577,000	1,577,000	1,576,571	1,573,935	1,550,313
2016	1,581,288	1,508,000	1,424,668	1,576,830	1,478,643	1,437,371
2026	1,691,360	1,508,000	1,424,668	1,691,215	1,476,758	1,442,230

Figure Q-5 provides a comparison of the cumulative distribution of Mexico's water deliveries under Methodology A and Methodology B. The results presented in Figure Q-5 can be used to compare how often Mexico might expect deliveries in excess of, or less than,1.5 maf under these different modeling assumptions. The occurrence of water deliveries to Mexico greater than 1.5 maf reflect years when additional water up to 200 kaf is made available when Lake Mead is in flood control operations. Deliveries less than 1.5 maf reflect the modeling assumptions regarding water delivery reductions to Mexico. Again, because Upper Basin shortages occur more frequently than Lower Basin shortages, there are also more frequent water delivery reductions to Mexico under Methodology B relative to Methodology A.

Figure Q-5
Mexico Modeled Annual Depletions
Comparison of Methodologies A and B
Years 2008 to 2026

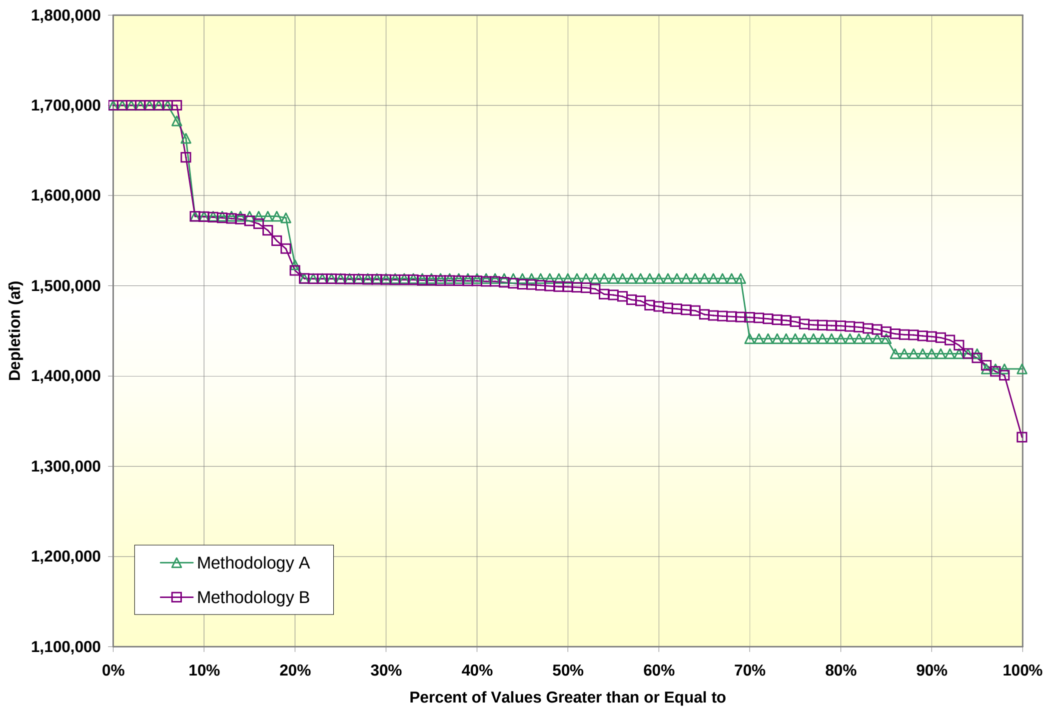


Table Q-6 provides a comparison of the information presented in Figure Q-5 in tabular format. Again, the data presented in this table shows that the modeling of the Preferred Alternative using Methodology B will generally result in lower water deliveries to Mexico during the interim period as compared to the modeled conditions using Methodology A.

Table Q-6
Mexico Modeled Annual Depletions
Comparison of Methodologies A and B
Years 2008 to 2026

Percent Exceedence	Mexico Annual Depletions (afy)	
	Methodology A	Methodology B
Maximum	1,700,000	1,700,000
10	1,577,000	1,576,354
25	1,508,000	1,507,411
50	1,508,000	1,498,902
75	1,441,332	1,460,289
90	1,424,668	1,443,716
Minimum	1,408,000	1,332,081

Figure Q-6 shows a comparison of the probability of annual deliveries to Mexico less than 1.5 maf under Methodologies A and B. The modeling assumptions under Methodology B provide higher probabilities that Mexico will receive less than 1.5 maf. The average probability of deliveries less than 1.5 maf to Mexico under Methodology A is 31 percent and the average probability under Methodology B is 89 percent. The more frequent occurrence of reduced deliveries under Methodology B reflects the more frequent occurrence of shortages due to drought conditions in the Upper Basin.

Figure Q-6
Mexico Modeled Annual Depletions
Comparison of Methodologies A and B
Probability of Depletions Less than 1.5 kaf

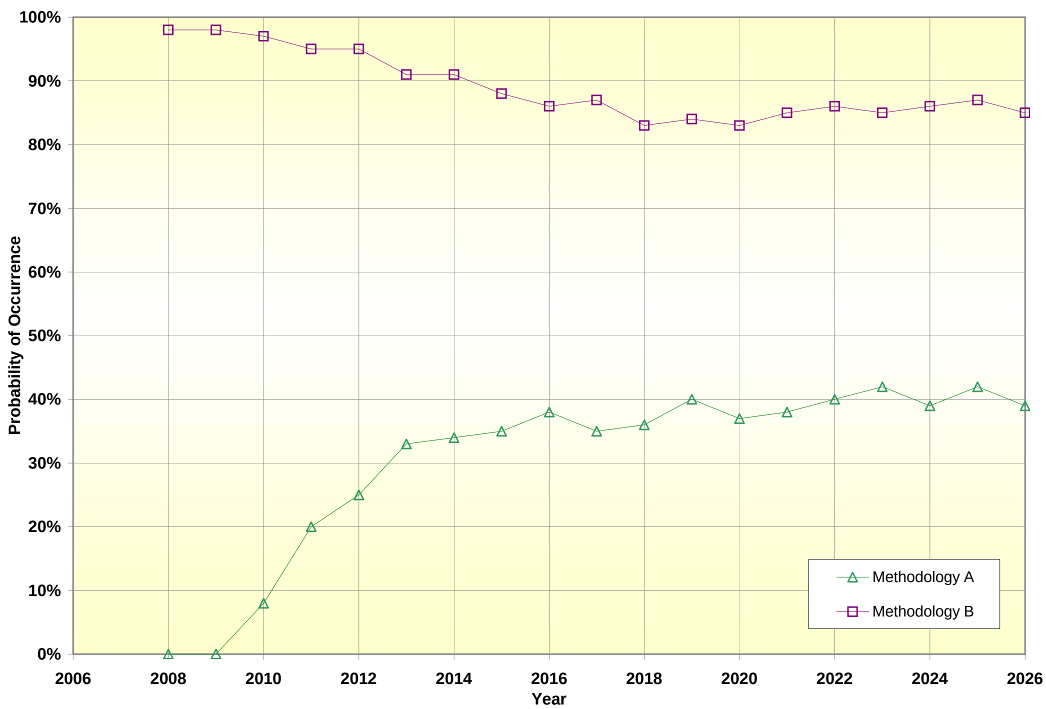
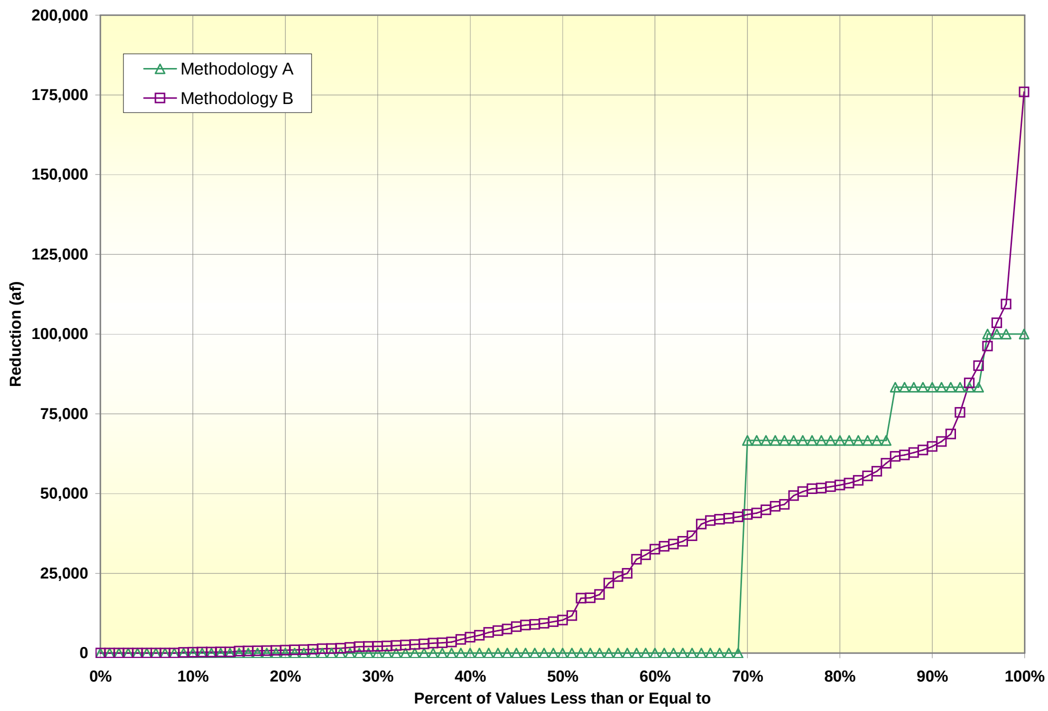


Figure Q-7 shows the cumulative annual water delivery reductions to Mexico under Methodologies A and B. Under Methodology A, there are only three water delivery reduction volumes that can occur: 67 kaf, 83 kaf or 100 kaf. Approximately 30 percent of the time there is a water delivery reduction to Mexico of at least 67 kaf. Approximately four percent of the time there is a water delivery reduction to Mexico of 100 kaf.

Figure Q-7
Mexico Water Delivery Reductions
Comparison of Methodologies A and B
Years 2008 to 2026



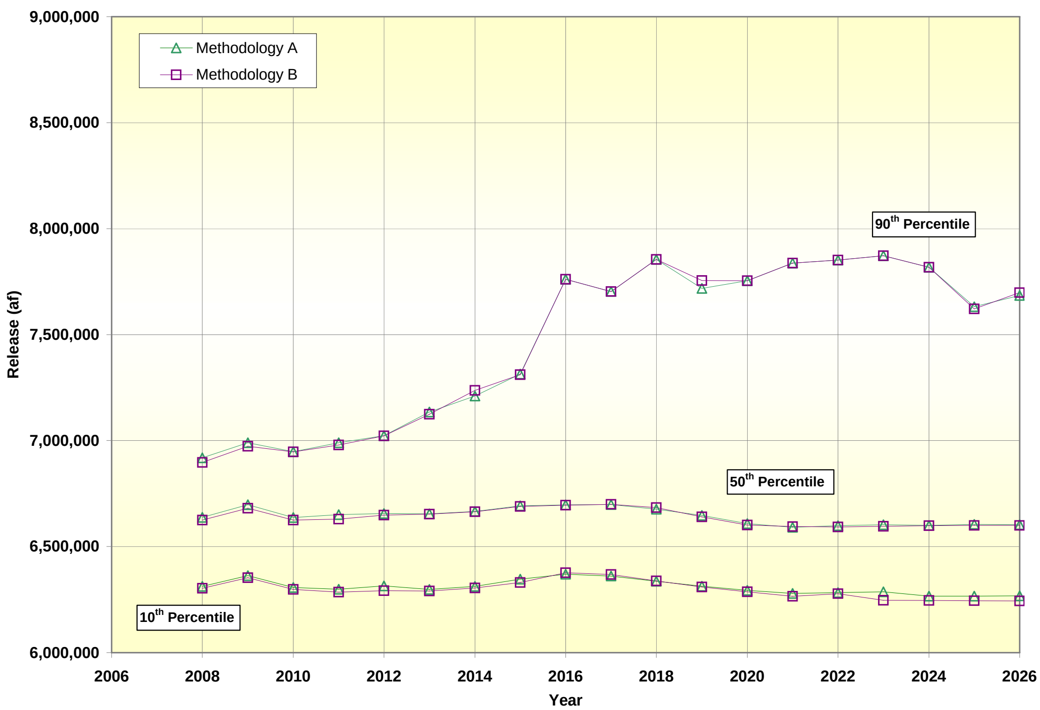
Under Methodology B, there is a water delivery reduction to Mexico approximately 92 percent of the time. This high frequency of water delivery reductions is due to the high frequency of shortages in the Upper Basin. However, 57 percent of these water delivery reductions are less than 25 kaf. Water delivery reductions of the magnitude 67 kaf or greater occur approximately nine percent of the time under Methodology B compared to approximately 30 percent under Methodology A. Methodology B results in a maximum water delivery reduction of 176 kaf compared to 100 kaf under Methodology A. A higher maximum reduction amount exists under Methodology B because shortages can occur simultaneously in both the Upper and Lower Basins, resulting in a larger volume reduction when compared to Methodology A.

Methodology B generates a larger range of water delivery reductions to Mexico when compared to Methodology A. Under Methodology B these reductions also occur more frequently due to the high frequency of Upper Basin shortages compared to the frequency of shortages in the Lower Basin.

Q.3.4 Parker Dam Releases

The flows in the river from Parker Dam to Imperial Dam result primarily from the controlled releases from Parker Dam. Figure Q-8 compares the 90th, 50th and 10th percentile releases from Parker Dam.

Figure Q-8
Parker Dam Annual Releases
Comparison of Methodologies A and B
90th, 50th and 10th Percentile Values



The effect of the Methodology B water delivery reduction assumptions on releases from Parker Dam is minor. The releases under Methodology B are slightly lower due to the increased frequency of water delivery reductions to Mexico. This results in less water being delivered to Mexico when compared to Methodology A. The maximum difference at the 10th and 50th percentiles is about 40 kaf (in 2023) and 22 kaf (in 2011), respectively. The average difference at the 10th and 50th percentiles is approximately 11 kaf and 5 kaf, respectively.

Attachment A

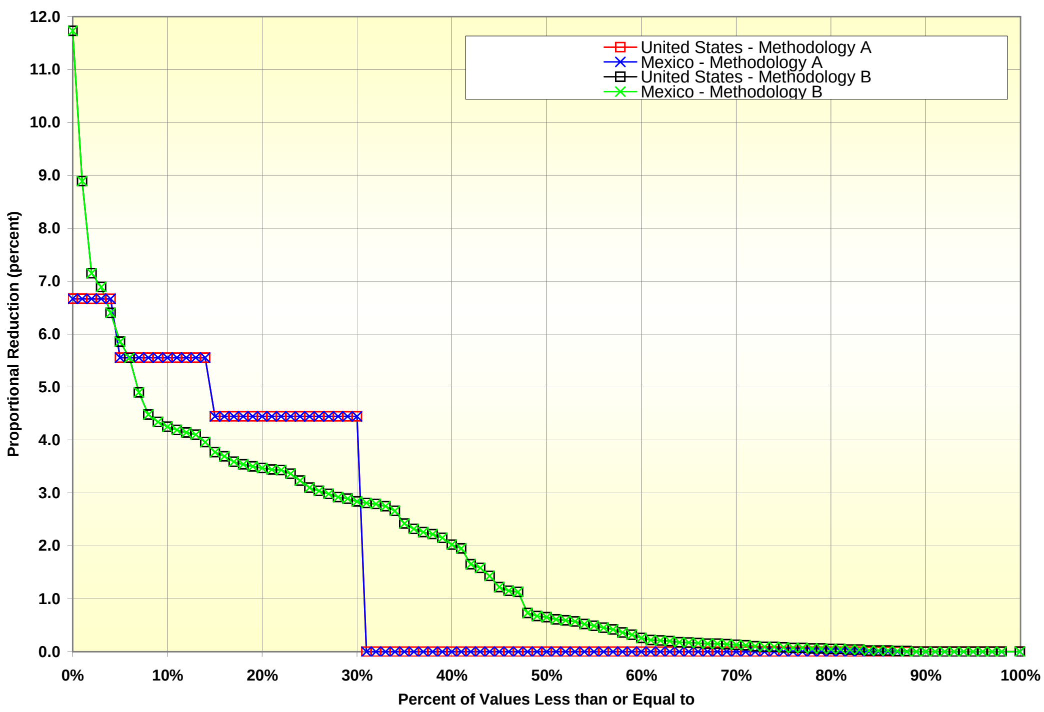
Verification of Equal Proportional Reductions to United States and Mexico for Methodology A and Methodology B

Both Methodology A and Methodology B assume that the water deliveries to Mexico would be reduced in the same proportion as reductions in consumptive uses in the United States (shortages). This attachment provides additional information with regard to equal proportional reductions.

Model Verification

In order to verify that the model was accurately computing equal proportional water delivery reductions to Mexico, output from the model included the computed proportional reduction for both the United States and Mexico each time a shortage occurred in the United States. Figure Att. A-1 provides a comparison of the cumulative distribution of these computed values using Methodology A and Methodology B for the United States and Mexico. Figure Att. A-1 verifies that under both methodologies, deliveries to Mexico are reduced in the same proportion as deliveries to the United States.

Figure Att. A-1
Proportional Reductions to United States and Mexico
Comparison of Methodologies A and B
Years 2008 to 2026



Alternative Representation of Methodology A

Under Methodology A, water delivery reductions to Mexico are triggered only by shortages to United States users in the Lower Basin. When triggered, the water deliveries to Mexico are reduced in the same proportion as the reduction in the United States users in the Lower Basin. Alternatively, the volume of the reduction to Mexico may be computed by taking 16.7 percent of the total water reduction applied to both the United States and Mexico. This percentage is computed by taking the ratio of Mexico's allotment to the sum of the Lower Basin United States apportionments and Mexico's allotment (1.5 maf/(7.5 maf + 1.5 maf) = 0.167 or 16.7 percent).

It can be shown algebraically that this approach results in the same proportional reduction to Mexico as occurs to the United States users in the Lower Basin.

<u>Define</u>:

TS = total water delivery reduction to Lower Division states and Mexico
% reduction to United States or Mexico = amount of reduction / apportionment or allotment * 100

<u>Assume</u>:

The percentage of the total water delivery reduction applied to the Lower Division states = 7.5/9.0 * 100 = 83.3%
The percentage of the total water delivery reduction applied to Mexico = 1.5/9.0 * 100 = 16.7%

Then:

% reduction to United States = TS * (7.5/9.0)/7.5 = TS/9.0
% reduction to Mexico = TS * (1.5/9.0)/1.5 = TS/9.0
Clearly yielding the same proportional reduction

<u>Example</u>: (with rounding)

Total shortage = 0.400 maf
Shortage to Lower Division states = 0.400 * 0.833 = 0.333 maf
Water delivery reduction to Mexico = 0.400 * 0.167 = 0.067 maf
% reduction to United States = % reduction to Mexico = 0.400/9.0 = 4.4%

<u>Check</u>:

% reduction to United States = 0.333 / 7.5 * 100 = 4.4%
% reduction to Mexico = 0.067 / 1.5 * 100 = 4.4%

Appendix R

Biological Assessment

This appendix contains the biological assessment (BA) for Reclamation's proposed Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead prepared by Reclamation as part of its compliance with the Endangered Species Act of 1973, 87 Stat. 884, as amended, 16 U.S.C. §1531 et seq.

Table of Contents

List of Figures

List of Tables

List of Attachments

R.1 Introduction and Background

This document serves as the biological assessment (BA) for Reclamation's proposed Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead prepared by Reclamation as part of its compliance with the Endangered Species Act of 1973 (ESA), 87 Stat. 884, as amended, 16 U.S.C. §1531 et seq. This document is designed to facilitate compliance with Sections 7 and 9 of the ESA with respect to potential effects to listed species within the United States.

R.1.1 Proposed Federal Action

The Secretary of the United States Department of the Interior (Secretary), acting through the Bureau of Reclamation (Reclamation), proposes to adopt specific interim guidelines for Colorado River Lower Basin (Lower Basin) shortages and coordinated operations for Lake Powell and Lake Mead. Reclamation, as the agency that is designated to act on the Secretary's behalf with respect to operation of Glen Canyon Dam and Hoover Dam and managing the mainstream waters of the Colorado River pursuant to applicable federal law, has prepared this Biological Assessment (BA) to determine if its proposed discretionary actions, as described in a forthcoming final environmental impact statement (Final EIS) that will be entitled *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*, may affect endangered or threatened species or destroy or adversely modify critical habitat of those species, as defined under the ESA.

Reclamation desires that this consultation, as defined under ESA §7(a)(2) and its implementing regulations, and resulting biological opinion (BO), if applicable, cover the period from the Secretary of the Interior's decision (proposed to be from December 2008 through September 2026)[1]. The proposed federal action includes the adoption and implementation of interim Colorado River guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead. These interim guidelines would remain in effect for determinations to be made through water year 2025 regarding water supply and reservoir operating decisions through 2026 and would provide guidance each year in development of the Annual Operating Plan for Colorado River Reservoirs (AOP). This proposed federal action considers four operational elements that collectively are designed to address shortages and coordinated operations for Lake Powell and Lake Mead.

[1] It should be noted that although the interim guidelines are for the period 2008 through 2026, the creation and delivery of conserved water from the Muddy and Virgin Rivers by Southern Nevada Water Authority, which is addressed as an interdependent/interrelated action in this BA, is proposed to be approved for a 50-year period.

The interim guidelines would be used by the Secretary to:

1. Determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) below 7.5 million acre-feet (maf) (a ‘‘Shortage’’) pursuant to Article II(B)(3) of the United States Supreme Court in the case of *Arizona v. California*, 547 U.S. _____ (2006) (Consolidated Decree);

2. Define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;

3. Allow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions; and

4. Determine those conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing Interim Surplus Guidelines (ISG), published in the Federal Register on January 25, 2001 (66 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026.

The ESA compliance for the proposed action is comprised of three distinct segments. This approach is being used because three geographical areas of impact are involved, with varying degrees and types of impacts. These geographical areas include:

- Lake Powell and the Colorado River from Glen Canyon Dam to the upper end of Lake Mead (primarily related to operational element no. 2, coordinated reservoir operations).

- The full length of the Muddy River in Nevada, and the Virgin River from the Mesquite Diversion near Mesquite, Nevada, to Lake Mead (primarily related to operational element no. 3, storage and delivery mechanism).

- The Colorado River from Lake Mead to the Southerly International Boundary with Mexico (related to operational element no.1, shortage guidelines; operational element no.2, coordinated reservoir operations; operational element no. 3, storage and delivery mechanism; and operational element no. 4, ISG). These operational elements constitute “covered actions” covered by the 2005 Biological and Conference Opinion on the Lower Colorado River Multi-Species Conservation Program (MSCP) and are encompassed within the boundaries of the MSCP planning area and are not addressed in this transmittal.

Each of the three segments of the consultation is prepared as a stand-alone analysis for ease of understanding. The specific elements of the proposed action that are considered discretionary and subject to compliance are described in detail below, after reviewing Reclamation's legal authorities.

R.1.2 Relevant Statutory Authority

In complying with ESA §7(a)(2) and its implementing regulations at 50 CFR §402.03, Reclamation is responsible for defining the extent of its discretionary authority with respect to this action. Reclamation's authority (discretionary and non-discretionary) stems from the following laws.

R.1.2.1 Law of the River

The Secretary is vested with the responsibility to manage the mainstream waters of the Lower Basin pursuant to applicable federal law. The responsibility is carried out consistent with a body of documents commonly referred to as the Law of the River. While there is no universally accepted definition of this term, the Law of the River comprises numerous operating criteria, regulations, and administrative decisions included in federal and state statutes, interstate compacts, court decisions and decrees, an international treaty, and contracts with the Secretary.

Particularly notable among these documents are:

1) The Colorado River Compact of 1922 (Compact), which apportioned beneficial consumptive use of water between the Upper Basin and Lower Basin;

2) The Boulder Canyon Project Act of 1928 (BCPA), which authorized construction of Hoover Dam and the All-American Canal (AAC), required that water users in the Lower Basin have a contract with the Secretary, and established the responsibilities of the Secretary to direct, manage and coordinate the operation of Colorado River dams and related works in the Lower Basin;

3) The California Seven Party Water Agreement of 1931, which, through regulations adopted by the Secretary, established the relative priorities of rights among major users of Colorado River water in California;

4) The 1944 Treaty (and subsequent minutes of the IBWC) related to the quantity and quality of Colorado River water delivered to Mexico;

5) The Upper Colorado River Basin Compact of 1948, which apportioned the Upper Basin water supply among the Upper Basin states;

6) The Colorado River Storage Project Act of 1956 (CRSPA), which authorized a comprehensive water development plan for the Upper Basin that included the construction of Glen Canyon Dam and other facilities;

7) The 1963 United States Supreme Court Decision in *Arizona v. California* which confirmed that the apportionment of the Lower Basin tributaries was reserved for the exclusive use of the states in which the tributaries are located; confirmed the Lower Basin mainstream apportionments of 4.4 maf for use in California, 2.8 maf for use in Arizona and 0.3 maf for use in Nevada; provided water for Indian reservations and other federal reservations in California, Arizona and Nevada; and confirmed the

significant role of the Secretary in managing the mainstream Colorado River within the Lower Basin;

8) The 1964 United States Supreme Court Decree in *Arizona v. California* which implemented the Court's 1963 decision; the Decree was supplemented over time after its adoption and the Supreme Court entered a Consolidated Decree in 2006 which incorporates all applicable provisions of the earlier-issued Decrees;

9) The Colorado River Basin Project Act of 1968 (CRBPA), which authorized construction of a number of water development projects including the Central Arizona Project (CAP) and required the Secretary to develop the LROC and issue an AOP for mainstream reservoirs;

10) The Colorado River Basin Salinity Control Act of 1974, which authorized a number of salinity control projects and provided a framework to improve and meet salinity standards for the Colorado River in the United States and Mexico; and

11) The Grand Canyon Protection Act of 1992, which addressed the protection of resources in Grand Canyon National Park and in Glen Canyon National Recreation Area, consistent with applicable federal law.

R.1.3 Detailed Description of Discretionary Elements of the Proposed Action

The proposed action includes a coordinated operation of Lake Powell and Lake Mead that is designed to minimize shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin; and also provides a mechanism, called Intentionally Created Surplus (ICS), for promoting water conservation in the Lower Basin. Upon adoption of the proposed action, the maximum cumulative amount of ICS credits that can be available at any one time will be 2.1 million acre-feet (maf). This amount could be increased up to 4.2 maf in future years during the interim period. The analysis of potential effects in this assessment includes this maximum ICS volume of 4.2 maf. The expansion of the ICS mechanism in the future would be based on operational experience gained during implementation of the proposed action. The formulation of the four operational elements for the proposed action follows.

R.1.3.1 Shortage Guidelines

The proposed action provides discrete levels of shortage associated with specific Lake Mead elevations as presented below. The shortages modeled under the proposed action are as follows:

- ♦ When Lake Mead is projected to be below elevation 1,075 feet msl and at or above 1,050 feet msl on January 1, a shortage of 333 kaf shall be declared for that year;

- When Lake Mead is projected to be below elevation 1,050 feet msl and at or above 1,025 feet msl on January 1, a shortage of 417 kaf shall be declared for that year;

- When Lake Mead is projected to be below elevation 1,025 feet msl on January 1, a shortage of 500 kaf shall be declared for that year; and

- When Lake Mead is below elevation 1,025 feet msl, the Secretary shall undertake appropriate consultation, including with the Basin States, to discuss further measures that may be undertaken consistent with the Law of the River. [2]

The volumes of shortages are expressed as reductions to water users in the United States. However, modeling of the proposed action includes the assumption that Mexico would also incur water reductions proportional to the reductions to United States users in the Lower Basin at the same Lake Mead elevations (equivalently expressed as a water reduction to Mexico of 16.7 percent of the total shortage volume). As such, the maximum shortage volume modeled under this alternative is 600 kaf and water reductions of water deliveries are assumed to be applied to deliveries to the Lower Division states and Mexico.[3]

R.1.3.2 Coordinated Reservoir Operations

Under the proposed action, the annual Lake Powell release is based on a volume of water in storage or corresponding elevation in Lake Powell and Lake Mead as described below.

R.1.3.2.1 Equalization

The proposed action provides an elevation schedule (Table R-1) that would be used in determining when equalization releases would be made.

When Lake Powell is at or above these specified elevations and when the volume of Lake Powell is projected to be greater than the volume of Lake Mead at the end of the water year, Lake Powell would release greater than 8.23 mafy to equalize its volume with Lake Mead. Otherwise, 8.23 maf is released from Lake Powell.

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[2] The specific outcome of a consultation process to define additional shortages cannot be predicted; therefore, for modeling purposes it was assumed that shortages of 500 kaf would continue to be imposed at Lake Mead elevations below 1,025 feet msl.

[3] Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1994 Treaty between the United States and Mexico Relating to the Utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande (1944 Treaty) or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the International Boundary and Water Commission in consultation with the Department of State.

Table R-1
Proposed Action
Lake Powell Equalization Elevations

Year	Reservoir Elevation (feet msl)
2008	3,636
2009	3,639
2010	3,642
2011	3,643
2012	3,645
2013	3,646
2014	3,648
2015	3,649
2016	3,651
2017	3,652
2018	3,654
2019	3,655
2020	3,657
2021	3,659
2022	3,660
2023	3,662
2024	3,663
2025	3,664
2026	3,666

R.1.3.2.2 Upper Elevation Balancing

When Lake Powell is below the elevations stated in Table R-1 and is projected to be at or above 3,575 feet msl at the end of the water year, a release in the amount of 8.23 maf from Lake Powell would be made if the projected elevation of Lake Mead is at or above 1,075 feet msl at the end of the water year. If the projected end of water year elevation of Lake Mead is below 1,075 feet msl, the volumes of Lake Mead and Lake Powell would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.0 maf and no less than 7.0 maf.

R.1.3.2.3 Mid-Elevation Releases

When Lake Powell elevation is projected to be below 3,575 feet msl and at or above 3,525 feet msl at the end of the water year, a release in the amount of 7.48 maf would be made if the projected end of water year elevation of Lake Mead is at or above 1,025 feet msl. If the projected end of water year elevation of Lake Mead is below 1,025 feet msl, a release of 8.23 maf from Lake Powell would be made.

R.1.3.2.4 Lower Elevation Balancing

When the projected end of water year elevation of Lake Powell is below 3,525 feet msl, Lake Mead and Lake Powell would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.5 maf and no less than 7.0 maf.

R.1.3.3 Storage and Delivery of Conserved Water

The proposed action includes the adoption of a mechanism (ICS) to encourage and account for augmentation and conservation of water supplies, e.g., fallowing of land, canal lining, system efficiency improvements, and tributary conservation (retirement of pre-Boulder Canyon Project Act of 1929 water rights on the Virgin and Muddy rivers). The ICS mechanism provides for creating credits for the conserved or imported water and delivering the water at a later date.

The analysis of potential effects in this assessment includes a maximum cumulative amount of ICS credits that would be available at any one time of up to 4.2 maf. However, it is anticipated that the ICS mechanism will be initially implemented to allow a maximum cumulative amount of ICS credits of up to 2.1 maf.

The volumes of ICS activity that are assumed for each state and other entities (shown as "Additional Amounts") are presented in Table R-2. At this time, it is unknown exactly which entities might participate in the ICS mechanism. Furthermore, the timing and magnitude of the conservation and subsequent delivery of conserved water is unknown. In order to analyze the maximum effects of the mechanism to reservoir storage and river flows below Lake Mead, it was assumed that conservation would originate from a point on the river within each state located furthest downstream with respect to ICS activities within that state. Similarly, conservation within the Additional Amounts category was assumed to originate in Mexico in order to disclose the maximum effects of the mechanism to reservoir storage and river flows below Lake Mead.[4]

In addition to increasing the flexibility of meeting water use needs from Lake Mead, the ICS mechanism would benefit the system through Lake Mead storage credits. At the time the ICS credits are created, five percent of the ICS credits would be dedicated to the system on a one-time basis. Additionally, ICS credits would be subject to annual evaporation losses of three percent per year. If flood control releases occur, ICS credits would be reduced on a pro-rata basis among all holders of ICS credits until no credits remain.

[4] Notwithstanding the lack of an existing mechanism to implement such modeling assumptions, Reclamation utilized these assumptions for a number of reasons, including the following: (1) a larger volume of potential storage in Lake Mead is identified, (2) the maximum potential impacts on river flows below Hoover Dam are identified, (3) the arbitrary assignment of water conservation amounts to entities in the Lower Basin states is avoided, and (4) the modeling impacts of a program of potential future cooperation between the United States and Mexico are identified.

Table R-2
Proposed Action Alternative Volume Limitations of Storage and Delivery Mechanism

Entity	Maximum Annual Storage of Conserved System or Non-system Water (kaf)	Maximum Total Storage of Conserved System or Non-system Water (kaf)	Maximum Annual Delivery of Conserved System or Non-system Water (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Total[1]	625	2,100	1,000
Additional Amounts	625	2,100	1,000
Total[2]	1,250	4,200	2,000

1 *It is anticipated that the ICS mechanism will be implemented to allow a maximum cumulative amount of ICS credits that would be available at any one time of up to 2.1 maf.*

2 *The analysis of potential effects in this BA includes a maximum cumulative amount of ICS credits that would be available at any one time of up to 4.2 maf.*

Under the assumptions made for the analysis contained herein, the maximum amount of ICS credits that can be created during any year, the maximum cumulative amount of ICS credits that can be available at any one time, and the maximum amount of ICS credits that may be recovered in any one year under the proposed action are presented in Table R-2.

R.1.3.4 Interim Surplus Guidelines

The proposed action includes both a modification and an extension of the existing ISG currently in place through 2016. The ISG would be extended through 2026 and be modified by eliminating the Partial Domestic Surplus Condition, beginning in 2008, and limiting the amount of water available under the Full Domestic Surplus Condition during the period 2017 through 2026.[5] These modifications reduce the amount of surplus water that could be made available and leaves more water in storage to reduce the frequency and severity of future shortages.

R.1.3.5 Interdependent and Interrelated Actions

Interdependent and interrelated actions are defined as those actions having no independent utility from the proposed action (50 CFR §402.02) and actions that are part of a larger action and depend on the larger action for their justification (50 CFR § 402.02) respectively. The following describes the interdependent actions associated with the proposed action.

[5] During 2017 through 2026, the distribution of Domestic Surplus water would be limited as follows: 1) for use by MWD, 250 kafy in addition to the amount of California’s basic apportionment available to MWD; 2) for use by SNWA, 100 kafy in addition to the amount of Nevada’s basic apportionment available to SNWA; and 3) for use in Arizona, 100 kafy in addition to the amount of Arizona’s basic apportionment available to Arizona contractors.

R.1.3.5.1 Storage and Delivery of Conserved Water by Southern Nevada Water Authority

The Southern Nevada Water Authority (SNWA) intends to allow water in the Muddy and Virgin Rivers that was historically diverted from those rivers for beneficial use to remain in the rivers. Such water will flow downstream to be captured in and diverted from Lake Mead as part of the ICS feature of the proposed action. The mechanism to allow for the creating, storage and delivery of conserved water in Lake Mead does not currently exist. Therefore, SNWA would not be able to perform this activity absent adoption of the proposed action. Therefore, the effects of routing the additional Virgin and Muddy River flows downstream to Lake Mead will be analyzed in this BA (Attachment B) as an interdependent action.

R.1.4 Geographic Scope and Extent of Action Area

The geographic region that could be affected by the proposed action and interdependent actions (i.e., the action area) is shown in Figure 1 and includes the following areas:

- The Colorado River and its floodplain from the high pool elevation of Lake Powell (elevation 3,700) to the high pool elevation of Lake Mead (elevation 1,229). Elevation 1,229 was used to define the full pool of Lake Mead in the MSCP BA.

- The channel of the Lower Virgin River and its floodplains and the channel of the Muddy River and its floodplains. The action area in the Lower Virgin River extends from the Nevada/Arizona border, to the confluence of Lake Mead. The action area in the Muddy River begins south of the headwaters at Warm Springs and extends to the confluence of Lake.

- The Colorado River and its floodplain from the high pool elevation of Lake Mead to the Southerly International Boundary (SIB) with Mexico.

This BA addresses the potential affects of the proposed action for all portions of the action area except from the high pool elevation of Lake Mead (elevation 1,229) to the SIB. The Lower Colorado River MSCP provides ESA compliance for a range of river operations from the high pool elevation of Lake Mead to the SIB and included development of shortage criteria as a covered action. Based on Reclamations review of the proposed action described in Attachment A (transmitted in a separate letter), Reclamation has concluded that the range of operations under the proposed action was fully covered under the MSCP BCO, and that no significant new information exists that would require additional consultation for the four operational elements of the proposed action within the MSCP planning area boundary. This conclusion is documented in Attachment A. Consequently, the potential effects of the proposed action on the segment of the action area from the high pool elevation of Lake Mead to the SIB is not addressed further in this BA.

Reclamation has concluded that the service areas of the CAP (and other 4th priority Arizona contractors), SNWA, and Metropolitan Water District should not be included within the action area for this BA. Section 7 analyses require the definition of an "action area" for use in describing the environmental baseline and the effects of the action (including indirect, interrelated, and interdependent effects). The action area is defined as the area likely to be affected by the direct and indirect effects of the proposed agency action (50 CFR §402.02). Regulations for implementing section 7 of ESA define indirect effects as those effects that are caused by or result from a proposed action, occur later in time than the direct effects, and are reasonably certain to occur. All of these conditions must be met to qualify as an indirect effect.

As described in the EIS for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, the proposed action is expected to have socio-economic effects in the service areas in terms of fallowing of agricultural lands and reductions in Colorado River water available to municipal users during shortages.[6] However, Reclamation does not have the authority to decide how farmers or municipal water providers will operate under Shortage conditions. For example, Reclamation does not control, and cannot anticipate which specific agricultural acreages may be planted or fallowed as a result of changes in water deliveries under the proposed action, nor are individual water district's and farm operator's responses to various water delivery conditions predictable over the long-term given access to alternative sources of water, economic conditions, and other factors. Additionally, many of the potentially affected Colorado River water users have alternative water supplies. Reclamation has no relationship or role with respect to how these entities may use these alternative water supplies.

In order to identify indirect effects on listed species, the effect must be identifiable (site-specific), caused by the proposed action, and reasonably certain to occur. Available information does not support a substantive causal connection between shortage conditions and fallowing of specific lands in the Arizona. While fallowing is likely to occur under the proposed action (and under No Action), the extent and location of such fallowing is subject to a number of factors beyond Reclamation's control as described above. Therefore, the effect on any specific parcel of land is not reasonably certain to occur as a result of the adoption of the proposed action. Accordingly, Reclamation has determined to exclude the water-use areas from the action area described in this BA.

The proposed action will not affect environmental conditions along the Muddy and Virgin Rivers, however, as described under Section 1.3.5, *Interdependent and Interrelated Actions*, SNWA's interdependent action could affect ESA-listed, proposed, and candidate species present along the Muddy and Virgin Rivers. A separate assessment of the potential effects of SNWA's action on ESA-listed, proposed, and candidate species within this portion of the action area is included in Attachment B and is summarized in this BA.

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[6] It should be noted that shortage conditions also occur under the No Action Alternative. The timing, probability, and magnitude of shortages may be different under the proposed action.

Figure R-1 shows the geographic scope for the BA. The portion of the Geographic Scope from the full pool of Lake Mead to the SIB is addressed via correspondence with the FWS found in Attachment A and is not specifically addressed further in this BA. Attachment B describes the geographic scope associated with the interdependent and interrelated actions of SNWA on the Muddy and Virgin Rivers. The portion of the Geographic Scope shown on Figure 1 that is specifically analyzed further in this BA includes the full pool of Lake Powell and the Colorado River and its floodplain from Glen Canyon Dam to the full pool elevation of Lake Mead defined by elevation 1,229 feet msl.

R.1.5 Species Identified for Analysis

ESA-listed, proposed, and candidate species that are or could be present in the action area and the species that are evaluated in this BA are listed in Table R-3. Reclamation has determined that, based on information presented in the MSCP BA and BCO regarding the potential effects of similar actions, the proposed action will have no effects on the California brown pelican, California condor, and desert tortoise. The portion of the Colorado River within the action area is outside of the range of the California brown pelican, though a few individuals may infrequently stray into the study area during migration. Additionally, anticipated effects of the proposed action on aquatic habitats used by the species (i.e., reservoir and river stage elevations) are not expected to affect individuals that stray into the affected area. The California condor and desert tortoise are both associated with upland habitats that will not be affected by the proposed changes in reservoir and river operations. The bald eagle has recently been delisted and only occurs as a wintering species from Lake Powell to Lake Mead. The proposed action is not expected to affect the bald eagle because it will not affect the availability of fish or other bald eagle prey. The relict leopard frog only occur from Lake Mead to the SIB and, therefore, are covered under the MSCP BCO and are not addressed further in this BA.

Figure R-1
Geographic Scope

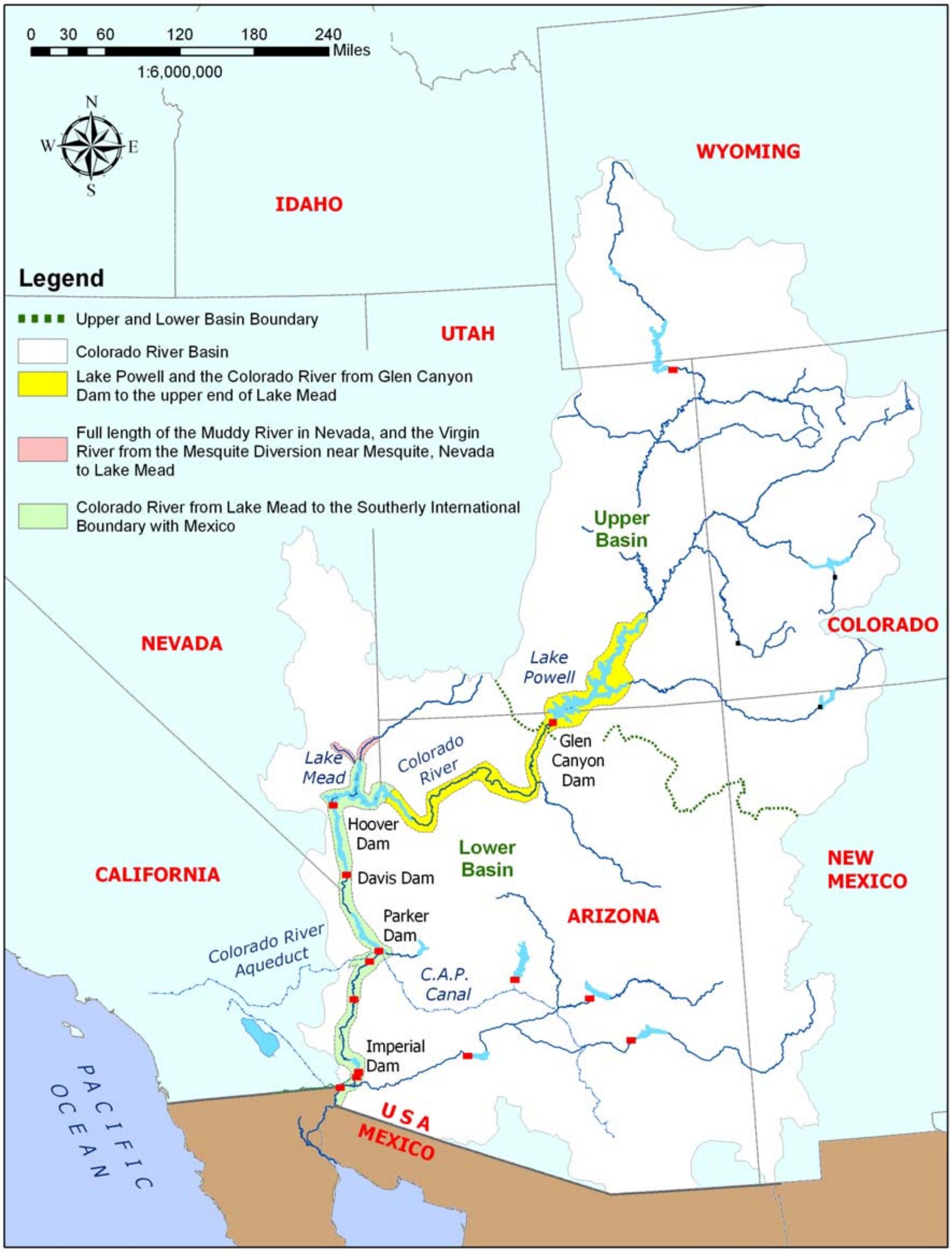


Table R-3
Species Analyzed in this Biological Assessment from Lake Powell
to the Upper End of Lake Mead, and Along the Muddy and Virgin Rivers in Nevada

Common and Scientific Name	ESA Status[1]	Designated Critical Habitat Present in the Action Area	Evaluated in this BA
California brown pelican[2] *Pelecanus occidentalis*	E	No	No
Bald eagle[3] *Haliaeetus leucocephalus*	D	No	No
Yellow-billed cuckoo[5] *Coccyzus americanus*	C	Not applicable	Yes
Southwestern willow flycatcher[4] *Empidonax trailii extimus*	E	Yes	Yes
California Condor[3] *Gymnogyps californianus*	E	No	No
Yuma clapper rail[5] *Rallus longirostris yumanensis*	E	No	Yes
Desert tortoise (Mohave population)[2] *Gopherus agassizii*	T	Yes	No
Relict leopard frog[2] *Rana onca*	C	Not applicable	No
Moapa dace[6] *Moapa coriacea*	E	No	Yes
Woundfin[6] *Plagopterus argentissimus*	E	Yes	Yes
Virgin River Chub[6] *Gila robusta seminude*	E	Yes	Yes
Bonytail [4] *Gila elegans*	E	No	Yes
Humpback chub[7] *Gila cypha*	E	Yes	Yes
Razorback sucker[4] *Xyrauchen texanus*	E	Yes	Yes
Colorado pikeminnow[4] *Ptychocheilus lucius*	E	Yes	Yes
Kanab ambersnail[4] *Oxyloma haydeni kanabensis*	E	No	Yes

1 ESA Status
E = Listed as endangered under the Federal Endangered Species Act (ESA).
T = Listed as threatened under ESA.
C = Candidate for listing under ESA.
D = Delisted.

2 Species only present from Lake Mead to the Southerly International Boundary (SIB).

3 Species present only from Lake Powell to the SIB.

4 Species present in all portions of the action area.

5 Species present from Lake Mead to the SIB, and along Muddy and Virgin Rivers.

6 Species present only along the Muddy and/or Virgin Rivers and only analyzed in Attachment B.

7 Species present from Lake Powell to Lake Mead.

R.2 Environmental Baseline

The environmental baseline for Lake Powell to Separation Canyon includes past and present impacts of all Federal, state, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 C.F.R. §402.02). In terms of past federal actions, the most important past actions that are included in the baseline are:

- Reclamation's construction and continued operation of Glen Canyon Dam and Hoover Dam;
- Reclamation's implementation of the 1996 ROD on Glen Canyon Dam and subsequent experimental actions and consultations, including the Interim Surplus Guidelines; and
- Stocking of rainbow trout, brook trout and brown trout in the Colorado River and various tributaries.

In terms of past state or tribal actions, the most important past actions in the baseline are:

- Stocking rainbow trout in the tailwater below the dam;
- Stocking sport fish (largemouth bass, crappie, smallmouth bass, striped bass) in Lakes Powell and Mead; and
- Stocking threadfin shad to provide a forage base (NPS, 1996).

R.2.1 Related Consultation History

Reclamation has consulted with the USFWS under section 7 of the ESA for various projects that could have had effects on ESA listed species and designated critical habitat within the action area from Lake Powell to Lake Mead. These consultations are included in the environmental baseline. Although the projects and their potential effects have varied, the FWS has concluded that the projects would not jeopardize the continued existence of any species or adversely modify designated critical habitat or that jeopardy and adverse modification could be avoided through reasonable and prudent alternatives (RPAs). All elements of the 1995 Biological Opinion on Glen Canyon Dam have not yet been fully implemented.. However, FWS has agreed with Reclamation that significant progress has been made on some elements of the of the 1995 biological opinion. Reclamation continues efforts to implement the 1995 biological opinion through experimentation and adaptive management in consultation with FWS. Reclamation consultations on projects relevant to the proposed action are summarized below.

R.2.1.1 Operation of Glen Canyon Dam

Reclamation received a BO from the FWS on their proposed alternative for the Operation of Glen Canyon Dam EIS in January 1995. The FWS concluded that the preferred alternative, the modified low fluctuating flow (MLFF) alternative, was likely to jeopardize the continued existence of the humpback chub and razorback sucker and was likely to destroy or adversely modify their critical habitat, but was not likely to jeopardize the bald eagle, Kanab ambersnail and peregrine falcon. The 1995 BO on the Operation of Glen Canyon Dam identified reasonable and prudent alternatives (RPAs) that were necessary to avoid jeopardizing the continued existence of the humpback chub and razorback sucker. Elements of the RPA included the following:

- Development of an adaptive management program including: an experimental flow program, including study of seasonally adjusted steady flows; feasibility analysis of a selective withdrawal program for Glen Canyon Dam; and determination of native fish responses to various temperature and flow conditions.

- Protection of the humpback chub spawning population in the Little Colorado River by participating in development of a management plan for this river.

- Sponsor a workshop to develop a razorback sucker management plan for the Grand Canyon.

- Establishment of a second spawning aggregation of humpback chub downstream of Glen Canyon Dam.

The Operation of Glen Canyon Dam Final EIS analyzed alternative operation scenarios that met statutory responsibilities for protecting downstream resources and achieving other authorized purposes. The 1996 Glen Canyon Dam ROD describes detailed criteria and operating plans for dam operations and includes other management actions to accomplish this objective; among these are the Glen Canyon Dam Adaptive Management Program (AMP) of scientific monitoring and experimentation, beach/habitat-building flows (BHBF), and further study of temperature control.

The AMP provides a process for assessing the effects of Glen Canyon Dam operations on downstream resources and project benefits. The results of those assessments are used to develop recommendations for modifying Glen Canyon Dam operations and other resource management actions. This is accomplished through the Adaptive Management Work Group (AMWG), a federal advisory committee. The AMWG consists of stakeholders that include federal and state agencies, representatives of the seven Basin States, Indian tribes, hydroelectric power customers, environmental and conservation organizations, and recreational and other interest groups.

The BHBF releases are scheduled high releases of short duration that are in excess of power plant capacity in accordance with hydrologic triggering criteria. These BHBFs are designed to rebuild high elevation sandbars, deposit nutrients, restore backwater channels, and provide some of the dynamics of a natural system. The first test of a BHBF was conducted in spring of 1996, and a subsequent test of a BHBF was conducted in November 2004.

Evaluating the feasibility of increasing the temperature of water released from Glen Canyon Dam was a common element in the Glen Canyon Dam EIS and one of the elements of the reasonable and prudent alternative in the 1995 Biological Opinion (BO) of that document. In 1999, Reclamation issued an environmental assessment regarding potential modification of Glen Canyon Dam to construct a selective withdrawal structure, and has subsequently continued to investigate various structural designs. The recent drought-induced drawdown of Lake Powell has resulted in warmer release temperatures, providing an opportunity to monitor the effects on habitat, reproduction and recruitment. Reclamation has initiated a NEPA process that, among other elements, will consider construction of a selective withdrawal structure as part of a long-term experimental plan. This process will include additional consultation on the long-term experimental plan, which includes a program of experimentation, building on past scientific efforts within the AMP(71 Fed. Reg. 64982-64983 and 71 Fed. Reg. 74556-74558).

R.2.1.2 Spring 1996 Beach/Habitat-Building Flow from Glen Canyon Dam

The consultation that resulted in the January 1995 BO on the preferred alternative for the Operation of Glen Canyon Dam (Section 2.4.1.2 above) was re-initiated in November of 1995 to allow for a proposed test of beach/habitat-building flow (test flow) from Glen Canyon Dam in the spring of 1996 in the Colorado River. Consultation with the FWS was re-initiated on the preferred alternative from the 1995 FEIS because a new species was listed since the original consultation (the southwestern willow flycatcher with proposed critical habitat), and new information revealed that incidental take for the Kanab ambersnail determined in the January1995 biological opinion on the Operation of Glen Canyon Dam preferred alternative would be exceeded. Reclamation concluded in its BA that the test flow would have no effect on the endangered peregrine falcon, threatened bald eagle and the endangered razorback sucker. The FWS concluded it its BO that the proposed test flow was not likely to jeopardize the continued existence of the humpback chub, Kanab ambersnail and southwestern willow flycatcher, and was not likely to destroy or adversely modify humpback chub critical habitat. The FWS also provided a conference opinion that the test flow was not likely to destroy or adversely modify proposed southwestern willow flycatcher critical habitat.

R.2.1.3 November 1997 Fall Test Flow from Glen Canyon Dam

The Fall Test flow was proposed as a test of a powerplant release of 31,000 cfs for 48 hours. While powerplant capacity releases were described in the FEIS as Habitat Maintenance Flows, such a test in the fall was not addressed in the 1995 FEIS, which necessitated the re-initiation of consultation. Reclamation concluded in its BA that this proposed action would have no effect on the southwestern willow flycatcher or its critical habitat, the razorback sucker or its critical habitat, the bald eagle or the American peregrine falcon. The FWS in its BO concluded that the test flow was not likely to jeopardize the continued existence of the humpback chub or Kanab ambersnail and is not likely to destroy or adversely modify designated critical habitat for the humpback chub.

R.2.1.4 2002-2004 Proposed Experimental Releases From Glen Canyon Dam and Removal of Non-Native Fish

The 2002 biological opinion included the following actions: (1) experimental releases from Glen Canyon Dam (2) mechanical removal of non-native fish from the Colorado River in an approximately 9-mile reach in the vicinity of the mouth of the Little Colorado River to potentially benefit native fish and; (3) release of non-native fish suppression flows having daily fluctuations of 5,000-20,000 cfs from Glen Canyon Dam during the period January 1-March 31.

Reclamation in its September 2002 BA (included within the Environmental Assessment for the proposal) concluded the action was likely to adversely affect the Kanab ambersnail, humpback chub and its critical habitat and bald eagle and was not likely to adversely affect the razorback sucker and its critical habitat, southwestern willow flycatcher and its critical habitat and California condor. The FWS concluded that the proposed action was not likely to jeopardize the continued existence of the humpback chub, Kanab ambersnail and bald eagle and concurred that the proposed action was not likely to adversely affect the razorback sucker or its critical habitat, California condor and southwestern willow flycatcher. The December 2002 BO included the incidental take of up to 20 humpback chub during the non-native fish removal efforts and the loss of up to $117m^2$ of Kanab ambersnail habitat.

Two Conservation Measures included were included in the FWS BO. The first included re-location of 300 humpback chub above Atomizer Falls, an impassable barrier, in the Little Colorado River to increase the likelihood of humpback chub surviving a flood in the Little Colorado River basin, reduce predation and other inclement environmental conditions. The second conservation measure consisted of temporary removal and safeguard of approximately $29m^2$ – $47m^2$ (25 to 40 percent) of Kanab ambersnail habitat that would be flooded by the experimental release. The relocated habitat would be replaced once the high flow was complete to facilitate re-establishment of vegetation.

The sediment input-triggered high experimental flow was analyzed for an indefinite period of time because of the uncertainty of knowing when the sediment trigger would be reached. The other two actions were analyzed for the period of water years 2003 and 2004. Consultation was re-initiated in 2004 to make several changes to the timing and duration of the proposed experiments described in the 2002 consultation. The 2004 high flow experiment was intended to occur in the fall, immediately following significant tributary sediment inputs, while the 2002 high flow experiment was proposed to occur in the spring. In November 2004 Reclamation reinitiated consultation and concluded that the proposed changes were likely to adversely affect the humpback chub and its critical habitat, Kanab ambersnail and bald eagle. Reclamation requested concurrence that the proposed changes to the action were not likely to adversely affect the razorback sucker and critical habitat, the California condor and southwestern willow flycatcher. In a BO dated November 2004, the FWS concurred that the project was not likely to affect razorback sucker or its critical habitat, California condor or southwestern willow flycatcher and concluded that the modified action was not likely to jeopardize the continued existence of the humpback chub, Kanab ambersnail or bald eagle. The FWS also concluded that designated humpback chub critical habitat would not be destroyed or adversely modified. The BO included several conservation measures related to humpback chub including the continuation of translocating humpback chub in the Little Colorado River, and further study and monitoring of the results and study of effects on chub from various flow conditions. Kanab ambersnail conservation measures included removal and safeguard of Kanab ambersnail habitat that would be inundated by the experimental release.

R.2.2 Regulatory Context

Glen Canyon Dam is operated in accordance with the 1996 ROD, its associated BO and subsequent experiments under the AMP. These requirements serve as the regulatory baseline for this BA between Lake Powell and Lake Mead. This reach was not addressed in the MSCP and thus no ESA coverage from the MSCP applies upstream of Lake Mead. The range of releases and operational constraints covered by the 1996 ROD is described below in Table R 4.

Table R-4
Glen Canyon Dam Release Constraints

Parameter	Release Volume (cfs)	Conditions
Maximum Flow[1]	25,000	
Minimum Flow	5,000	Nighttime
	8,000	7:00 a.m. to 7:00 p.m.
Ramp Rates		
Ascending	4,000	Per hour
Descending	1,500	Per hour
Daily Fluctuations[2]	5,000 to 8,000	

1 *May be exceeded for emergency and during extreme hydrological conditions.*

2 *Daily fluctuation limit is 5,000 cubic feet per second (cfs) for months with release volumes less than 0.6 maf; 6,000 cfs for monthly release volumes of 0.6 maf to 0.8 maf; and 8,000 cfs for monthly volumes over 0.8 maf.*

In the past, the annual volume of water released from Glen Canyon Dam has been made according to the provisions of the LROC that include a minimum objective release of 8.23 maf. The proposed action would allow Reclamation to change these operations by allowing for potential annual releases less than the minimum objective release under certain conditions. However, even in years with an annual release less than 8.23 maf, daily and hourly releases would continue to be made according to the parameters of the 1996 Glen Canyon Dam ROD, which would not be affected by the proposed federal action. The No Action alternative as described in the DEIS for the proposed action (Bureau of Reclamation, 2007) depicts how Reclamation would likely operate Glen Canyon Dam under shortage conditions without adoption of the proposed Shortage Criteria and Coordinated Operations for Lake Powell and Lake Mead. Effects to the species may occur when flow or reservoir conditions in this reach would deviate from flow, reservoir or water quality conditions that would occur under baseline conditions (the No Action alternative in the DEIS).

On September 1, 2006, Reclamation and the Center for Biological Diversity, Arizona Wildlife Federation, Living Rivers, Sierra Club – Grand Canyon Chapter and Glen Canyon Institute entered into a settlement agreement whereby Reclamation agreed to assess under NEPA and ESA the impacts of modifying current or prospective operations of Glen Canyon Dam. Reclamation initiated an analysis under NEPA of a long-term experimental plan (LTEP) related to the operation of Glen Canyon Dam (71 Fed. Reg. 64982-64983 and 71 Fed. Reg. 74556-74558) and anticipates that it will initiate consultation under ESA by May 1, 2008. The LTEP process is properly excluded from the Environmental Baseline and Cumulative Effects analysis in this BA as it has not yet undergone consultations. Reclamation is committed to perform this assessment and further study and has included completion of the LTEP as a proposed conservation measure for the above-listed fish species, which will be discussed later in this BA.

R.2.3 Description of Glen Canyon Dam Adaptive Management Program

The Glen Canyon Dam Adaptive Management Program (AMP) was established in 1997 to implement the Grand Canyon Protection Act of 1992 (GCPA), the 1995 Operation of Glen Canyon Dam Final Environmental Impact Statement (final EIS), and the 1996 Record of Decision (ROD). The AMP provides a process for assessing the effects of current operations of Glen Canyon Dam on downstream resources and using the results to develop recommendations for modifying operating criteria and other resource management actions. This is accomplished through the Adaptive Management Work Group (AMWG), a federal advisory committee. The AMWG consists of stakeholders that are federal and state resource management agencies, representatives of the seven Basin States, Indian Tribes, hydroelectric power marketers, environmental and conservation organizations and recreational and other interest groups. The duties of the AMWG are in an advisory capacity only. Coupled with this advisory role are long-term monitoring and research activities that provide a continual record of resource conditions and new information to evaluate the effectiveness of the operational modifications to Glen Canyon Dam and other management actions.

The GCDAMP consists of the following major components:

- The Adaptive Management Work Group (AMWG) which is a Federal Advisory Committee which makes recommendations on how to adjust the operation of Glen Canyon Dam and other management actions to fulfill the obligations of the GCPA.
- The Secretary of the Interior’s Designee which serves as the chair of the AMWG and provides a direct link between the AMWG and the Secretary of the Interior.
- The Technical Work Group (TWG) which translates AMWG policy into information needs, provides questions that serve as the basis for long-term monitoring and research activities, and conveys research results to AMWG members.

The USGS Grand Canyon Monitoring and Research Center (GCMRC) which:

- ♦ Provides scientific information on the effects of the operation of Glen Canyon Dam and related factors on natural, cultural, and recreational resources along the Colorado River between Glen Canyon Dam and Lake Mead.

- ♦ The independent review panels (IRPs) which provide independent assessments of the program to ensure scientific validity. Academic experts in pertinent areas make up a group of Science Advisors (SAs).

R.2.4 Status of Species and Critical Habitat

R.2.4.1 Southwestern Willow Flycatcher

Please refer to Attachment B for additional information related to the southwestern willow flycatcher along the Muddy and Virgin Rivers.

Legal Status. The southwestern willow flycatcher (SWFL) was designated by the U.S. Fish and Wildlife Service as endangered, on February 27, 1995 (USFWS 1995a). A final recovery plan was completed in August 2002 (USFWS 2002a), and the designation of critical habitat was finalized in October 2005 (USFWS 2005). Critical habitat was previously designated on July 22, 1997 (62 FR 39129), but was rescinded by court order on May 11, 2001.

Critical habitat has been designated for the southwestern willow flycatcher in the action area along a contiguous segment of the Virgin River in Utah, Arizona, and Nevada (USFWS 1995b). The segment extends for 73.8 miles from the Washington Field Diversion Impoundment in Washington County, UT, downstream through the Town of Littlefield, AZ, and ends in NV at the upstream boundary of the Overton State Wildlife Area in Clark County, NV.

Historical and Current Range. The historic breeding range of the SWFL included southern California, southern Nevada, southern Utah, Arizona, New Mexico, western Texas, southwestern Colorado, and extreme northwestern Mexico (Unitt 1987, Browning 1993, Paxton 2000, USFWS 2002a). According to the critical habitat designation for SWFL, the current occupied geographic area crosses six southwestern states including southern California, southern Nevada, southern Utah, southern Colorado, Arizona, and New Mexico, from sea level to approximately 8000 feet above sea level. In general, flycatcher distribution occurs mainly in lower elevation riparian habitat, with a few patches distributed in relatively small isolated locations. When SWFL was listed as endangered in 1995, populations were estimated at 350 territories (USFWS 2002a). Through an increase in survey effort that number has increased to over 1000 territories (Durst et al. 2005). Arizona Game and Fish documented 883 resident flycatchers at 483 territories in 47 sites in 2005 (English et al. 2006). Nevada Department of Wildlife reported a total of 18 resident flycatchers at sites not surveyed by SWCA Environmental Consultants, and an average of 9 territories for surveys from 2001-2005. Approximately 73 territories were documented in 2005 by SWCA

Environmental Consultants along the lower Colorado River and at sites in Nevada and the lower Grand Canyon (Koronkiewicz et al. 2006).

Another important aspect to the distribution of SWFL is its migration routes and migration stopover habitats. This neotropical migrant travels between breeding areas in the United States to wintering grounds in Central and South America (USFWS 2005). Migration flyways include major river corridors and their tributaries such as the Gila River, Rio Grande and lower Colorado River basins (Yong and Finch 1997, Moore 2005, Koronkiewicz et al. 2006, English et al. 2006, USFWS 2005).

Wintering grounds for the willow flycatcher include portions of southern Mexico, Central America, and northern South America. Specific surveys have been conducted at sites in El Salvador, Costa Rica, Panama, Mexico, Ecuador, Nicaragua, and Guatemala (Phillips 1948, Koronkiewicz and Whitfield 1999, Koronkiewicz and Sogge 2000, Lynn and Whitfield 2002, Lynn et al. 2003, Nishida and Whitfield 2005). It is suspected that all subspecies may winter in similar locations. Because it is difficult to identify subspecies of willow flycatchers, specific areas where the SWFL winters are not fully known at this time.

Populations within the Action Area. Presence/absence surveys, along with life history studies, have been conducted along the LCR since 1996 (McKernan 1997, McKernan and Braden 1998, 1999, 2001a, 2001b, 2002, 2006, Koronkiewicz et al. 2004, 2006, and McLeod 2005). Approximately 100 sites have been surveyed in an area that includes the Virgin River, Pahranagat NWR, the Grand Canyon south of Separation Canyon, and throughout the LCR from Lake Mead to the Southerly International Boundary with Mexico. These surveys indicate that the main breeding populations occur along the Virgin River from north of Mesquite, NV to the Virgin River Delta with Lake Mead, at Pahranagat National Wildlife Refuge, in the Grand Canyon from Separation Canyon to the delta of Lake Mead, at Topock Marsh near Needles, CA, and on the Bill Williams National Wildlife Refuge. Flycatchers have nested along the river corridor in the Grand Canyon, particularly in salt-cedar. One to five territories of breeding southwestern willow flycatcher were observed between 1992 and 2003 in any one year between the Little Colorado River confluence and the Grand Canyon gauging station (Gloss, et al 2005). These occurrences have been in riparian vegetation between river miles 28 and 71. Between the Grand Canyon gauging station and the western boundary of Grand Canyon National Park, southwestern willow flycatchers have been detected at a several locations. Seven to twelve territories were identified between 1998 and 2001 between river miles 246 and 273. Surveys in 2002 and 2003 found no territories and surveys in 2004 found two territories (Gloss, et al 2005). Southwestern willow flycatcher breeding occurred in 2005 at river mile 274.5 and 15 southwestern willow flycatchers were detected during 2006 surveys at 13 different sample sites in the Lower Grand Canyon and Lake Mead delta (approximately river mile 251 to 286) (SWCA, 2007).

Populations of southwestern willow flycatcher along the LCR over the past 10 years are listed in Table R-5.

Table R-5
Southwestern Willow Flycatcher (*Empidonax traillii extimus*)
Population Along the Lower Colorado River from 1996-2005

Year	Total WIFL Detected*	SWFL Summer Resident/ Breeding
1996	202	34
1997	154	68
1998	302	113
1999	NA	133
2000	NA	135
2001	NA	218
2002	NA	142
2003	356	115
2004	793	193
2005	473	133

* *Total WIFL Detected = Migratory and breeding birds detected during presence/absence surveys. Migratory birds include other subspecies than just E.t. extimus and thus we can only confirm to species E. traillii. NA=not available.*

Breeding. The SWFL breeds across the lower southwestern United States from May through August. SWFL typically arrive on the breeding grounds between early May and early June. Males generally arrive first to set up territories, with females arriving a week or two later. Males are highly territorial and will defend their territory through counter singing and aggressive interaction. Flycatchers often clump together in one area of the habitat patch, which leads to an indication that this species is "semi-colonial". Males are usually monogamous, but polygyny does occur at approximately 10-20 percent (USFWS 2002a, Pearson 2002). Genetic evidence suggests extra pair copulation exists by either mated or unmated males with females in neighboring territories (USFWS 2002a).

Territory size varies greatly, potentially due to population density, habitat quality, and nesting stage. Territory sizes have been estimated from approximately 0.1 ha to 2.3 ha (0.25-5.7 acres) (McCabe 1991), with most territories encompassing 0.2-0.5 ha (.5-1.2 ac) (Sogge 1995, USFWS 2002a). Territories of polygynous males are usually larger than those of monogamous males. Flycatchers' home ranges are greater than their territories and can vary in size from 0.13 to 360 ha, depending on breeding status and surrounding habitat areas (Bakian and Paxton 2004, Cardinal and Paxton 2005).

Multi-year color banding studies have shown high site fidelity among after-second-year birds returning to former breeding patches (McKernan and Braden 2002, Koronkiewicz et al. 2006a). Juvenile dispersal is largely within the regional area, although long distance dispersal has occurred, with movements greater that 200 km reported (McKernan and Braden 2001b, Koronkiewicz et al. 2006). These movements and site fidelity suggest that the Virgin River/LCR population may be a sub-population of a greater meta-population (Koronkiewicz et al. 2006).

Nest building usually begins 3-7 days after pair formulation. Flycatchers nest in various tree species including Goodding's willow, coyote willow, cottonwood, saltcedar, boxelder, and other native and exotic tree species. Egg laying can start as early as late May, but is usually in early to mid June (Sogge et al. 1997a, Sogge et al. 1997b). Upon completion of egg laying, the female usually incubates the eggs for approximately 12 days, and all eggs usually hatch within 24-48 hours of one another. Nestlings fledge usually within 12-15 days (Paxton and Owen 2002). Chicks are usually present from mid-June through early August. SWFL will re-nest, either after the first nest fledges or after failure, and have been documented to have up to four nesting attempts and three clutches (Sferra et al. 1997, McKernan and Braden 2001b, Koronkiewicz et al. 2006). Adults depart from breeding territories as early as mid-August, but may stay until mid-September if nesting was late. Fledglings usually leave the breeding areas a week or two after adults (Sogge et al. 1997a).

Nest success averages from 40-50 percent through all years of study along the lower Colorado River (McKernan 1997, McKernan and Braden 1998, 1999, 2001a, 2001b, 2002, 2006, Koronkiewicz et al. 2004, 2006, and McLeod 2005) and approximately 25-70 percent over complete range of the SWFL (USFWS 2002a). Predation has been the leading cause of nest failure at many study sites throughout the range (USFWS 2002a), including along the LCR (McKernan and Braden 2001b and 2002, Koronkiewicz et al. 2004, 2006, McLeod 2005).

Parasitism by brown-headed cowbirds is another cause of nest failure. Cowbird parasitism may impact some SWFL populations enough to warrant management actions. The cowbird lays it eggs in the nest of the host species, and the host then incubates the cowbird eggs, which typically hatch prior to the hosts own young.

Abandonment and desertion, although typically low, are also causes of nest failure. Typically, causes for these are unknown, but addled or unfertilized eggs, disturbance, and in some cases brood parasitism may all contribute. Abandonment and desertion accounted for 13 percent and 9 percent respectively, for nest failures at life history study sites along the LCR and tributaries in 2005 (Koronkiewicz et al. 2006). For Arizona statewide surveys, abandonment and desertion together accounted for less than 6 percent of the nest failures.

Diet. The SWFL is an insectivore that hawks insects while in flight, gleans insects from foliage, and occasionally captures them from the ground (USFWS 2002a). Flycatchers forage from within the habitat or above the canopy, above water, or glean from trees and herbaceous cover (McCabe 1991, Sogge 2000, USFWS 2002a). The main diet of the flycatcher consists of small to medium size insects such as true bugs (order Hemiptera), wasps and bees (Hymenoptera), flies (Diptera), beetles (Coleoptera), butterflies and caterpillars (Lepidoptera), and spiders (Araneae) (Drost et al. 1998, McCabe 1991, Sogge 2000, Drost et al. 2001, DeLay et al. 2002, Durst 2004). Berries and small fruits have also been reported but are typically rare (McCabe 1991). The flycatcher can exploit a diverse array of insects depending on availability within the habitat (Drost et al. 1998, Drost et al. 2001, Drost et al. 2003, DeLay et al. 2002, Durst 2004). Diet may differ between sites and between years depending on abundance and availability of insects in and near the breeding habitat (DeLay et al. 2002, Drost et al. 2003, Durst 2004). Although there were differences in prey types consumed by the flycatcher among different habitats (e.g. native versus non-native), there is no significant differences in the abundance of insects available between habitats (Durst 2004), and there is no evidence that the physiological condition of flycatchers is lower in saltcedar habitats (Owen et al. 2005).

Habitat. The SWFL breeds in dense riparian vegetation near surface water or saturated soil, across a large elevational and geographic area (USFWS 2002a, Sogge et al. 1997a). Dominant plant species consist of large riparian trees such as Coyote willow (*Salix exigua*), Goodding willow (*Salix goodingii*), Fremont cottonwood (*Populus fremontii*), boxelder (*Acer negundo*), and non-native saltcedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) (USFWS 2002a). SWFL typically nest in saltcedar in the Grand Canyon (Gloss et al. 2005).

Occupied sites vary in size and shape but all are relatively dense, with some open areas, and are usually associated with open or standing water. Occupied patches can be as small as 0.8 ha and as large as several hundred hectares, but are typically greater than 10 m wide. Although most of the sites are associated with open water, marshy seeps, or saturated soil where the nest tree can be in standing water, hydrologic conditions can change drastically during the breeding season and between years (Sogge et al. 1997a, Sogge and Marshall 2000, USFWS 2002a, Koronkiewicz et al. 2006). Because birds are exposed to extreme environmental conditions throughout the desert southwest, dense vegetation and moist soils at the nest may be needed to provide a more suitable microclimate for raising young by increasing humidity within the utilized site (Allison et al. 2003, Sogge and Marshall 2000, Koronkiewicz et al. 2006).

Vegetation analysis has occurred at life history sites along the LCR and its tributaries since 1996 (McKernan and Braden 2002, Koronkiewicz et al. 2006). Data gathered includes average canopy height, total canopy closure, woody ground cover, distance to nearest standing water or saturated soil, and additional foliage density measurements. Measurements have been taken at the nest, within territory, and at non-use plots. Analysis of this data is still being conducted and will be presented in a final report in 2008. Preliminary analysis suggests that, overall, flycatchers breed in a wide variety of habitats throughout the Virgin River and LCR. These areas contain relatively homogenous, contiguous stands of riparian vegetation that differ from each other both structurally and compositionally. Preliminary nest productivity, as related to vegetation type (e.g. non-native versus native), shows no significant difference (McKernan and Braden 2002), but further analysis will be conducted.

The presence of water is an important component of SWFL habitat (Sogge and Marshall 2000, USFWS 2002a). Studies indicate that SWFL nest sites are usually closer to water than non-use sites (Stoleson and Finch 2003, Paradzick 2005, Koronkiewicz et al. 2006). Nest sites are usually located within 200 m of open or standing water and usually contain soils that are higher in water content than non-use sites (McKernan and Braden 2002, Stoleson and Finch 2003, Paradzick 2005, Koronkiewicz et al. 2006). Water and/or moist soils help regulate temperature and relative humidity within the stand, produce the right conditions for insect development and survival, and are associated with creating a greater foliage density (USFWS 2002a, Paradzick 2005, Koronkiewicz et al. 2006).

Threats. Habitat alteration, as well as loss and fragmentation are considered one of the greatest threats to the SWFL (Marshall and Stoleson 2000). Riparian habitats in the Southwest are naturally patchy and subject to periodic disturbance. Factors contributing to habitat loss include water management, such as dams and reservoirs, diversions and groundwater pumping, channelization and bank stabilization, agricultural development, livestock grazing, phreatophyte control, increased recreation, and urbanization. All of these cause loss of habitat, habitat fragmentation, loss of critical water underneath stands, and human disturbance (Marshall and Stoleson 2000).

Although the SWFL now nests in saltcedar, this has some disadvantages. Saltcedar exudes salts and creates soils that are too salty for other native species to propagate, thus reducing diversity in the stand which may affect prey base for flycatchers. Deep root systems and extended production and proliferation of seeding from March through October gives saltcedar selective advantage over natives under stressed conditions such as lack of flooding, and may reduce soil moisture and standing water conditions needed for flycatcher habitat (Marshall and Stoleson 2000).

The SWFL has evolved with predation and cowbird parasitism, but increased populations of predators and cowbirds has become a major threat to some local populations. Predation is the leading cause of nest failure in many populations of SWFL (Marshall and Stoleson 2000, USFWS 2002a), including those along the LCR and its tributaries (McKernan and Braden 2002, Koronkiewicz et al. 2006). Known and suspected nest predators include snakes, predatory birds such as raptors, corvids, grackles and cowbirds, small mammals, and even ants (Marshall and Stoleson 2000).

Other threats that have not been studied as thoroughly include parasites, disease, and environmental toxins. Internal and external parasites have been recorded, but the extent of impacts has not been determined. Diseases such as West Nile Virus and Avian Flu are new threats that so far have not gotten into the SWFL population, but could have a devastating effect if they do, due to the small population size and the semi-colonial aspect of the SWFL. Environmental toxins may also play a factor as populations close to agriculture and human habitats, such as golf courses, increase the possibility of toxins entering into the diet of the flycatcher. Although this has not been studied to any great extent, bill deformities and missing eyes have been reported from birds at sites in Arizona, Colorado, and New Mexico. A study was completed on environmental contaminants in surrogate birds and insects found in SWFL habitat in Arizona. This study showed an accumulation of inorganic elements in eggshells and contents of eggs, although the only contaminant in this study with unusually high levels was strontium (Mora 2002). Increased concentrations of this metal may be associated with decreased egg production, and potentially higher embryonic mortality, but further studies are needed.

R.2.4.2 Yellow-billed cuckoo, Yuma Clapper Rail, Moapa Dace, Woundfin, Virgin River Chub

Please refer to Attachment B for information related to the yellow-billed cuckoo, Yuma clapper rail, Moapa dace, woundfin and Virgin River chub along the Muddy and Virgin Rivers since these species do not occur in the action area from Lake Powell to Lake Mead.

R.2.4.3 Bonytail Chub

Legal Status. The bonytail was federally listed as endangered under the Endangered Species Act in 1980. No critical habitat is designated in the action area.

Historical and Current Range. Bonytail was historically widespread and common throughout tributaries of the Colorado River and other larger rivers, with historical captures documented from Mexico to Wyoming (Behnke and Benson 1980, Minckley and Deacon 1991, Mueller and Marsh 2002). The first recorded capture of bonytail from the Upper Colorado River Basin (UCRB) was by Jordan (1891) with one specimen collected from the Green River. Subsequent historical collections, albeit limited largely to anecdotal and historical fishing creel interviews, in conjunction with limited scientific collection information combine to demonstrate the once-expansive range of bonytail (USFWS 2002b). However, during the 1950s bonytail populations began a rather large, yet poorly documented decline in abundance following numerous biotic and abiotic habitat modifications. Holden (1991) described the effects of a large-scale rotenone treatment in the upper Green River, while simultaneously providing insight to the rather large population of bonytail present until 1962, at which time a large piscicide treatment occurred in the UCRB. Bonytail numbers were drastically reduced following the closure of Flaming Gorge Dam in 1963, with very few and sporadic captures of bonytail occurring in the UCRB since that time (Vanicek and Kramer 1969, Holden and Stalnaker 1975, Tyus et al. 1982, Valdez 1990).

Bonytail captures along the Lower Colorado River (LCR) follow similar trends. The USFWS (2002b) documents an early capture of 16 individuals from the LCR by R.R. Miller (from the Grand Canyon). Jonez and Sumner (1954) documented a large aggregation of an estimated 500 adults spawning over a gravely shelf in Lake Mohave. During the period between 1976-1988, 34 bonytail were captured in Lake Mohave, and some of these fish were incorporated in the establishment of a brood stock, the progeny of which are presently stocked into Lakes Mohave and Havasu (Minckley et al. 1989, Minckley et al. 1991, USFWS 2002b) and a number of UCRB rivers. Very few documentations of wild bonytail capture have been recorded in recent years and, therefore, little is known about the specific habitat requirements of this unique species. Bonytail are considered extirpated from the Colorado River between Glen Canyon Dam and Lake Mead, and they have a low probability of occurring at the inflow areas of Lake Powell (see below).

Populations within the Action Area. Populations of bonytail in the action area are limited primarily to those within Lake Mohave and Lake Havasu, and these populations are being augmented with stocking with hatchery-reared young due to lack of natural recruitment (Moyle 2002, USFWS 2001). A self-sustaining population has been established in the Cibola High Levee Pond that is not connected to the Colorado River. A few individuals may also be present in Lake Powell (USBR 2000). Small populations may still be present in the Upper Colorado River Basin in the Yampa River, Green River, and Colorado River at the Utah/Colorado border (USBR 2000, USFWS 2006). The last bonytail to be captured in Lake Powell during annual gillnet surveys (1972 through 2006) was in 1972 when a single adult was found (Utah DWR, 2007). Due to the small numbers that appear to be present in Lake

Powell and in the Colorado River upstream of the lake, the probability of any being present in the Colorado River inflow to Lake Powell is very low.

Reproduction. Vanicek and Kramer (1969) documented the last substantial spawning of a wild, riverine population of bonytail in Dinosaur National Monument. Ripe fish were collected from mid June through early July in water temperatures around 18ºC. Bonytail estimated between 5-7 years old were found ripe (Vanicek 1967), whereas in controlled hatchery environments, Hamman (1985) found bonytail to begin maturing sexually at age 2. Johnston (1999) classified bonytail as being broadcast spawners and suggested that loss of eddy habitat types due to the construction of impoundments may contribute to the apparent reproductive failure of a closely related species, the humpback chub. Marsh (1985) reported bonytail eggs to be adhesive and apparently remain so throughout the incubational period, which is thought to be an adaptive strategy to swift-moving currents of the mainstem Colorado River.

Ripe bonytail have also been collected from lentic, reservoir situations. As stated previously, Jonez and Sumner (1954) reported active spawning of a large (approximately 500 individuals) aggregate of bonytail in Lake Mohave. Eggs were described as being adhesive, and one individual female contained over 10,000 eggs, suggesting a high level of fecundity, a trait that appears to be typical for native, Colorado River endemics (see razorback sucker species profile). Even higher levels of fecundity were found in hatchery settings, with individual female egg production averaging over 25,000 eggs per female (Hamman 1982). Spawning bonytail in Cibola High Levee Pond were observed utilizing shoreline riprap materials, typically in mid April and frequently during nighttime hours, in water temperatures ranging from 20.4-21.6ºC. They were observed consuming their own gametes, as well as young razorback sucker larvae (Mueller et al. 2003).

Valdez (2006) summarized spawning and incubation temperatures for bonytail as 18-22ºC with an optimum of 20ºC and 18-28ºC with an optimum of 21ºC, respectively.

Bonytail egg survival appears to be highly influenced by incubation temperature. Hamman (1982) found 90 percent survival at water temperatures of 20-21ºC, 55 percent survival at 16-17ºC, and only 4 percent survival when temperatures were held between 12-13ºC. Incubation periods ranged from 99 hours to nearly 500 hours, depending upon water temperatures. Newly hatched fry averaged 6.8 mm (Hamman 1982). This research is corroborated by Marsh (1985), who found bonytail embryos to have the highest survival rates at temperatures near 20ºC and indicated that newly hatched larvae averaged 6.0-6.3 mm in size.

Diet. Bonytail diet is reportedly comprised of a wide variety of aquatic and terrestrial insects, worms, algae, plankton, and plant debris (Mueller and Marsh 2002). This information is corroborated by McDonald and Dotson (1960) and Vanicek (1967) who also found Colorado River chub to feed omnivorously. More detailed and quantitative descriptions of bonytail diet preferences are not available, including shifts in diet composition by life stage, with the exception of information from bonytail stocked into Cibola High Levee Pond. This experimental population also fed omnivorously, with adult bonytail consuming algae, vegetative material, small fish, and crayfish (Procambarus and *Orcopectes* sp.). Young bonytail were documented to feed near the surface of the pond, with gut analysis demonstrating that smaller size classes typically fed on zooplankton and invertebrates (Mueller et al. 2003). Again, more detailed knowledge is unavailable, likely due to the overall rarity of the species.

Habitat. As stated previously, information pertaining to bonytail habitat preferences is very limited due to the extirpation of this species prior to extensive sampling of the Colorado River and its fishery. Limited, early fisheries surveys indicate that the bonytail tended to be found in higher-gradient, gravelly riverine sections, with some degree of habitat use similarities as described for the flannelmouth sucker. For example, bonytail is widely characterized as being adapted to the swifter sections of the Colorado River, with affinity for areas of high flow and rocky habitat. Available information suggests that adult bonytail used fast-water sections, as well as eddies and pool habitats. Vanicek (1967) noted habitat selection of bonytail to coincide with habitats occupied by another native chub, the roundtail chub. Vanicek (1967) found these species in pools and eddies, typically near “fast-flowing” riverine areas but also in slower sections. Holden (1991), citing Flaming Gorge preimpoundment surveys, noted that bonytail were apparently fairly common in the Flaming Gorge area of the upper Green River, a canyon-bound, relatively fast water section of river. Valdez (1990) reported bonytail habitat use as being similar to that of humpback chub, with collections being made in shoreline eddy habitats, boulders and cobble, and near swift-water sections (in Cataract and Desolation Canyons).

Telemetry studies by Mueller et al. (2003) revealed that adult bonytail prefer interstitial spaces associated with shoreline riprap during daylight hours in Cibola High Levee Pond, whereas open-water areas are more commonly utilized during the nighttime hours. Intensive telemetric surveillance suggests a high degree of site-specific habitat fidelity, with individually marked bonytail consistently returning to the same cavities formed within the riprap type shoreline. These areas may simulate the boulder fields of many of the Upper Colorado River Basin canyon areas where bonytail were once common. Interestingly, a study conducted by Pimentel and Bulkley (1983) suggests that bonytail, when given the opportunity, tend to select water with high levels of total dissolved solids (TDS). Bonytail are able to persist in water with TDS of 4,700 mg/L, the highest tolerance reported for any species of Colorado River Gila, suggesting an ability to persist despite anthropogenic water quality and habitat degradation.

Bonytail have been documented to spawn over gravel substrates, near shore, and were found in water up to 30 ft deep in reservoir situations (Jonez and Sumner 1954). They are hypothesized to use gravel-cobble habitats in lotic environments. Most recently in the Lower Colorado River Basin (LCRB), documentation of successful, natural reproduction in Cibola High Levee Pond suggests that bonytail select shoreline-associated, riprap materials (large-diameter gravel, cobble, and boulder substrates) in water 2-3 m deep for spawning activities (Mueller et al. 2003). Spawning individuals in Lake Mohave display similar diet habitat shifts: adults use in deeper habitats during the day and later form congregations along shoreline habitats (Mueller and Marsh 2002).

Relatively little is known about habitat needs for young bonytail. Similar to other native fishes, backwaters and other slackwater habitat types are thought to serve as important nursery areas for young bonytail (USFWS 2002b). Larval roundtail and humpback chub tend to use low-velocity backwaters, embayments, and other small, low-velocity habitats along shorelines, moving to water with more current as they become larger (50-75 mm) (Holden 1977, Valdez 1990, Valdez and Ryel 1997). Whether bonytail exhibit the same habitat shift is not known, but it is very likely that the primary reason for the loss of bonytail throughout the basin is related to loss of important nursery habitat. Relatively narrow nursery habitat requirements separate razorback sucker and Colorado pike minnow from the non-endangered, more common species such as flannelmouth sucker and roundtail chub. Therefore, it seems likely that in a riverine situation bonytail may have a nursery habitat requirement that has not as yet been fully explained.

Young bonytail were most commonly associated with areas of dense overhead cover in depths greater than 1 m. They displayed schooling in warm, shallow areas of Cibola High Levee Pond (Mueller et al. 2003). These findings suggest that refugia-type backwaters designed for bonytail should have similar components in terms of riprapped shoreline materials, one of the few specific habitat preferences that have been documented to date.

Threats. Numerous researchers have identified that the major factor contributing to the decline of bonytail and other large-river fishes has been the construction of mainstem dams and the resultant cool tailwaters and reservoir habitats that replaced a once warm, riverine environment (Holden and Stalnaker 1975, Minckley et al. 1991, Mueller and Marsh 2002, USFWS 2002b). Competition and predation from non-native fishes that are successfully established in the Colorado River and its reservoirs have also contributed to their decline (Minckley and Deacon 1991, USFWS 2002b). For further detailed information including examples, ramifications, and research needs pertaining of the effects of habitat modifications on native Colorado River fishes, please see Tyus (1982), Minckley and Deacon (1991), Mueller and Marsh (2002), and USFWS (2002b).

R.2.4.4 Humpback chub

Legal Status. Humpback chub is listed as endangered under the ESA. Critical habitat has been designated in the Colorado River from Nautiloid Canyon to Granite Park in the Grand Canyon, and in the lower eight miles of the Little Colorado River, including its confluence with the Colorado River.

Historical and Current Range. Historically, humpback chub populations existed in the Little Colorado, Green, Yampa, White, and mainstem Colorado Rivers. The species was first described in 1946, and exact historical distributions within the Colorado River Basin cannot be confirmed.

Populations in the upper basin occur in canyon reaches of the mainstem Colorado, Green, and Yampa Rivers (Tyus et al. 1982). Populations exist in the Black Rocks and Westwater Canyon reaches of the mainstem Colorado River (Badame and Hudson 2003, Wick et al. 1981, Valdez and Clemmer 1982, Archer et al. 1985) and in Desolation and Gray Canyons on the Green River (Jasckon and Hudson, 2005). In Westwater Canyon an estimated 2,201 to 4,744 adults were present in 1998 to 2000 (Badame and Hudson 2003), and at Black Rocks an estimated 478 (confidence interval of 221 to 1,176) were present in 2003 (unpublished data, C. McAda personal communication, 2007). The population of adults in Desolation and Gray canyons on the Green River was estimated at 937 to 2,612 in 2001 to 2003 (Jackson and Hudson 2005). The Yampa Canyon population is thought to be nearly extirpated (Finney et al. 2006).

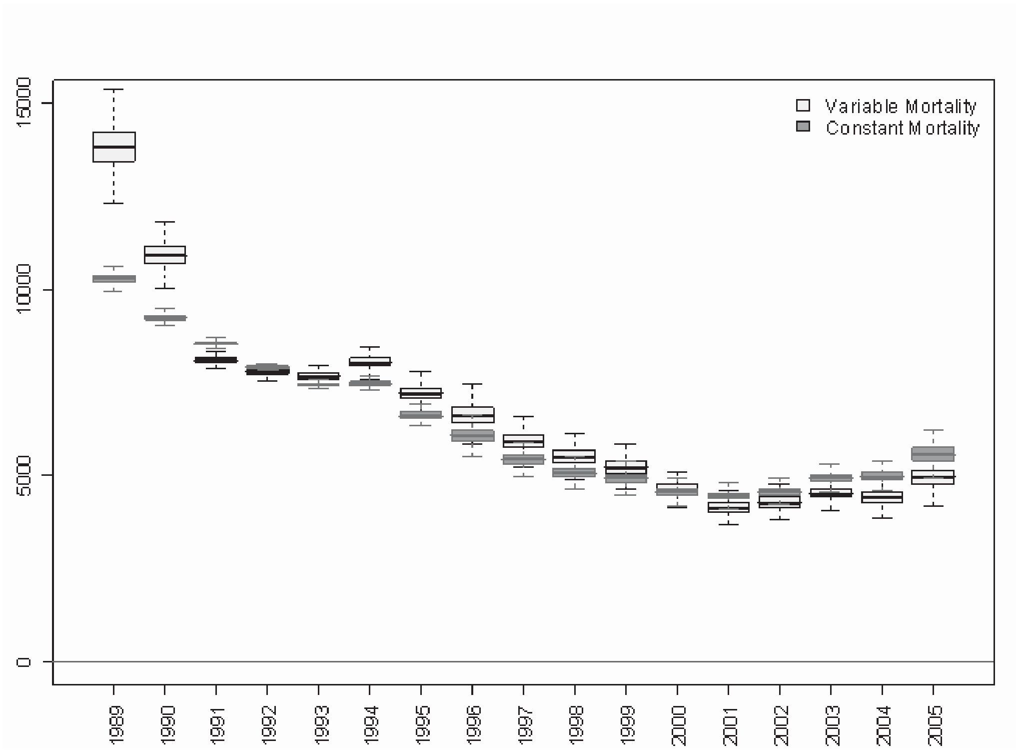
Populations within the Action Area. In the action area, humpback chub is present in the Marble and Grand Canyons of the Colorado River, and in the Little Colorado River for 13 km (8 miles) upstream from the river's mouth (Kaeding and Zimmerman 1983, Maddux et al. 1987). Valdez and Ryel (1995) identified 10 aggregations of humpback chub in the Grand Canyon, mostly near tributary inflows. Young-of-year humpback chub were reported from the warm spring at RM 30 in 1994 as compelling evidence of reproduction at that locale (Valdez and Masslich 1999). Also, young-of-year humpback chub were collected in substantial numbers in both 2005 and 2006 between RM 30 and the LCR, suggesting spawning success in the main channel Colorado River during those years (Ackerman 2007). Observations of this sort since closure of the dam are almost nonexistent and it is hypothesized that water temperatures warmer than the post-dam average may be largely responsible for the successful spawning activity.

In the Little Colorado River, Douglas and Marsh (1996) estimated a population size of 4,508 humpback chub. This population declined from 1989 to 2000 but appears to have stabilized between 2001 and 2005 (Figure R-2) at approximately 5,000 adult fish (USGS 2006a). Stabilization may be due in part to increased water temperatures caused by drought and warmer release temperatures from Glen Canyon Dam, experimental removal of non-native fish, and experimental water releases. The species has also been successfully translocated to above Chute Falls in the Little Colorado River, and the fish have spawned there (USGS 2006b).

Aside from mainstem reaches immediately below the LCR, YOY and juvenile humpback chub occur in the main channel Colorado River most commonly from RM 110-130 (Middlge Granite Gorge) and RM 160-200 (AGFD 1996; Trammell et al. 2000; Lauretta and Johnstone and Lauretta 2004, 2007; Ackerman 2006). The Middle Granite Gorge aggregation (which includes adults) has been stable or increasing in size since 1993 (Trammell et al. 2000) and may be sustained via immigration from the LCR spawning aggregation. Valdez et al. (2000) has identified this aggregation as the most likely candidate for a second spawning population in the main channel given favorable conditions (mainly temperature).

Observations of humpback chub below Diamond Creek are sporadic due to infrequent sampling. In the 1940s, five humpback chub were collected from the Colorado River near Spencer Creek (Miller 1944; Bookstein et al. 1985), and one juvenile humpback chub was reported from Spencer Creek in the 1950s (Wallis 1951; Kubly 1990). One adult humpback chub was captured downstream of Maxson Canyon (RM 244; RKM 407) in 1994 (Valdez 1994). More recently, four humpback chub were collected between Diamond Creek and Lake Mead during 2006 (AGFD, unpublished).

Figure R-2
Adult (age 4+) Humpback Chub Population Estimates (1989-2005) for the Little Colorado River.
Confidence Intervals are 95% Bayesian Credible Intervals. (Source: USGS 2006a)



Habitat. Humpback chubs use swift, deep, canyon stretches of river (Valdez and Clemmer 1982, Archer et al. 1985). Within the lower basin canyon reaches, adults occupy main channel eddies, and subadults are near shore (Valdez and Ryel 1995). Converse et al. (1998) report that the highest densities of subadult humpback chub in the Grand Canyon occur along vegetated shorelines. Kaeding and Zimmerman (1983) found this species in association with large travertine dams in the Little Colorado River. Maddux et al. (1987) captured young-of-the-year humpback chub in sandy runs and backwaters of the Little Colorado River. Valdez and Ryel (1995) found that subadult and adult humpback chub demonstrate diel depth preferences, using deeper water during the day and shallower water at night.

Although humpback chub are generally considered nonmigratory, migrations to spawning areas may occur from the main river to tributary streams, including the Little Colorado River (Kaeding and Zimmerman 1983). The abundance and persistence of the humpback chub in the Grand Canyon reach of the Colorado River may be linked to the use of the Little Colorado River for spawning and nursery habitat (Carothers and Minckley 1981).

In the Grand Canyon, humpback chub larvae are found almost exclusively in the warmer waters of the Little Colorado River (Carothers and Minckley 1981, Maddux et al. 1987) and in mainstem backwaters. Larvae tend to utilize silty bottom habitats. Later, humpback chub utilize a variety of habitats within a boulder strewn canyon environment (i.e., pools, riffles and eddies). They move between habitats dependent on life history needs and natural habitat change (NPS 1998).

Reproduction. Humpback chub reproductive timing is variable; ripe fish have been collected from April to July and at water temperatures of 11.5–23ºC. Under laboratory conditions, however, egg hatching success is greatest at 20ºC (Marsh 1985). Bulkley et al. (1981) estimate a final thermal preferendum of 24ºC for humpback chub during their first year of life (80–120 mm). Valdez (2006) summarized humpback chub temperature requirements as ranging from 16-22ºC with an optimum of 18ºC for spawning and ranging from 16-27ºC with an optimum of 19ºC for egg incubation.

Diet. Humpback chub are omnivorous (Valdez and Carothers 1998). Juvenile humpback chub forage near the substrate, feeding on benthic insect larvae and organic detritus (Carothers and Minckley 1981). Midge larvae, biting midge larvae, fly larvae, and planktonic crustaceans were found in the stomach contents of a juvenile humpback chub collected during the winter (Carothers and Minckley 1981). Adult humpback chub have been observed feeding on *Cladophora* and organic debris (Carothers and Minckley 1981). Valdez and Ryel (1995) found that adult humpback chub from the Little Colorado River and Middle Granite Gorge consumed primarily *Gammarus* sp. (freshwater amphipod), Simuliids (black flies), and terrestrial invertebrates. They concluded that food was not a limiting factor for juvenile and adult humpback chub.

Threats. Numerous researchers have identified that the major factor contributing to the decline of humpback chub and other large-river fishes has been the construction of mainstem dams, which had resulted in altered thermal and hydrologic regimes. Cold, stenothermic dam releases and reservoirs have replaced warm, riverine environments (Holden and Stalnaker 1975, Minckley et al. 1991, Mueller and Marsh 2002, USFWS 2002c). Competition and predation from non-native fishes that have adapted to these conditions have also contributed to decline of native fishes (Minckley and Deacon 1991). For further detailed information including examples, ramifications, and research needs pertaining of the effects of habitat modifications on native Colorado River fishes, see Tyus (1982), Minckley and Deacon (1991), Mueller and Marsh (2002), and USFWS (2002c). Spatial distribution of humpback chub in the Colorado River basin is limited by the species' affinity for and distribution of swift, deep canyon stretches of river within the system (Valdez and Clemmer 1982, Archer et al. 1985). The Colorado River exhibits diurnal and seasonal flow fluctuations in response to variable hydroelectric demands. The diurnal fluctuations in stage approach 2 feet, in contrast to daily flow changes of less than a foot prior to impoundment. The temporal stability of inshore, shallow water, backwater, and low-water environments used by native fish for resting, feeding, spawning, and nursery areas is greatly decreased by existing fluctuating flows (Maddux et al. 1987).

The cooler temperature of the Colorado River due to Glen Canyon Dam releases is strongly implicated as a primary cause of the humpback chub population decline. Egg hatching success of humpback chub is highly temperature dependent, with the highest success occurring at a water temperature of about 20ºC and very low success at temperatures below 15ºC (Hamman 1982, Marsh 1985). Water released by Glen Canyon Dam from Lake Powell is generally cold, with temperatures ranging from 6–12ºC (Maddux et al. 1987). However, recent release temperatures approaching 15°C along with downstream warming may benefit various life stages of humpback chub. When low release temperatures occur, reproductive success of humpback chub in the mainstem Colorado River is drastically reduced below Glen Canyon Dam. . If successful spawning occurred in the mainstem Colorado River, humpback chub would still be adversely affected by the daily fluctuations in discharge below Glen Canyon Dam, which can dry and introduce colder mainstem water to backwaters used by young-of-the-year humpback chub.

Interactions with the many introduced nonnative species continue to threaten the existence of humpback chub. Nonnative species tend to be highly competitive and productive generalists. Habitat and dietary overlap exists between humpback chub and many nonnative species. In the upper basin, common carp (Behnke and Benson 1983, Valdez 1990), green sunfish, largemouth bass, redside shiner (Joseph et al. 1977), red shiner (Joseph et al. 1977, Valdez 1990), and channel catfish (Joseph et al. 1977, Behnke and Benson 1983, Valdez 1990) use habitats with similar environmental conditions as humpback chub. Valdez and Ryel (1995) found habitat and dietary overlap between rainbow trout and humpback chub in the Grand Canyon. Spawning and egg hatching temperatures are similar for humpback chub and common carp, fathead minnows, and channel catfish (Valdez and Carothers 1998). Nonnative fish spawning sympatrically (i.e., in the same area) may displace humpback chub or reduce success. Some species are also predators on humpback chub. Predation by channel catfish, brown trout, rainbow trout, and black bullhead on humpback chub has been documented (Valdez and Ryel 1995).

R.2.4.5 Razorback Sucker

Legal Status. Razorback sucker were listed as endangered under the ESA in 1991. Critical habitat has been designated and it includes the Dirty Devil arm of Lake Powell and the Colorado River and its 100 year floodplain from the confluence of Paria River (located below Glen Canyon Dam) to Hoover Dam, including Lake Mead to its full pool elevation (59 FR 13399).

Historical and Current Range. Razorback sucker was historically widespread and common throughout the larger rivers of the Colorado River Basin, from Sonora and Baja, California, into Arizona, Colorado, Nevada, New Mexico, and Wyoming (Minckley et al. 1991, Marsh 1996). Gilbert and Scofield (1898) noted particularly high razorback sucker abundance in the Lower Colorado River Basin (LCRM) near Yuma, Arizona.

To date, the only substantial natural razorback sucker recruitment (low, yet steady numbers) and documentation of razorback sucker progression through all life stages in the LCRB occurs in Lake Mead, with limited and sporadic captures of naturally occurring fish throughout the remainder of the LCRB (Marsh and Minckley 1989; Holden et al. 1997, 1999, 2000a, 2000b, 2001; Abate et al. 2002; Welker and Holden 2003; Welker and Holden 2004). Razorback sucker do occur above Lake Powell and some may wash down into Lake Powell and persist at the inflow areas. However, there is not a regionally significant population of razorback sucker within Lake Powell. Razorback sucker are rarely caught in the Colorado River between Glen Canyon Dam and Lake Mead and are widely considered extirpated from this reach (Gloss et al. 2005). Annual monitoring at random locations in this reach of the river has not captured any razorbacks in more than 15 years. In 1997, 15 hatchery-reared razorback suckers were released into the lower gorge by the Hualapai Tribe (NPS 2005). Thus, it is possible that a few individuals could still be present.

Several investigators have reported hybrids between razorback suckers and flannelmouth suckers in Grand Canyon (Suttkus et al 1976; Maddux et al. 1987; Valdez and Ryel 1995). Although hybridization between these species has been reported for many years (Hubbs and Miller 1953; McAda and Wydoski 1980), the incidence in Grand Canyon appears high relative to the number of razorback suckers, especially in the LCR where these fish concentrate during spawning (Douglas and Marsh 1998).

Populations within the Action Area. Razorback sucker populations are present in Lake Havasu, Lake Mohave, Lake Mead, as well as in the Cibola High Levee Pond and Senator Wash in the lower Colorado River Basin. This species has been stocked in Lakes Mohave, Havasu, and Mead as well as in the Colorado River below Parker Dam (USFWS 2001). The population estimate for Lake Mohave is 3,000 to 4,000 fish (Stefferud et al. 2003), and less than 300 fish may be present in Lake Mead (USBR 2000). Spawning and recruitment of razorback suckers has been documented for Lake Mead through a monitoring program funded by the Bureau of Reclamation and the Southern Nevada Water Authority (Welker and Holden 2003). Larvae have been collected, and age calculations for juvenile to adult fish are 4 to 35 years indicating that recruitment has taken place. Spawning occurs in Echo Bay and Las Vegas Bay/Wash. Spawning also appears to be occurring in Lake Havasu, Senator Wash, and in the river below Parker Dam with low recruitment (Moyle 2002). Due to spawning and recruitment of razorback suckers in Lake Mead, individuals of this species could move upstream into the Colorado River from the lake.

No population estimates of razorback sucker have been conducted in the upper basin, The species is known to be present in Lake Powell at the mouths of the Dirty Devil, San Juan, and Colorado rivers (USFWS 2006), in the Green River to the confluence with the Colorado River (Modde et al. 2002), and in the San Juan River (Pfeifer et al. 2002). Stocking is being undertaken to augment the populations it the upper basin. Razorback suckers from previous stocking were collected in 2005 (46 individuals) and 2006 (64 individuals) during nonnative control in the lower San Juan River with three adults captured below the waterfall (RM 0.6) in 2005 and one adult taken below the waterfall in 2006 (Jackson 2006, Elverud and Jackson 2007). Approximately one to four individuals are regularly captured in the annual surveys of the San Juan arm of Lake Powell, and all are from hatchery stock (Gustaveson 2007). Gillnet surveys in Lake Powell have recorded one adult razorback in 1975 at the Good Hope station, two at the Wahweap station in 2006, and seven in the San Juan arm in 2004 plus 2006 (Utah DWR, 2007). Larval drift data from the middle Green River in Utah strongly suggests successful reproduction by stocked fish (Bestgen and Haines 2006), and wild juvenile suckers have been collected in the lower San Juan River in recent years.

Habitat. . Bestgen (1990) indicates that razorback sucker may have historically been uncommon in the turbulent canyon reaches of the Colorado River, citing research by Tyus (1987) and Lanigan and Tyus (1989) that suggests that razorback sucker in the Green River (the largest known riverine population) were typically found in calm, flatwater river reaches, not turbulent, fast-water canyon reaches. This trend is evident even within basins, as razorback sucker are typically collected in sand-bottomed, low gradient, flatwater reaches outside of the spawning period. However, razorback sucker inhabit virtually all components of riverine habitat at some point in their lives. In particular, low-velocity habitats such as backwaters, sloughs, oxbow lakes, and other slackwater habitats within the main channel were important for razorback sucker (Holden 1973, Holden and Stalnaker 1975, Behnke and Benson 1980, Minckley 1983). Seasonally submerged off-river habitats, including bottomlands and other marsh-like, lowland habitats, may have also been important habitat for razorback sucker prior to the construction of mainstream dams and the resultant changes in flow regimes, especially during spring-runoff periods (Tyus and Karp 1989, Bestgen 1990, Osmundson 2001).

More recent authors have documented that habitat selection by adult razorback sucker changes seasonally. Tyus and Karp (1990) document habitat use by adult razorback sucker to consist of flooded areas during spring months. Radiotelemetry efforts by Tyus (1987) identified adult fish utilizing near-shore runs during the spring, but they subsequently shifted habitat use during the summer to shallow waters associated with submerged mid-channel sandbars, with little use of backwaters. This suggests that the use of backwaters by razorback sucker may be overstated and an artifact of relatively easy capture with electrofishing rather than actual habitat use and preference. Osmundson and Kaeding (1989) reported adult razorback using pools and slow eddies from November through April, shifting to runs and pools from July through October. They also note increased backwater habitat use by adult fish during the months of May and June, the typical Upper Colorado River Basin (UCRB) spawning period.

Water velocity selection by adult razorback sucker is also typified by seasonal shifts in preferences. Tyus (1987) noted that during the summer, razorback sucker typically were found utilizing velocities averaging 0.5 m/s, while in the winter months adult fish were typically found in currents moving 0.03-0.33 m/s. These findings corroborate hypotheses and findings of Lanigan and Tyus (1989) and Minckley et al. (1991) that few adult razorback sucker utilize swift, whitewater habitats (e.g., Marble and Grand Canyons of the LCRB), although other efforts have documented movement of radio-telemetered fish through these locations (Tyus and Karp 1990). Furthermore, it becomes apparent that razorback sucker in a natural river setting do not appear to utilize solely backwater habitat types, although it appears that these habitats are important to young-of-year and juveniles. Lastly, adult razorback sucker have been reported to select shallower depths during the summer months

(0.9-1.65 m) while typically utilizing deeper depths during the winter months (1.65-2.16 m) (Osmundson and Kaeding 1989).

Razorback sucker are present in lentic environments in the LCRB, where they sometimes exhibit interesting and rather extensive habitat use. The majority of such information suggests that lentic-dwelling razorback sucker use a wide variety of habitats, including vegetated areas, littoral shoreline habitats, and substrates ranging from silt and sand to gravel and cobble. Adult razorback sucker have been documented via sonic surveillance to typically occupy depths less than 30 m (averaging between 3.1-16.8 m) and are generally located within 50 m from the shore during winter months (less than 30 m from shore during peak spawning activity). However, during summer months, adults were located at deeper depths, often surpassing 30 m, in an effort to hold body temperatures between 18-22 degrees C, a behavior thought to maximize bioenergetics (Marsh and Minckley 1989; Holden et al. 1997, 1999, 2000a, 2000b, 2001; Mueller et al. 2000; Abate et al. 2002; Welker et al. 2003; Welker and Holden 2004). Thermal preferendum for adult razorback sucker was estimated to lie within the range of 22-25 degrees C based on laboratory observations (Bulkley and Pimentel 1983).

In lentic (reservoir) settings razorback sucker larvae have been collected over a variety of habitat types, but they typically are collected over or near areas frequented by adult spawning aggregates. As a result, the majority of larval fish are captured over gravel and cobble, at near-shore locations, typically at depths of 0.0-4.9 m (Sigler and Miller 1963; Minckley 1983; Bozek et al. 1984; Marsh and Langhorst 1988; Holden et al. 1997, 1999, 2000a, 2000b, 2001; Abate et al. 2002; Welker et al. 2003; Welker and Holden 2004). In the Green River larval razorback sucker are entrained by spring flows into backwater and flooded bottomland habitats, where they benefit from warmer temperatures and abundant food resources (Tyus 1987, Muth et al. 1998). Historically, high spring flows flooded low-lying areas along the river and redistributed recently emerged and drifting larval razorback sucker into these food-rich backwaters and other seasonally flooded bottomlands, providing unique nursery habitats for razorback sucker (Tyus and Karp 1989, 1990; Modde 1996; Modde et al. 1996; Modde et al. 2005).

Habitat important to the juvenile life stages of razorback sucker remains relatively understudied, as catches of this size class remains minimal, presumably due to the predatory and competitory impacts of non-native species (Tyus 1987, Bestgen 1990, USFWS 1998b). The majority of juvenile, riverine catches come from the UCRB (Taba et al. 1965, Gutermuth et al. 1994, Modde 1996), with almost non-existent data on juvenile habitat use from the LCRB. Brandenburg et al. (2005) recently captured wild-spawned juvenile razorback sucker in the San Juan River. All of the juveniles in the San Juan River were found using seines in shoreline habitats including backwaters, embayments, and other lower-velocity habitats.

Reproduction. Although spawning razorback sucker have been collected over a variety of substrates, the majority of spawning individuals tend to be captured over clean gravel- and cobble-sized substrates (Douglas 1952, Tyus 1987, Bozek et al. 1990, Tyus and Karp 1990, Minckley et al. 1991). In UCRB rivers spawning occurs during the ascending limb of the hydrograph (Modde et al. 2005), which apparently an important adaptive feature for larvae as discussed below. Reservoir-spawning razorback sucker have been documented to successfully spawn in various LCRB impoundments. Spawning populations have been located in Lake Mead (Jonez and Sumner 1954; Holden et al. 1997, 1999, 2000a, 2000b, 2001; Abate et al. 2002; Welker and Holden 2003; Welker and Holden 2004), Lake Mohave (Bozek et al. 1984, Marsh and Langhorst 1988, Mueller 1989, Bozek et al. 1990), Lake Havasu (Douglas 1952, Minckley 1983), Senator Wash Reservoir (Medel-Ulmer 1980), and likely other locations. Spawning fish have been documented to congregate near river inflow areas that tend to be somewhat more turbid than the majority of the available spawning areas (Jonez and Sumner 1954; Holden et al. 1997, 1999).

The spawning season for razorback sucker has been reported to begin as early as November in some LCRB reservoirs and documented to continue through June in some populations of the UCRB. In upper basin riverine habitats, ripe razorback sucker have been collected from mid April to mid June, typically over a very limited time frame (4-5 weeks) (Tyus 1987; Osmundson and Kaeding 1989; Tyus and Karp 1989, 1990; Bestgen 1990). However, in lentic lower basin habitats the majority of spawning generally is carried out between January and April, months when water temperatures are typically within the range of 10-15 degrees C (Bestgen 1990). Male razorback sucker remain ripe for a period of 2-28 days, while females apparently are ripe for less time (2-15 days) in the Green River (Tyus and Karp 1990) but appear to have extended periods of sexual activity in lower basin reservoirs (Holden et al. 2001).

Research efforts by Bozek et al. (1990) show that successful incubation of razorback sucker eggs in Lake Mohave occurs between 9.5-15.0 degrees C, and in the laboratory successful embryo hatching occurs at 10-20 degrees C. Hatching (eggs at a controlled 15 degrees C) was reported to occur in 5.2-5.5 days (Minckley and Gustafson 1982). Egg mortality has been attributed to fluctuating water levels, scouring by currents and/or wave action, suffocation due to silt deposition, and non-native egg predation (Minckley 1983, Bozek et al. 1984). Fertilized gametes are reported by Minckley and Gustafson (1982) as adhesive for a 3-4 hour duration post fertilization, with cleavage being completed within 24 hours, gastrulation occurring at 34 hours, and blood circulation becoming established at 117 hours.

Valdez (2006) summarized temperatures required for spawning and egg incubation for this species as 12-22ºC with an optimum of 18ºC and 14-25ºC with an optimum of 19ºC, respectively.

Diet. Razorback sucker diet composition is highly dependant upon life stage, habitat, and food availability. Upon hatching, razorback sucker larvae have terminal mouths and shortened gut lengths (less than 1 body length) which in combination, appears to facilitate and necessitate selection of a wide variety of food types. Exogenous feeding occurs at approximately 10 mm TL (approximately 8-19 days), after which larvae from lentic systems feed mainly on phytoplankton and small zooplankton, while riverine inhabiting larvae are assumed to feed largely on chironomids and other benthic insects (Minckley and Gustafson 1982, Marsh and Langhorst 1988, Bestgen 1990, Papoulias and Minckley 1990, USFWS 1998b). Papoulias and Minckley (1992) reared larval razorback sucker in three different ponds containing different densities of food resources to demonstrate that increased growth was positively related to invertebrate densities, suggesting the importance of larval food switching from algal and detrital food items to a diet enriched with invertebrates. Papoulias and Minckley (1990) show that larval razorback mortality is minimized when food levels are within the range of 50-1,000 organisms/L.

Later during growth (age and size information unknown, but at some point during the juvenile life stage), razorback sucker undergo an ontogenetic shift in mouth morphology, with the mouth becoming more inferior and allowing for more efficient access to benthic food sources. Thereafter, razorback sucker likely consume a variety of benthic-associated food items (USFWS 1998b).

Threats. Numerous researchers have identified that the major factor contributing to the decline of razorback sucker and other large-river fishes has been the construction of mainstem dams and the resultant cool tailwaters and reservoir habitats that replaced a once warm, dynamic, riverine environment (Holden and Stalnaker 1975, Joseph et al. 1977, Wick et al. 1982, Minckley et al. 1991). This change in the physical environment presumably allowed for an increase in competition and predation from nonnative fishes, which are successfully established in the Colorado River and its reservoirs and have also contributed to native fish population declines (Minckley et al. 1991). In the middle Green River, also, lower peak flows (due to regulation) are thought to limit floodplain nursery habitat availability for larval fish (Muth et al. 2000).

R.2.4.6 Colorado Pikeminnow

Legal Status. Colorado pikeminnow were listed as endangered by U.S. Fish and Wildlife Service in 1967 and given full protection under the Endangered Species Act of 1973. Critical habitat was designated for Colorado pikeminnow in the upper Colorado River basin effective April 20, 1994. Critical habitat includes the Dirty Devil arm and the San Juan arm of Lake Powell in the action area. No critical habitat was designated in Arizona in the lower basin. Outside Arizona, six reaches in the upper Colorado basin [totaling 1848 km (1148 miles)], have been designated as critical habitat (AGFD 2001). Critical habitat is designated within the Colorado, Yampa, White and San Juan Rivers in the upper basin (59 FR 13384, March 21, 1994).

Historical and Current Range. Historically, Colorado pikeminnow were found in the mainstem of the Colorado River and its tributaries, from Wyoming to the Gulf of California. Currently, the species persists only in the upper Colorado River basin. In the upper Colorado River basin, the highest concentration of Colorado pikeminnow occurs in the Green River, from the mouth of the Yampa River to its confluence with the Colorado River. They have been reintroduced in the Salt and Verde Rivers in Arizona. Reintroductions are considered experimental, nonessential populations and reproducing populations of Colorado pikeminnow have not been established (Maddux et al. 1993).

Populations within the Action Area. The Colorado pikeminnow is present in the Colorado River downstream to Lake Powell (USFWS 2006), and the species is present in the San Juan River where it is also stocked (Pfeifer et al 2002). A few individuals are also present in Lake

Powell (USBR 2000). Nonnative fish control efforts in the lower San Juan River in 2005 and 2006 captured 287 and 256 juvenile pikeminnows, respectively, with only two collected below the waterfall in 2005 (Jackson 2006, Elverud and Jackson 2007). Studies of stocked Colorado pikeminnows in the San Juan River from 2002 through 2005 (Golden et al. 2006) collected 22 young pikeminnows between Clay Crossing and Lake Powell from November 2004 to November 2005. These data indicate that few individuals of Colorado Pikeminnow are present in the inflow area below the waterfall when Lake Powell elevations are low.

Habitat. Colorado pikeminnow are fish-eating, long-lived, large-river fish that use a variety of substrates, depths, and velocities. Historically, large adults were found in the turbid, silty waters of the Colorado River and large pools in tributaries to the Colorado River. Currently, they have a home range of approximately 5 km and move around the main stem river in their range. They utilize areas with slower currents, such as backwaters or near shore habitat. During spring and early summer, adult fish use areas inundated by spring flooding. Spring inundation of lowlands is believed to be important to the overall health of this species. Thermal adult preference is 25.3ºC (Black and Bulkley 1985).

Adult Colorado pikeminnow can display long-distance (up to 322 km) migratory behavior in sexually mature fish, and this behavior is important to reproduction (Maddux et al. 1993). Migration in the upper Colorado begins in early summer, possibly in response to falling water levels and increasing water temperatures. Colorado pikeminnow spawning migrations are initiated at water temperatures of 14-20ºC, while spawning occurs at an average temperature of 22ºC in late June to early August (Moyle 2002, 159). Colorado pikeminnow demonstrate a fidelity to spawning locations (Tyus 1985; Tyus 1990; Wick et al. 1983), with reproduction occurring in whitewater canyons. Fertilized eggs adhere to rocks and gravel. After spawning, adult fish return to their home range (Moyle 2002, 159).

In laboratory experiments, embryo hatching success was highest at 20ºC (Marsh 1985). Once larval pikeminnow emerge, they undergo a period of drift to reach nursery habitat. During the larval drift, they may be transported up to 161 km downstream (Tyus and Haines 1991). Nursery areas consist of ephemeral backwaters and shoreline embayments with little or no current (Tyus and Haines 1991). Bestgen (1996) reports that Colorado pikeminnow larval growth rate declines at water temperatures below 22ºC. Temperatures required for spawning and egg incubation summarized by Valdez (2006) are 16-14ºC with an optimum of 22ºC and 19-25ºC with an optimum of 22ºC, respectively.

Juveniles use quiet water habitats but move in and out of the habitats according to water temperatures. Juveniles prefer warmer temperatures in backwater areas rather than the cooler water temperatures in the main stem river. Bulkley et al. (1981) estimate the final thermal preferendums for juvenile Colorado pikeminnow to be 24.6ºC. Young Colorado pikeminnow have very specific streamflow and temperature requirements. Kaeding and Osmundson (1988) correlated lower water temperatures with reduced growth of age-0 Colorado pikeminnow and concluded that Colorado pikeminnow (45-100 mm) would not grow at water temperatures below 13ºC.

Reproduction. Naturally reproducing populations are presently found in the Green, Yampa, upper Colorado, Gunnison and San Juan Rivers. Approximately 8,000 adults spawn in the Green River basin (USFWS 2002d, Appendix A-2); 1,400 adults in the Yampa River (USFWS 2002d, Appendix A-2); and about 600–900 adults (USFWS 2002d, Appendix A-2) are believed to spawn in the upper Colorado River and near Grand Junction, Colorado, and in the lower Gunnison River (USFWS 2002d, Appendix A-2). Adult spawning estimates in the San Juan River range from 19 to 50 fish (USFWS 2002d, Appendix A-2). Average fecundity of 24, 9 year old females was 77,400 (range, 57,766–113,341) or 55,533 eggs/kg, and average fecundity of 9 ten-year old females was 66,185 (range, 11,977–91,040) or 45,451 eggs/kg (USFWS 2002d, Appendix A-2). Hybridization with other species is not known to occur.

Diet. Juveniles up to 50 mm in length consume zooplankton and insect larvae. Colorado pikeminnow from 50-100 mm in length feed on insects, and individuals larger than 200 mm eat mostly fish (Vanicek and Kramer 1969).

Threats. Numerous researchers have identified that the major factor contributing to the decline of Colorado pikeminnow and other large-river fishes has been the construction of mainstem dams and the resultant cool tailwaters and reservoir habitats that replaced a once warm, riverine environment (Holden and Stalnaker 1975, Minckley 1991, Mueller and Marsh 2002, USFWS 2002d). Competition and predation from non-native fishes that are successfully established in the Colorado River and its reservoirs have also contributed to their decline (Minckley and Deacon 1991, USFWS 2002d).

R.2.4.7 Kanab Ambersnail

Legal Status. Kanab ambersnail was listed as an endangered species in 1992 under the ESA (USFWS 1992). No critical habitat has been designated in the action area. The species is undergoing a 5-year review by the FWS, including a genetic evaluation of the species relatedness to other *Oxyloma*.

Historical and Current Range. The genus *Oxyloma* has a broad distribution (North America, Europe and South Africa) with two species recognized in the southwestern U.S.: *O. retusa* in New Mexico and *O. haydeni* in Arizona and Utah. Within O. haydeni there are two subspecies, the Niobrara ambersnail (*O. h. haydeni*) and the Kanab ambersnail (*O. h. kanabensis*), both of which are found in Arizona and Utah. Populations of Kanab ambersnail presently occur from only three springs: one at Three Lakes, near Kanab, Utah, and two in the in Grand Canyon National Park, Arizona, one at a spring and hanging garden at Colorado River mile 31.5 R known as Vaseys Paradise and a translocated population at Upper Elves Chasm, at Colorado river mile 116.6mi L (Gloss et al. 2005). In the Kanab area, two populations were known to exist, but one was extirpated by desiccation of its habitat. The remaining population at Three Lakes is located on private lands at several small spring-fed ponds on cattail (*Typha* sp.) (Clarke 1991).

KAS populations in the American Southwest are believed to be relictual populations from the Late Pleistocene ice age, when springs, seeps, and wetland habitat were more abundant in the region (Spamer and Bogan 1993, Szabo 1990). Historically, the Grand Canyon region may have harbored many populations of ambersnails in close proximity to each that are now lost under Lake Powell. Through analysis of historic photographs of the region, an increase in the vegetative cover along the Canyon to river level has occurred since the completion of the Glen Canyon Dam in 1963 (Turner and Karpiscak 1980). This increase in cover, the reduction in beach-scouring flows, and the introduction of non-native water-cress (*Nasturtium officinale*) has lead to an increase in suitable KAS habitat area at Vaseys Paradise of more than 40 percent from pre-dam conditions (Stevens et al. 1997a). It is believed that a similar increase in abundance of KAS occurred in this region over this same time period.

Intensive search efforts at more than 150 springs and seeps in tributary canyons to the Colorado River between 1991 through 2000 found no additional KAS in the region (Sorensen and Kubly 1997, 1998, Meretsky 2000, Meretsky and North 2000, Webb and Fridell 2000). As part of the KAS recovery effort required under the ESA, three natural springs along the Colorado River corridor were stocked with young snails in September 1998 (AGFD 1998). Release sites were selected in areas above the historic flood elevation (~100,000 cfs stage) and where populations would not be affected by dam operations. One translocation site, Upper Elves Chasm, has established as a new population and continued monitoring efforts have detected numerous KAS persisting and reproducing at the initial release area, including migration into suitable adjacent habitat (Gloss et al. 2005).

Populations within the Action Area. Populations within the action area occur along the Colorado River at Vaseys Paradise and a spring and hanging garden at Colorado River Mile 31.5 R. No other populations are known within the action area.

Habitat. The Kanab Ambersnail is dependent upon wetland vegetation for food and shelter. KAS lives in association with watercress (*Nasturtium*), monkeyflower (*Mimulus*), cattails (*Typha*), sedges (*Carex*), and rushes (*Juncus*). KAS populations in the Grand Canyon region occur in areas where water sources originate from limestone or sandstone geologic strata (Stevens et al. 1997a). Stevens et al. (1997a) found KAS predominantly using crimson monkeyflower and water-cress for food and shelter at Vaseys Paradise and therefore identified these two species as key habitat components for KAS. The other Grand Canyon population, Upper Elves Chasm, is located above the 100,000 cfs stage of the river and is characterized by predominately crimson monkeyflower and maidenhair fern (*Adiantum capillus-veneris*), with lesser amounts of sedges (*Carex aquatilis*), rushes (*Juncus* sp.), cattails (*Typha* sp.), water-cress, helleborine orchids (*Epipactis gigantea*) and grasses (Nelson and Sorensen 2002). From evidence collected in laboratory conditions, microclimatic conditions such as higher humidity and lower air temperatures relative to the surrounding environments and high vegetative cover may be important habitat features related to KAS survival (Sorenson and Nelson 2002).

Reproduction. Kanab ambersnail are believed to live approximately 12-15 months and are hermaphroditic and capable of self-fertilization (Clarke 1991, Pilsbry 1948). Mature KAS mate and reproduce during the summer months (July and August), and deposit clear, gelatinous egg masses on undersides of moist to wet live stems, on the roots of water-cress, and on dead stems of crimson monkey-flower (Stevens et al. 1997a). In some years with relatively warm winters, more than one reproductive period can occur. Adult mortality increases in late summer and autumn leaving the overwintering population dominated by subadults. Young snails enter dormancy in October-November and typically become active again in March-April. Over-winter mortality of KAS can range between 25 and 80 percent (Stevens et al. 1997a & 1997b and IKAMT 1998).

Diet. This species of land snail feeds on plant tissue, bacteria, fungi and algae. It scrapes this food off of plants by means of a radula or rasp tongue. Stevens et al. (1997b) observed KAS feeding largely on crimson monkey-flower and water-cress.

Threats. Current threats to KAS include loss and adverse modification of wetland habitats, which are scarce in this semi-arid region (USFWS 1995c). The habitat for the Utah population is at risk due to commercial development by the private landowner. Historically, the Grand Canyon experienced annual floods of 90,000+ cubic-feet per second (cfs) and KAS were likely swept downstream and drowned (Stevens et al. 1997a). Today, Glen Canyon Dam limits such flood events, although several flows >45,000 cfs have occurred in the last 30 years (IKAMT 1998). For example, during the March 1996 experimental beach/habitat-building flow (BHBF) in the Grand Canyon, up to 16 percent of KAS habitat at Vaseys Paradise was lost or degraded and hundreds of snails were lost. Recovery of this habitat to pre-flood conditions required over two years (IKAMT 1998, Stevens et al. 1997b).

On a lesser scale, trampling by recreationists and flash floods from the talus slope above Vaseys Paradise also contribute to habitat loss and can results in direct KAS mortality. Due to steep slopes and a dense cover of poison ivy at this location, the impacts from recreationists are reduced. Additionally, plateau-origin flash floods are rare in the region (Stevens et al. 1997a).

Evidence exists that a small number of Kanab ambersnails at Vaseys Paradise were parasitized by a trematode, tentatively identified as *Leucochloridium* sp. (Stevens et al. 1997b). Potential vertebrate predators include rainbow trout (*Oncorhynchus mykiss*) in the stream mouth, summer breeding Say's and black phoebe (*Savornis savi* and *S. niaricans*), canyon wren (*Catherpes mexicanus*), winter resident American dipper (*Cinclus mexicanus*), and canyon mice (*Peromyscus crinitus*) (Stevens et al. 1997b, USFWS 1995c). Hard evidence of KAS consumption and predation rates by birds and mice are not available, but analysis of mice feces indicates that snails are not regularly eaten by rodents (Meretsky and Wegner 1999). Another natural threat is bighorn sheep. Water sedge, a plant with patchy distribution in Kanab ambersnail habitat, is a source of forage for bighorn sheep (*Ovis canadensis*), especially during a drought. As a result, the springs at Vasey's Paradise are now habitually visited by bighorn sheep, resulting in vegetation used by the snails being regularly trampled (Gloss et al. 2005).

R.3 Effects Analysis

R.3.1 Analysis Methodology and Assumptions

This section describes the methods and assumptions used to conduct the analysis of potential effects of the proposed action on the evaluated species in the Lake Powell to Lake Mead portion of the action area. Methods and assumptions used to conduct the analysis of SNWA's interdependent actions on the Muddy and Virgin River portions of the action area are described in Attachment B.

The approach for analyzing effects of the proposed action for the Lake Powell to Lake Mead portion of the action area consisted of comparing Lake Powell elevations, river flows, average monthly river temperatures at Lees Ferry, the Little Colorado River confluence and below Diamond Creek, and river sediment transport under the baseline condition to conditions expected under the proposed action and evaluating if differences in hydrologic conditions under the proposed action would affect ESA-listed, proposed, and candidate species and designated critical habitats.

R.3.1.1 Lake Powell Reservoir Elevation and Releases

Future Colorado River system conditions under the baseline and the proposed action conditions were simulated using the Colorado River Simulation System (CRSS). The model framework used for this process is a commercial river modeling software called RiverWare™. RiverWare™ is a generalized river basin modeling software package developed by the University of Colorado through a cooperative process with Reclamation and the Tennessee Valley Authority. CRSS was originally developed by Reclamation in the early 1970s and was implemented in RiverWare™ in 1996. River operation parameters modeled and analyzed in CRSS include the water entering the river system, storage in system reservoirs, releases from storage, river flows, and the water demands of and deliveries to water users in the Basin States and Mexico.

The future water supply used as input to the model consisted of data sampled from the historic record of natural flow in the river system over the 100-year period from 1906 through 2005 from 29 individual inflow points (or nodes) on the system. The future Colorado River water demands were based on demand and depletion projections prepared by the Basin States. Depletions are defined as diversions from the river less return flow credits, where applicable. The operation of the mainstream reservoirs including Lake Powell and Lake Mead is provided as a set of operating rules which describe how water is released and delivered under various hydrologic conditions. Additional information on the hydrologic modeling methodology is available in Section 4.2 of the Final EIS.

CRSS modeling outputs used to conduct the analysis of effects are presented in Attachment C. CRSS model outputs included the relative probability of different sized annual releases and minimum, average and maximum daily releases associated with various levels of annual release. The 10th, 50th and 90th percentile monthly releases from Glen Canyon Dam were also evaluated as a relative indicator of flow conditions between Glen Canyon Dam and Lake Mead. The 10th, 50th, and 90th percentile Lake Powell elevations were used to evaluate potential changes to Lake Powell conditions.

R.3.1.2 Water Temperature

Lake Powell undergoes seasonal transformations that can dramatically affect the temperatures of both the reservoir and the dam releases. During the spring, solar radiation and warmer air temperatures begin to warm the upper surface layers of the reservoirs. This warming is also affected by spring inflow volumes and temperatures. Larger inflows bring greater volumes of warmer water that can cause higher release temperatures. Reservoir draw downs can bring the warmer surface water closer to the power plant intake penstocks, also producing warmer releases. As summer progresses, surface warming of reservoirs increases, as does the warming of releases as the water moves downstream. During the winter months, reservoir temperature stratification is usually eliminated by reservoir mixing, and both reservoir and downstream water cooling occurs. Reclamation's CE-QUAL-W2 model was used to simulate this annual process and to analyze dam release temperatures for various reservoir starting elevations and inflows. The CRSS output of dam release and reservoir elevations was used in the CE-QUAL-W2 model to establish a relationship between reservoir elevations and dam release temperatures and project the impact of reservoir draw down on dam release temperatures. Calibration of the CE-QUAL-W2 model for Lake Powell used historic temperature profiles from 1990 to 2005 at 13 reservoir stations.

This 15-year data set provided a limited range of historic reservoir elevations, inflows, and releases. By using a combination of historic and modeled data for various reservoir elevations, and by analyzing the impact of a repetition of the recent drought years, dam release temperatures for a larger range of reservoir elevations could be analyzed.

The Generalized Environmental Modeling System for Surface Waters (GEMSS) model was used to route Glen Canyon Dam release temperatures through the Grand Canyon downstream to Lake Mead. The GEMSS model was calibrated for water temperature at three locations in this river reach: Lees Ferry, 15.9 miles downstream of Glen Canyon Dam; a point one mile downstream of the Little Colorado River confluence; and the Diamond Creek gaging station 240 miles downstream of Glen Canyon Dam. Below Diamond Creek, water temperatures approached equilibrium with the ambient air temperature, and the rate of temperature change decreased.

For any specific reservoir starting elevation, there is a range of potential dam release temperatures because the reservoir is affected by the magnitude of spring inflow and summer meteorological conditions. Downstream water temperatures produced by a routing of these releases are also affected by meteorological conditions and the magnitude of dam releases. Thus, for a single reservoir elevation the CE-QUAL-W2 and GEMSS modeling resulted in a range of water temperatures. This range is depicted graphically in Attachment C for reference and includes a minimum and maximum monthly temperature at three river locations for the 10^{th}, 50^{th}, and 90^{th} percentile Lake Powell elevation release condition. However, to provide a more meaningful comparison, this analysis used the average of the potential range as the basis of impact analysis. Both the temperature range and average temperatures are provided in Attachment C (Figures BA-18 through BA-27, and Tables BA-5 through BA-7).

Average river temperature by month at Lees Ferry, Little Colorado River confluence and Diamond Creek confluence were evaluated to identify whether the proposed action would affect river temperature compared to baseline conditions. Temperature model results were used to evaluate potential effects to various life stages of the evaluated fish species. Additional information on the water quality modeling methodology is available in Section 4.5 of the Final EIS.

R.3.1.3 Sediment Transport

To estimate the effects of modifying the annual release volumes from Glen Canyon Dam under the proposed action on sediment transport, the USGS prepared an analysis relating normalized sediment transport from the Grand Canyon to annual release volumes. Table R-6 shows this relationship, with 8.23 maf release volumes as the basis for normalization.

The probabilities of different levels of annual release were used to qualitatively evaluate potential differences in sediment transport and instream conditions for ESA-listed fish.

R.3.1.4 Effects of Climate Change

The hydrologic model, CRSS, used as the primary basis of the effects analysis does not project future inflows, but rather relies on the historic record to analyze a range of possible future inflows. Projections of future reservoir elevations are probabilistic, based on the 100-year historic record to protect future inflows. The historic record includes periods of extreme drought and periods with above average flow, allowing analysis of the proposed federal action under a wide range of future flow conditions. However, it is possible that future flows may include periods of wet or dry conditions that are outside the range of sequences observed in the historical record, particularly as a result of climate change and increased climate variability.

Table R-6
Relationship of Glen Canyon Dam Annual Release Volumes to Sediment Transport

Release (maf)	Normalized Sand Export
6.00	0.26
7.00	0.51
8.00	0.89
8.23	1.00
9.00	1.43
10.00	2.15
11.00	3.03
12.00	4.11
13.00	5.43
14.00	7.01
15.00	8.88
16.00	11.02
17.00	13.53
18.00	16.67
19.00	19.72
20.00	23.40

The Fourth Assessment Report (Summary for Policymakers) of the Intergovernmental Panel on Climate Change (IPCC), published in April of 2007, presented a selection of key findings regarding projected changes in precipitation and other climate variables as a result of a range of unmitigated climate changes projected by IPCC over the next century. Although annual average river runoff and water availability are projected to decrease by 10-30 percent over some dry regions at mid-latitudes, information with regard to potential impacts on specific river basins is not included. Recently published projections of potential reductions in natural flow on the Colorado River Basin by the mid 21st century range from approximately 45 percent by Hoerling and Eischeid (2006), to approximately 6 percent by Christensen and Lettenmaier (2006). A recent analysis of future precipitation minus evaporation (a surrogate for runoff) in the basin suggests an "imminent transition to a more arid climate in southwestern North America" (Seager et al (2006). While these projections are of great interest, additional research is both needed and warranted to quantify the uncertainty of these estimates (in terms of the actual uncertainty in the climate response as well as the uncertainty due to differences in methodological approaches and model biases) in order to better understand the risks of current and future water resource management decisions.

Reclamation has been involved in a multi-faceted research and development program over the past three years to improve its risk assessment capabilities regarding projected climate change in the Colorado River Basin. Key components of this program include:

- Sponsorship of NRC’s Committee on the Scientific Bases of Colorado River Basin Water Management in collaboration with the California Department of Water Resources, the Metropolitan Water District of Southern California, the Southern Nevada Water Authority, and the National Research Council’s (NRC) Water Science and Technology Board

  This study culminated in a report published in early 2007, “Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability”. Among several conclusions and recommendations, this report concluded that the trend of increasing mean temperatures across the Colorado River Basin over the 20th century and into the 21st century is likely to continue and although there is less consensus regarding future trends in precipitation and runoff, the preponderance of the scientific evidence suggests warmer future temperatures will reduce future streamflow and water supplies and contribute to increase the severity, frequency, and duration of future droughts. It is anticipated that the Final EIS will include the executive summary of this report as Appendix T.

- Collaboration with several climate researchers to assess the state of knowledge regarding the potential impacts of climate change on the Colorado River Basin, to assess methodologies that would be appropriate to quantify future conditions, and to prioritize future research and development needs

  This work culminated in a report titled “Review of Science and Methods for Incorporating Climate Change Information into Reclamation’s Colorado River Basin Planning Studies”. Among several conclusions and recommendations, this report concluded that for shorter look-ahead horizons (e.g., less than 20 years), interannual and decadal variability is likely to be a more significant source of uncertainty than the uncertainty due to near-term climate change. Although paleoclimatic information may not necessarily represent future climate scenarios, this information may be useful in framing assumed variability in future hydrologic sequences, particularly with respect to drought potential. It is anticipated that the Final EIS will include this report in its entirety as Appendix U.

- Collaboration with several research partners including the USGS, NOAA, and various universities to improve the accuracy and spatial resolution of the output data from the climate change models to enable use in CRSS

- Improvements to the decision-modeling framework (including the CRSS model and associated data handling and analysis tools)

Based on the current inability to precisely project future impacts of climate change to runoff throughout the Colorado River Basin at the spatial scale needed for CRSS, Reclamation based its hydrologic analysis for the Final EIS and this BA primarily on the re-sampled historical record. However, in order to understand the potential effects of future inflow sequences outside the range of the historical flows (i.e., future sequences with increased variability including the severity, frequency, and duration of droughts), particularly during the 19-year period of the application of the proposed action, Reclamation analyzed the sensitivity of the hydrologic resources (including reservoir storage, reservoir releases, and river flows) to hydrologic scenarios derived from alternative methodologies. The methodologies, including stochastic hydrology methods and paleo-reconstruction methods and the results, were analyzed in Appendix N of the Draft EIS. An additional analysis has been added in the Final EIS that incorporates a newly published tree-ring reconstruction (Meko et al., 2007) that extends the estimate of annual flow at Lees Ferry back to the year 762, a record length of 1244 years.

Although precise estimates of the future impacts of climate change to runoff throughout the Colorado River Basin at appropriate spatial scales are not currently available, these impacts may include decreased mean annual flow and increased variability, including more frequent and more severe droughts. Furthermore, even without precise knowledge of the effects on runoff, increasing temperatures alone would likely increase losses (e.g., evapotranspiration and sublimation), resulting in reduced runoff. Acknowledging this potential, the proposed action includes operational elements that would respond if these impacts are realized during the interim period (2008 through 2026). In particular, the proposed action includes a coordinated operation element that allows for the reduction of Lake Powell's release below the current minimum objective release of 8.23 mafy (down to a new proposed minimum of 7.0 maf) if water in storage of Lake Powell decreases to specified levels. In addition, the proposed action includes a storage and delivery mechanism that is designed to enhance conservation opportunities in the Lower Basin and the retention of water in Lake Mead. Finally, the proposed action includes a shortage strategy at Lake Mead that would result in additional shortages being applied, after appropriate consultation, if Lake Mead water surface elevations were to drop below elevation 1,025 feet msl.

R.3.2 Direct and Indirect Effects of the Proposed Action

Potential effects of the proposed action on the evaluated species could result from changes in Lake Powell reservoir storage and release operations from baseline operations. The potential hydrologic effects could result in changes in the range and duration of the water elevations maintained in Lake Powell, river flow, river temperature, and sediment transport that support habitat conditions for the evaluated species. The following section describes the potential effects of the proposed action on the evaluated species from Lake Powell to the upper end of Lake Mead and summarizes the effects of SNWA's interdependent actions that are evaluated in Attachment B.

R.3.3 Species Effects

R.3.3.1 Southwestern Willow Flycatcher

Based on the following analysis, the proposed action in combination with SNWA's interdependent action may affect and is likely to adversely affect the southwestern willow flycatcher through occasional, temporary desiccation of occupied habitat.

Potential southwestern willow flycatcher habitat does not occur below the full pool of Lake Powell due to the steep topography and fluctuating nature of the reservoir. Southwestern willow flycatchers are known to nest in tamarisk along the Colorado River in the Grand Canyon. The southwestern willow flycatcher can be affected by high flows through scouring and destruction of willow/tamarisk shrub nesting habitat or wetland foraging habitat. Conversely, a reduction in flows could have adverse effects on riparian and marsh vegetation, which could adversely affect southwestern willow flycatcher. In April and May, the 90th percentile flows under the proposed action are higher than baseline conditions (Attachment C, Figures BA-9 and BA-10). However, willow flycatcher nests in the Grand Canyon are typically above the 45,000 cfs stage (Gloss et al, 2005), which is not approached at the 90th percentile in these months. Therefore these somewhat higher flows in April and May should not affect southwestern willow flycatcher nests in saltcedar. Monthly low releases (10th percentile) can be lower than under baseline conditions, in part because this action would allow for an annual release lower than 8.23 maf under certain circumstances (Attachment C, Table BA-4). These lower annual releases would result in lower hourly maximum flows as well as lower monthly low flows than baseline (Attachment C, Table BA-3). However, the probability of an annual release of less than 8.23 maf is relatively low (Attachment C, Table BA-4). Southwestern willow flycatcher nest in primarily tamarisk shrub in the lower Grand Canyon which is quite common along the Colorado River in the Grand Canyon. Tamarisk is not an obligate phreatophtye and is capable of surviving lowered water levels. Therefore, the potentially lower flows associated with the proposed action are not expected to kill tamarisk and thus no loss of southwestern willow flycatcher nesting habitat is anticipated.

An important element of flycatcher nesting habitat is the presence of moist surface soil conditions. Moist surface soil conditions are maintained by overbank flow or high groundwater elevations supported by river stage. At the 50th percentile, modeled monthly releases during the breeding season (April-August) from Glen Canyon Dam under the proposed action is almost always either equal to or greater than under baseline conditions (Attachment C, Figures BA-9 through BA-13). Under these conditions, flycatcher habitat conditions would be expected to be the same or improved relative to baseline conditions. During periods of the breeding season that flows could be less than under baseline conditions (10th percentile flows), the potential exists for lowering of groundwater elevations adjacent to the channel to decline, which could desiccate occupied nesting habitat and result in take of southwestern willow flycatcher. The probability for such take is considered to be low and the level of any such take would be low because only a few nest sites are known from this reach of the Colorado River, as indicated in Section 2.4.1 of this BA. Furthermore, the effect of take, should it occur, would be temporary because nesting habitat conditions are expected to be restored during periods when the flows are at or above the 50th percentile (Attachment C, Figures BA-9 through BA-13). The level of this effect, however, is not expected to substantively affect the abundance or distribution of southwestern willow flycatcher in the action area or regionally.

As indicated in Attachment B, interdependent actions on the Muddy and Virgin Rivers are to not expected to result in take of southwestern willow flycatcher nor appreciably diminish the value of critical habitat designated along the Virgin River for flycatcher conservation or the value of critical habitat for survival or recovery of the species.

R.3.3.2 Yellow-billed Cuckoo

The proposed action in combination with SNWA's interdependent action may affect, but is not likely to adversely affect the yellow-billed cuckoo. As described in Attachment B, SNWA's interdependent actions are not expected to result in take of yellow-billed cuckoo and may be beneficial by improving hydrological conditions that support species' habitat.

R.3.3.3 Yuma Clapper Rail

The proposed action in combination with SNWA's interdependent action may affect, but is not likely to adversely affect the Yuma clapper rail. The Yuma clapper rail is only present along the Muddy and Virgin River portion of the action area and, as described in Attachment B, SNWA's interdependent actions are not expected to result in take of the rail and may benefit the rail by improving hydrological conditions that support its habitat.

R.3.3.4 Moapa Dace

The proposed action in combination with SNWA's interdependent action is not expected to have any effects on the Moapa dace. The Moapa dace is only present in the Warm Springs area along the Muddy River portion of the action area and, as described in Attachment B, SNWA's interdependent actions are not expected to affect the dace or its habitat.

R.3.3.5 Woundfin and Virgin River Chub

The proposed action in combination with SNWA's interdependent action may affect, but is not likely to adversely affect the woundfin or Virgin River chub. The woundfin and Virgin River chub are only present along the Virgin River portion of the action area and, as described in Attachment B, SNWA's interdependent actions are not expected to result in take of these species nor appreciably diminish the value of critical habitat designated along the Virgin River for woundfin and Virgin River chub conservation or the value of critical habitat for survival of these species. Furthermore, these independent actions may benefit the woundfin and Virgin River chub by improving hydrological conditions that support their habitat.

R.3.3.6 Humpback Chub

Based on the following analysis, Reclamation has determined there is the possibility of take of individual humpback chub through increased competition, predation, and parasitism, and therefore Reclamation has concluded the proposed action may affect and is likely to adversely affect the humpback chub.

Humpback chub occur in the Colorado River below Glen Canyon Dam and in the Little Colorado River that is tributary to this river segment. None are known to be present in Lake Powell, and the species is not found in the Virgin or Muddy Rivers.

The proposed action could alter sediment transport, water temperature, and daily flows in the Colorado River below Glen Canyon Dam relative to baseline conditions. Sediment transport is directly related to river flow (Table R-6). The proposed action could result in annual releases from Glen Canyon Dam of less than 8.23 mafy approximately 9.7 percent more frequently than under baseline conditions, which would reduce the transport of sand out of the river and into Lake Mead (Attachment C, Table BA-4). During those times, sediment transport out of the river and into Lake Mead would be reduced per the relationship described in Table R-6. Annual release rates above the minimum objective release of 8.23 maf could occur with a frequency about 17 percent higher than under baseline conditions (Attachment C, Table BA-4). These higher releases would transport more sediment out of the river. The probability of releases above 9 mafy (9.01 mafy to above 16 mafy) is very similar under baseline conditions and the proposed action (differ by approximately 0.5 percent) and thus the effect on sediment transport would be very similar.

The quantitative effects of these changes in release rates on instream habitat suitability for humpback chub are difficult to predict. Goeking et al. 2003 noted considerable temporal variability in both backwater number and area with river discharge, and also variability among sights within a given year. They also found that backwater area tends to decline in the absence of floods (releases at or above powerplant capacity) and increase following floods, however the relationship between backwater area, depth and water temperature has not been established, making predictions for the welfare of the fish very difficult. On the other hand, Stevens and Hoffnagle found that both backwater number and area decrease at flows above 10,000 cfs, and similar findings were documented by McGuinn-Robbins (1997). These relationships, together with more frequent releases above 8.23 maf under the proposed action may act reduce backwater availability during certain years, especially during the months of August and September when those habitats are most critical to the fish. High releases along with increased flow fluctuations may exacerbate this problem.

For the baseline and proposed action, modeling results indicate that monthly average water temperatures in the Colorado River at Lees Ferry would be the same and would be below the requirements for humpback chub spawning and egg incubation under the 10th, 50th, and 90th percentile conditions (Attachment C, Table BA-5) during the spawning season of March through July. Near the confluence of the Little Colorado River, the average water temperatures could meet or exceed minimum spawning, egg incubation and growth requirements during July (end of spawning season) only under the 10th percentile conditions for both baseline and the proposed action. The average water temperature near the Little Colorado River would be less than 1ºC warmer for the proposed action than for the baseline in most months (Attachment C, Table BA-6), which may benefit humpback chub during 10^{th} percentile years when life stage minimum temperature thresholds are exceeded; this slight increase may also help minimize thermal shock to young-of-year humpbach chub entering the main channel from the LCR. At the confluence of Diamond Creek, average water temperatures could be suitable for humpback chub spawning, egg incubation and growth in

June and July under baseline 10th percentile conditions and in May through July under proposed action 10th percentile conditions. The average temperatures at the Diamond Creek confluence could be up to 1.4ºC warmer for the proposed action than for the baseline in most months, which may benefit humpback chub during 10^{th} percentile years when optimal spawning, incubation and growth temperatures are attained earlier in the year. However, under the proposed action the maximum temperature for growth (22° C) may be approached more frequently during 10^{th} percentile years, which may result in impeded growth compared to the no action.

For the 50th percentile conditions, average temperatures at Diamond Creek could be less than 1ºC warmer for the proposed action than for the baseline in April through August, and spawning could occur one month earlier (June), compared to the baseline. This would be beneficial to humpback chub as minimum incubation and growth temperatures would also be met earlier in the year. For the 90th percentile conditions, average temperatures at Diamond Creek would be the same for the proposed action and the baseline (Attachment C, Table BA-7). The slightly warmer water temperatures in the river from the confluence of the Little Colorado River to Diamond Creek in some months under the proposed action could also increase growth of humpback chubs and their food base organisms, a benefit to the species.

Under 50^{th} percentile conditions, average monthly temperatures for the proposed action would be less than 1.5ºC lower than under baseline conditions near the Little Colorado River confluence and less than 1.8ºC lower than baseline conditions at Diamond Creek from September through March (Attachment C, Tables BA-6 and BA-7). The temperatures would be the same under baseline and proposed action conditions at Lees Ferry (Attachment C, Table BA-5). Near the Little Colorado River, the average monthly water temperatures during these months would be less than that required for growth (16ºC) of the humpback chub under both baseline and proposed action conditions (Attachment C, Table BA-6). At Diamond Creek, the average monthly water temperature for the proposed action in September would be 0.8 ºC cooler than for baseline but would remain above the minimum growth temperature (Attachment C, Table BA-7). From October through March, average monthly water temperatures would be below the minimum growth temperature under both baseline and proposed action conditions. Thus, the slightly lower water temperatures under the proposed action would adversely affect growth of the humpback chub to about the same extent as the no action alternative.

The slightly warmer water temperatures under the proposed action relative to baseline conditions also could benefit the nonnative fish species present in the river by allowing earlier reproduction and increased growth similar to that for the humpback chub in those years when such temperature increases occur. Nonnative species that are common in the river from the Paria River confluence to Lake Mead include channel catfish, brown trout, rainbow trout, common carp, and fathead minnow. Red shiner, plains killifish and mosquitofish are locally common below the LCR, and striped bass, and channel catfish increase in abundance below RM 160 (Gloss et al. 2005). Also present in low numbers are black bullhead, yellow bullhead, green sunfish (GCMRC, unpublished).

Common carp, fathead minnow, red shiner, and mosquitofish feed primarily on aquatic insects, other small invertebrates, and plant material, although they can eat fish eggs and larvae as well (Moyle 2002). The plains killifish feeds near the surface on invertebrates and algae (Colorado State 2007). The other species, at least larger individuals, are predatory (Moyle 2002). Predatory nonnative fish that are rare to uncommon in the river but common at the inflow to Lake Mead include channel catfish, walleye, striped bass, and largemouth bass. Smallmouth bass are rare in the river, inflow area, and Lake Mead. Temperature requirements for these species are shown in Table R-7. All but rainbow trout, brown trout, red shiner, walleye, striped bass, and smallmouth bass have minimum spawning and incubation temperatures at or above those for humpback chub and thus could benefit from slightly warmer temperatures for the proposed action under 10th percentile conditions (Attachment C, Tables BA-5 through BA-7). Temperatures under the 50th and 90th percentiles would provide no benefits to nonnative fish.

Since many nonnative fish prey on native fish, the potentially increased number and/or feeding activity of nonnative fish at 10th percentile temperatures could adversely affect the humpback chub in this reach. However, many species of non-native fish are already present in this reach and the infrequent, slightly warmer temperatures are unlikely to increase their long-term abundance or species composition. For example, smallmouth bass generally does not establish in habitats where water temperatures do not exceed 19ºC for extended periods in the summer (Moyle 2002). The proposed action would not increase average monthly water temperatures to above 19ºC (based on modeling results) near the Little Colorado River under any conditions (Attachment C, Table BA-6). Near Diamond Creek, average water temperatures are above 19ºC in July through September under baseline conditions, and the proposed action could increase these average temperatures by about 1ºC and extend the duration of warmer temperatures by a few weeks (Attachment C, Table BA-7). Thus, the preferred action would be unlikely to result in a population increase for smallmouth bass in the Colorado River between Glen Canyon Dam and Lake Mead.

Warmer river temperatures could increase the potential for expansion of the Asian tapeworm (*Bothriocephalus acheilognathi*) and anchorworm (*Lernaea cyprinacea*) in the mainstream Colorado River in some years. Currently, these nonnative fish parasites are found primarily in fish in the Little Colorado River and other side tributaries, and they mostly affect native fish. Under baseline conditions, these parasites are less likely to infect fish in the Colorado River because water temperatures are less than optimal for these parasites. The potential for these parasites to infect fish increases when Glen Canyon Dam releases occur at low Lake Powell elevations (10th percentile or lower), and this could adversely affect the humpback chub. The level of effect is unknown but in isolation could be negligible considering the low frequency of such occurrences and the small increase in average temperature that would occur as a result of the proposed action; however, when combined with the aforementioned effects of habitat and nonnative fish, parasitism could be significant. Glen Canyon Dam releases made when Lake Powell water levels are at the higher 50th and 90th percentile elevations result in approximately the same to cooler downstream temperatures that are always below 20°C for the baseline and proposed action (Attachment C, Tables BA-5 through BA-7).

Table R-7
Nonnative Fish Temperature Requirements (Minimum-Maximum)

Common and Scientific Name	Spawning (ºC)	Incubation (ºC)	Growth (ºC)
Black bullhead *Ameiusus melas*	19-22	21-24	20-22
Channel catfish *Ictalurus punctatus*	21-29	20-30	21-30
Brown trout *Salmo trutta*	7-14	8-20	12-20
Rainbow trout *Oncorhynchus mykiss*	8-13	7-15	12-21
Common carp *Cyprinus carpio*	18-30	20-30	15-30
Fathead minnow *Pimephales promelas*	16-30	16-29	18-27
Red shiner *Cyprinella lutrensis*	15-30	15-25	18-28
Mosquitofish *Gambusia affinis*	18-30	20-24	14-28
Plains killifish *Fundulus zebrinus*	20-30	20-30	20-30
Walleye *Stizostedion vitreum*	4-13	4-14	18-23
Striped bass *Morone saxatilis*	14-24	16-26	23-30
Green sunfish *Lepomis cyanellus*	19-31	19-24	26-31
Largemouth bass *Micropterus salmoides*	16-20	16-20	16-30
Smallmouth bass *Micropterus dolomieu*	13-18	14-18	20-26
Endangered Fish Temperature Requirements (Minimum-Maximum)			
Bonytail *Gila elegans*	18-22	18-28	18-24
Colorado pikeminnow *Ptychocheilus lucius*	16-24	19-25	18-23
Razorback sucker *Xyrauchen texanus*	12-22	14-25	18-24
Humpback chub *Gila cypha*	16-22	16-27	16-22

Source: Valdez 2006

Reduced annual releases from Glen Canyon Dam under the proposed action could also result in a reduction in the potential range of hourly maximum and minimum releases from Glen Canyon Dam. At the minimum objective release of 8.23 mafy, the daily range of flows from Glen Canyon Dam under baseline conditions is approximately 6,000 to 8,000 cfs with the wider range in July, August, December, and January (Attachment C, Tables BA-2 and BA-3). The potential hourly range at annual release rates of 7.48 mafy could be reduced by as much as 1,000 to 2,000 cfs/day in April and October through December (Attachment C, Tables BA-1 through BA-3). This lower potential flow range would be unlikely to occur under baseline conditions because there is a low probability 0.05 percent) of an annual release of 7.48 mafy and would have about an approximately 8 percent probability of occurring for the proposed action (Attachment C, Table BA-4). For release rates between 9.0 mafy and over 16 mafy, the probability of such releases under baseline conditions and the proposed action are very similar (differ by approximately 0.5 percent). Therefore, the flow effects of annual releases above 9 mafy on daily flows is very similar under baseline conditions and the proposed action. Because the probability of annual releases above 9 mafy is very similar under baseline and the proposed action, and the frequency of the lower range of potential hourly flows when the annual release is lower than 8.23 mafy is low, effects on habitat that could be used by humpback chubs from changes in the potential range of hourly flows would be negligible (Attachment C, Tables BA-2 through BA-4), unless equalization under volumes > 8.23 maf (17 percent greater chance of that) result in higher fluctuations during the months of August and September, impacts to backwater habitat availability and temperatures could be significant. Humpback chub young-of-year are typically abundant in the mainchannel during those months, so habitat availability may be an issue.

The level of take that could occur from the proposed action relative to that under baseline conditions, particularly due to potential beneficial effects on nonnative fish that result in competition with or predation on humpback chubs, cannot be quantified but is expected to be none in most years. However, a small level of take of individuals could occur in a few years from warmer 10^{th} percentile releases from Glen Canyon Dam, because of these temperatures benefiting non-native fish predators. The small amount of take, if it occurs, is not expected to cause a change in the population of the humpback chub. The benefits of warmer water on populations of the humpback chub could at least partially offset the take due to increased predation by nonnative fish.

The possible effects of the proposed action on the habitat (and its components including water temperature and quality, flows, etc.) as described above would be minor. Consequently, the possibility of impacts on critical habitat resulting from the proposed action is not expected to appreciably diminish the value of critical habitat for humpback chub conservation, affect the survival or recovery of the species, nor appreciably diminish the value of critical habitat for survival of the species

R.3.3.7 Razorback Sucker

Based on the following analysis, Reclamation has determined the proposed action may affect, but is not likely to adversely affect the razorback sucker. Razorback sucker can occur at the riverine inflow areas to Lake Powell but are considered rare here. Razorback sucker have not been found in the Colorado River between Glen Canyon Dam and Lake Mead for over 15 years although a few individuals could still be present. Razorback sucker are not found in the Virgin or Muddy Rivers.

When Lake Powell is below elevation 3,660 feet msl, a waterfall exists at the San Juan River inflow at RM 0.6. This waterfall serves as a fish barrier for the upstream movement of non-native fish into the San Juan River from Lake Powell. The proposed action is expected to result in a greater probability that Lake Powell elevations could be at or below 3,660 feet msl

(Appendix C, Figures BA-1 through BA-5) compared to baseline conditions. Accordingly, the waterfall could be established more often under the proposed action than under baseline conditions in the future, providing a minimal potential benefit to razorback sucker in the San Juan River upstream of Lake Powell. However, this same waterfall would prevent Razorback sucker that wash down into Lake Powell from moving back up into the San Juan River. Adults that are trapped this way could reside at the inflows, though juveniles are more likely to be eaten by striped bass and other piscivorous fish that reside in Lake Powell. However, juveniles that end up in Lake Powell when the waterfall is not present are also likely to be eaten. Therefore, the level of razorback sucker predation due to this waterfall that may be associated with the proposed action is expected to be the same as under baseline conditions. Consequently, compared to baseline conditions the proposed action may affect, but is not likely to adversely affect the razorback sucker.

The lower Lake Powell water levels under shortage conditions would increase the amount of riverine habitat in the Dirty Devil arm of Lake Powell and thus provide more suitable habitat for this species. The proposed action would result in Lake Powell lake levels that are up to 16 feet lower than under baseline conditions at the 50th percentile.

The proposed action could affect sediment transport, water temperature, and the potential range of hourly flows in designated critical habitat present from Glen Canyon Dam to Lake Mead. The proposed action could result in annual releases from Glen Canyon Dam of less than 8.23 mafy approximately 9.7 percent more frequently than under baseline conditions, which would reduce the transport of sand out of the river and into Lake Mead (as described in Section 3.3.6 of the BA for the Humpback Chub). During those times, sediment transport out of the river and into Lake Mead would be reduced (Table R-6). Annual release rates above the minimum objective release could occur with a frequency about 17 percent higher than under baseline conditions. These higher releases would transport more sediment out of the river. The probability of releases above 9 mafy (9.01 mafy to above 16 mafy) is very similar under baseline and the proposed action (differ by approximately 0.5 percent) and thus the effect on sediment transport would be very similar (Attachment C, Table BA-4). The effects of these changes in release rates on habitat suitability for razorback sucker are unknown.

Changes in release volumes also could increase water temperatures in the river when Lake Powell levels are low enough that warmer water would be released. Modeling results show that the increases would occur primarily at the 10th percentile lake levels and that the increase in average temperature would be about 1ºC in spring and summer (Attachment C, Tables BA-5 through BA-7). For the 50th percentile Lake Powell level, average water temperatures would change very little during most of the year with slightly colder temperatures in the fall. At the 90th percentile Lake Powell level, temperatures would be similar to baseline conditions. The slight warming in spring to summer would provide little or no benefit for razorback spawning because the time when suitable spawning temperatures are present would be changed very little (a few weeks at the most), but it could increase growth. The slightly warmer water temperature in the river near Lake Mead at the 10^{th} percentile level could result in some individual razorbacks moving from Lake Mead into the river upstream, at least during the spring to summer of those years when Lake Powell is at the 10th percentile elevation.

As described for the humpback chub above, average monthly water temperatures would be slightly lower for the proposed action than for the baseline from September through March under 50th percentile conditions near the confluence of the Little Colorado River and Diamond Creek (Attachment C, Tables BA-6 and BA-7). Temperatures under both the baseline and proposed action, however, would be below that required for growth of the razorback sucker (18 ºC) during all of these months, and the slightly lower temperatures under the proposed action would not adversely affect growth of this species.

Warmer water temperatures under the proposed action relative to baseline conditions also would have the potential to benefit nonnative fish species that compete with or prey upon razorback suckers by allowing earlier reproduction and increased growth in those years when such temperature increases occur. Furthermore, the small increase in average temperature in some years has a low potential to increase movement of nonnative species into the river from Lake Mead and from tributaries that provide inflow to the river in the years that such temperature increases occur (See discussion on Humpback Chub). Although many nonnative fish prey on native fish, the potentially increased number or feeding activity of nonnative fish would be unlikely to adversely affect the razorback suckers in this reach because the few that may be present are adults that would be too large for most nonnative fish to eat. Many species of non-native fish species are already present in this reach and the infrequent, slightly warmer temperatures are unlikely to increase their long-term abundance or species composition.

Warmer river temperatures could increase the potential for expansion of the Asian tapeworm (*Bothriocephalus acheilognathi*) and anchorworm (*Lernaea cyprinacea*) in the mainstream Colorado River in some years as described for the humpback chub. Under baseline conditions, these parasites are less likely to infect fish in the Colorado River because average water temperatures are less than optimal for these parasites. The potential for these parasites to infect fish increases when Glen Canyon Dam releases occur at low Lake Powell elevations (10th percentile or lower), and potential temperatures exceed 20 ºC. This could adversely affect the razorback sucker. The level of effect is unknown but expected to be negligible considering the low frequency of such occurrences and the small increase in average temperature that would occur as a result of the proposed action. Glen Canyon Dam releases made when Lake Powell water levels are at the higher 50th and 90th percentile elevations result in approximately the same to cooler downstream average river temperatures that are always below 20°C for the baseline and proposed action (Attachment C. Tables BA-5 through BA-7).

Reduced annual releases from Glen Canyon Dam under the proposed action could also result in a reduction in the potential range of the hourly maximum and minimum releases from Glen Canyon Dam. At the minimum objective release of 8.23 mafy, the range of potential hourly flows from Glen Canyon dam under baseline conditions is approximately 6,000 to 8,000 cfs with the wider range in July, August, December, and January (Attachment C, Tables BA-2 and BA-3). The potential hourly range at annual release rates of 7.48 mafy could be reduced by as much as 1,000 to 2,000 cfs in April and October through December. This lower potential flow range would be unlikely to occur under baseline conditions because there is a low probability (0.05 percent) of annual release of 7.48 mafy and would have an approximately 8 percent probability of occurring for the proposed action (Attachment C, Table BA-4). For release rates between 9.0 mafy and 16 mafy, the probability of such releases under baseline conditions, and the proposed action are very similar (Attachment C, Table BA-4). Therefore, the flow effects of annual releases above 9 mafy on daily flows is very similar under baseline conditions and the proposed action. Because the probability of annual releases above 9 mafy is very similar under baseline and the proposed action, and the frequency of the lower range of potential hourly flows when the annual release is lower than 8.23 mafy is low, effects on habitat that could be used b razorback sucker from changes to hourly flows would be negligible (Attachment C, Tables BA-2 through BA-4).

The possibility, therefore, of impacts on critical habitat resulting from the proposed action is not expected to appreciably diminish the value of critical habitat for razorback sucker conservation, affect the survival or recovery of the species, nor appreciably diminish the value of critical habitat for survival of the species.

R.3.3.8 Colorado Pikeminnow

Based on the analysis below, the proposed action may affect, but is not likely to adversely affect the Colorado pikeminnow.

Colorado pikeminnow can occur at the riverine inflow areas to Lake Powell but are considered rare here as indicated in Section 2.4.6 of this BA. Pikeminnow are extirpated from the Colorado River below Glen Canyon Dam and, as a result, the proposed action would not affect the species in this river reach. The species is also not present in the Virgin or Muddy Rivers.

In general, the lacustrine environment of Lake Powell is less than ideal habitat for Colorado pikeminnow. The proposed action may provide a minor benefit to pikeminnow upstream of Lake Powell because it is expected to result in a greater probability that Lake Powell elevations could be at or below 3,660 feet msl in the future than under baseline conditions (Attachment C, Figure BA-1). As indicated above, the waterfall on the San Juan River that can occur at lake levels below 3,660 feet msl, would block the upstream movement of non-native fish from Lake Powell. However, this waterfall also has the potential to block the upstream movement of pikeminnow out of Lake Powell and into the San Juan River. Any adults or juvenile pikeminnows washed into the lake would also be blocked from returning to the river when lake levels are low. Given the rarity of the species in Lake Powell, that the lake serves as less than ideal pikeminnow habitat, and that pikeminnow are similarly affected by Lake Powell conditions and non-native fish interactions when the San Juan waterfall is and is not present, take resulting from the proposed action is expected to be the same as under baseline conditions. Consequently, compared to baseline conditions the proposed action is not expected to result in take of Colorado pikeminnow.

Based on the above assessment, the changes in Lake Powell levels between the proposed action and baseline are also not expected to appreciably diminish the value of critical habitat for Colorado pikeminnow conservation, affect the survival or recovery of the species, nor appreciably diminish the value of critical habitat for survival of the species in the Dirty Devil and San Juan river areas in Lake Powell.

R.3.3.9 Bonytail

Based on the analysis below, the proposed action may affect, but is not likely to adversely affect the bonytail.

Bonytail can occur at the riverine inflow areas to Lake Powell but are considered rare here. Bonytail are presumed extirpated from the Colorado River below Glen Canyon Dam to Lake Mead, and thus, the proposed action would not affect the species in that river reach. Bonytail are not present in the Virgin or Muddy Rivers.

In general, the lacustrine environment of Lake Powell is less than ideal habitat for bonytail chub. Given the rarity of the species in Lake Powell and that the lake serves as less than ideal bonytail habitat, take resulting from the proposed action is expected to be the same as under baseline conditions.

R.3.3.10 Kanab Ambersnail

Based on the following analysis, there is potential for take of individual ambersnails and Reclamation has concluded the proposed action may affect and is likely to adversely affect the Kanab ambersnail.

The proposed action will have no effect on the water flow from the side canyon spring that maintains wetland and aquatic habitat at Vasey's paradise. Kanab ambersnail habitat can be adversely affected by scouring at Colorado River flows exceeding 17,000 cfs. As indicated above, the proposed action will allow Reclamation to release less than 8.23 maf/year under certain circumstances. In years where these lower annual releases occur, the typical hourly maximum flow from Glen Canyon Dam would be lower than would occur under the current minimum annual release of 8.23 (Attachment C, Table BA-3). These lower annual releases have a relatively low probability of occurring under the proposed action (about 0.68 percent for releases between 7.51 to 8.22 maf, 8.11 percent for releases between 7.01 to7.50 maf and 1.26 percent for releases less than or equal to 7.0 maf) (Attachment C, Table BA-4). These lower flows could allow wetland vegetation to establish lower down the canyon wall during some years. This could provide a temporary increase in Kanab ambersnail habitat, though such increase would be inundated and likely scoured in subsequent years with higher annual releases and corresponding higher hourly maximum flows. Consequently, the proposed action could result in take of the snail if the snail occupies new habitat that is created under the proposed action and then is subsequently inundated.

In certain months of the year, the average monthly flow could exceed 17,000 cfs and also be higher than baseline. These higher flows (90th percentile) would inundate a larger area of Kanab ambersnail habitat and are best illustrated in the April and May monthly release graphs (Attachment C, Figures BA-9 and BA-10). Conversely, the average monthly flows above 17,000 cfs in other months (e.g., June) are less frequent under the 90th percentile for the proposed action compared to the baseline condition (Attachment C, Figure BA-11). Consequently, the proposed action could result in some level of take greater than under baseline conditions in some months, but any increased incidence in take would not be expected to substantively affect the abundance or distribution of the snail.

R.3.4 Cumulative Effects

Cumulative effects are defined under ESA regulations as those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 C.F.R. §402.02). The action area from Lake Powell to Lake Mead is within the Glen Canyon National Recreation Area, Grand Canyon National Park, and Lake Mead National Recreation Area and is thus is largely under the control of the National Park Service. In addition, the action area includes the westernmost portion of the Navajo Indian Reservation and the northern boundary of the Hualapai Indian Reservation. While portions of these two reservations are within the action area, actions are likely to be subject to consultation through the Bureau of Indian Affairs, as well as the tribal governments. Consequently, it is assumed that activities that would occur in the future would be deemed Federal actions and fall outside the definition of actions causing potential cumulative effects.

R.3.5 Conclusions

Table R-8 on the following page provides the effects conclusions for the species listed in Table R-3. The findings are either "no effect," "may affect, not likely to adversely affect," or "may affect, is likely to adversely affect" and incorporate the conclusions reached in Attachment B where applicable.

Table R-8
Species Effects Conclusions

Common and Scientific Name	ESA Status[1]	No Effect	May Affect: Not Likely to Adversely Affect	May Affect: Likely to Adversely Affect	Will not Modify Designated Critical Habitat	May Modify Designated Critical Habitat[2]
Southwestern willow flycatcher *Empidonax trailii extimus*	E			X		X
Yellow-billed cuckoo *Coccyzus americanus*	C		X			
Yuma clapper rail *Rallus longirostris yumanensis*	E		X			
Moapa dace *Moapa coriacea*	E	X				
Woundfin *Plagopterus argentissimus*	E		X			X
Virgin River Chub *Gila robusta seminuda*	E		X			X
Bonytail *Gila elegans*	E		X			
Humpback chub *Gila cypha*	E			X		X
Razorback sucker *Xyrauchen texanus*	E		X			X
Colorado pikeminnow *Ptychocheilus lucius*	E		X			X
Kanab ambersnail *Oxyloma haydeni kanabensis*	E			X		

1 ESA Status:

E = Listed as endangered under the ESA.

C = Candidate species for listing under the ESA.

2 The effects are not expected to appreciable diminish the value of the critical habitat for species conservation.

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Attachment A

Existing ESA Coverage

This attachment to Appendix R is a description of coverage under the Lower Colorado River Multi Species Conservation Program Biological and Conference Opinion for the adoption of Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead.

A. Existing ESA Coverage

A.1 Introduction and Approach

The Bureau of Reclamation (Reclamation) proposes to adopt Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations of Lake Powell and Lake Mead (proposed action). The proposed interim guidelines would remain in effect for determinations to be made through 2026 and would provide guidance each year in development of the Annual Operating Plan for Colorado River Reservoirs (AOP).

A Draft Environmental Impact Statement (EIS) for the proposed action was distributed in February, 2007. After consideration of the comments received on the Draft EIS and further analysis[1], Reclamation has identified the operational elements that it intends to incorporate as the Preferred Alternative, herein after referred to as the proposed action, which will be analyzed in the Final EIS.

The four operational elements of the proposed action are the adoption of guidelines that would be used by the Secretary to:

1) Determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) below 7.5 million acre-feet (maf) (a ‘‘Shortage’’) pursuant to Article II(B)(3) of the United States Supreme Court Decree in the case of *Arizona v. California*, 547 U.S. 150 (2006)(Consolidated Decree);

2) Define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;

3) Allow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions; and

4) Determine those conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing Interim Surplus Guidelines (ISG), published in the *Federal Register* on January 25, 2001 (66 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026.

[1] The Draft EIS and comments are available at http://www.usbr.gov/lc/region/programs/strategies.html.

The ESA compliance for the proposed action is comprised of three distinct segments. This approach is being used because three geographical areas of impact are involved, with varying degrees and types of impacts. These geographical areas include:

1) Lake Powell and the Colorado River from Glen Canyon Dam to the upper end of Lake Mead (primarily related to operational element no. 2, coordinated reservoir operations). This segment is not addressed by this transmittal.

2) The full length of the Muddy River in Nevada, and the Virgin River from the Mesquite Diversion near Mesquite, Nevada, to Lake Mead (primarily related to operational element no. 3, storage and delivery mechanism). This segment is not addressed by this transmittal.

3) The Colorado River from Lake Mead to the Southerly International Boundary with Mexico (primarily related to operational element no. 1, shortage guidelines, operational element no. 2, coordinated reservoir operations, no. 3, storage and delivery mechanism, and operational element no. 4, ISG). These operational elements constitute "covered actions" within the Lower Colorado River Multi-Species Conservation Program (MSCP) and are encompassed within the boundaries of the MSCP planning area.

Each of the three segments of the consultation is prepared as a stand-alone analysis for ease of understanding.

A.2 Detailed Description of Proposed Action

The proposed action is Reclamation's adoption of Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations of Lake Powell and Lake Mead. The action is proposed in order to provide a greater degree of certainty to Colorado River water users and managers of the Colorado River Basin by providing more detailed objective guidelines for the operation of Lake Powell and Lake Mead, thereby allowing water users in the Lower Basin to know when, and by how much, water deliveries will be reduced during drought and other low reservoir conditions.

The proposed interim guidelines are anticipated to be promulgated in 2008 and would remain in effect for determinations to be made through 2026 and would provide guidance each year in development of the AOP. The interim period, 2008 through 2026, is the period of consultation for the potential effects of the proposed action. After the interim period the operations may revert to the AOP process that is described as the No Action Alternative in the EIS.

The proposed action considers four operational elements that collectively are designed to address the purpose and need for the proposed federal action. The interim guidelines would be used by the Secretary to:

- ♦ Determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River

Lower Division states below 7.5 maf (a ‘‘Shortage’’) pursuant to Article II(B)(3) of the Consolidated Decree;

- ♦ Define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;
- ♦ Allow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions; and
- ♦ Determine those conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing ISG, published in the *Federal Register* on January 25, 2001 (66 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026.

The proposed action includes a coordinated operation of Lake Powell and Lake Mead that would minimize shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin; and also provides a mechanism, called Intentionally Created Surplus (ICS), for promoting voluntary water conservation in the Lower Basin.

The formulation of the four operational elements for the proposed action follows:

1) **Shortage Guidelines.** The proposed action provides discrete levels of shortage associated with specific Lake Mead elevations as presented below. The shortages modeled under the proposed action are as follows:

    - When Lake Mead is projected to be below elevation 1,075 feet msl and at or above 1,050 feet msl on January 1, a shortage of 333 thousand acre-feet (kaf) shall be declared for that year;
    - When Lake Mead is projected to be below elevation 1,050 feet msl and at or above 1,025 feet msl on January 1, a shortage of 417 kaf shall be declared for that year;
    - When Lake Mead is projected to be below elevation 1,025 feet msl on January 1, a shortage of 500 kaf shall be declared for that year; and
    - When Lake Mead is below elevation 1,025 feet msl, the Secretary shall undertake appropriate consultation, including with the Basin States, to discuss further measures that may be undertaken consistent with the Law of the River.[2]

[2] The specific outcome of a consultation process to define additional shortages cannot be predicted; therefore, for modeling purposes it was assumed that shortages of 500 kaf would continue to be imposed at Lake Mead elevations below 1,025 feet msl.

The volumes of shortages are expressed as reductions to water users in the United States. However, modeling of the proposed action includes the assumption that Mexico would also incur water delivery reductions proportional to the reductions to United States users in the Lower Basin at the same Lake Mead elevations (equivalently expressed as a water delivery reduction to Mexico of 16.7 percent of the total shortage volume). As such, the total shortage volumes modeled under this alternative are 400, 500, and 600 kaf at elevations 1,075, 1,050, and 1,025 feet msl, respectively, and these reductions of water deliveries are assumed to be applied to the Lower Division states and Mexico.

2) **Coordinated Reservoir Operations.** Under the proposed action, the annual Lake Powell release is based on a volume of water in storage or corresponding elevation in Lake Powell and Lake Mead as described below.

- **Equalization.** The proposed action provides an elevation schedule (Table 1) that would be used in determining when equalization releases would be made.

Table 1
Lake Powell Equalization Elevations

Year	Reservoir Elevation (feet msl)
2008	3,636
2009	3,639
2010	3,642
2011	3,643
2012	3,645
2013	3,646
2014	3,648
2015	3,649
2016	3,651
2017	3,652
2018	3,654
2019	3,655
2020	3,657
2021	3,659
2022	3,660
2023	3,662
2024	3,663
2025	3,664
2026	3,666

When Lake Powell is at or above these specified elevations and when the volume of Lake Powell is projected to be greater than the volume of Lake Mead at the end of the water year, Lake Powell would release greater than 8.23 maf per year to equalize its volume with Lake Mead. Otherwise, 8.23 maf is released from Lake Powell.

- **Upper Elevation Balancing.** When Lake Powell is below the elevations stated in Table 1 and is projected to be at or above 3,575 feet msl at the end of the water year, a release in the amount of 8.23 maf from Lake Powell would be made if the projected elevation of Lake Mead is at or above 1,075 feet msl at the end of the water year. If the projected end of water year elevation of Lake Mead is below 1,075 feet msl, the volumes of Lake Mead and Lake Powell would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.0 maf and no less than 7.0 maf.

- **Mid-Elevation Releases.** When Lake Powell elevation is projected to be below 3,575 feet msl and at or above 3,525 feet msl at the end of the water year, a release in the amount of 7.48 maf would be made if the projected end of water year elevation of Lake Mead is at or above 1,025 feet msl. If the projected end of water year elevation of Lake Mead is below 1,025 feet msl, a release of 8.23 maf from Lake Powell would be made.

- **Lower Elevation Balancing.** When the projected end of water year elevation of Lake Powell is below 3,525 feet msl, Lake Mead and Lake Powell would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.5 maf and no less than 7.0 maf.

3) **Storage and Delivery of Conserved Water.** The proposed action includes the adoption of a mechanism (ICS) to encourage and account for augmentation and conservation of water supplies, e.g., fallowing of land, canal lining, system efficiency improvements, and tributary conservation (retirement of pre-Boulder Canyon Project Act of 1929 water rights on the Virgin and Muddy rivers). The ICS mechanism provides for creating credits for the conserved or imported water and delivering the water at a later date.

   The analysis of potential effects in this assessment includes a maximum cumulative amount of ICS credits that would be available at any one time of up to 4.2 maf. However, it is anticipated that the ICS mechanism will be initially implemented to allow a maximum cumulative amount of ICS credits of up to 2.1 maf.

   The volumes of ICS activity that are assumed for each state and other entities (shown as “Additional Amounts”) are presented in Table 2. At this time, it is unknown exactly which entities might participate in the ICS mechanism. Furthermore, the timing and magnitude of the conservation and subsequent delivery of conserved water is unknown. In order to analyze the maximum effects of the mechanism to reservoir storage and river flows below Lake Mead, it was assumed that conservation would originate from a point on the river within each state located furthest downstream with respect to ICS activities within that state. Similarly, conservation within the Additional Amounts category was assumed to originate in Mexico in order to disclose the maximum effects of the mechanism to reservoir storage and river flows below Lake Mead.[3]

In addition to increasing the flexibility of meeting water use needs from Lake Mead, the ICS mechanism would benefit the system through Lake Mead storage credits. At the time the ICS credits are created, five percent of the ICS credits would be dedicated to the system on a one-time basis. Additionally, ICS credits would be subject to annual evaporation losses of three percent per year. If flood control releases occur, ICS credits would be reduced on a pro-rata basis among all holders of ICS credits until no credits remain.

Under the assumptions made for the analysis contained herein, the maximum amount of ICS credits that can be created during any year, the maximum cumulative amount of ICS credits that can be available at any one time, and the maximum amount of ICS credits that may be recovered in any one year under the proposed action are presented in Table 2.

Table 2
Proposed Action Alternative Volume Limitations of Storage and Delivery Mechanism

Entity	Maximum Annual Storage of Conserved System or Non-system Water (kaf)	Maximum Total Storage of Conserved System or Non-system Water (kaf)	Maximum Annual Delivery of Conserved System or Non-system Water (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Total[1]	625	2,100	1,000
Additional Amounts	625	2,100	1,000
Total[2]	1,250	4,200	2,000

1 It is anticipated that the ICS mechanism will be implemented to allow a maximum cumulative amount of ICS credits that would be available at any one time of up to 2.1 maf.

2 The analysis of potential effects includes a maximum cumulative amount of ICS credits that would be available at any one time of up to 4.2 maf.

4) **Interim Surplus Guidelines.** The proposed action includes both a modification and an extension of the existing ISG currently in place through 2016. The ISG would be extended through 2026 and be modified by eliminating the Partial Domestic Surplus Condition, beginning in 2008, and limiting the amount of water available under the Full

[3] Notwithstanding the lack of an existing mechanism to implement such modeling assumptions, Reclamation utilized these assumptions for a number of reasons, including the following: (1) a larger volume of potential storage in Lake Mead is identified, (2) the maximum potential impacts on river flows below Hoover Dam are identified, (3) the arbitrary assignment of water conservation amounts to entities in the Lower Basin states is avoided, and (4) the modeling impacts of a program of potential future cooperation between the United States and Mexico are identified.

Domestic Surplus Condition during the period 2017 through 2026.[4] These modifications reduce the amount of surplus water that could be made available and leaves more water in storage to reduce the frequency and severity of future shortages.

A.3 The Lower Colorado River Multi Species Conservation Program

The MSCP is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the lower Colorado River.

As stated above, the MSCP planning area comprises areas up to and including the full pool elevations of lakes Mead, Mohave, and Havasu and the historical floodplain of the Colorado River from Lake Mead to the Southerly International Boundary. This includes a distance of about 400 river miles. The historical flood plain is defined as all lands that are or have been affected by the meandering or regulated flows of the Colorado River, which historically have been defined by the change in elevation that forms the adjoining uplands (see Figure 1).

Consultation under Section 7 of the ESA has been completed for the MSCP covered actions and activities. During the planning phase for the MSCP, Reclamation included in the covered actions a set of assumptions for future shortage criteria and the extension of the ISG as part of the effects modeling for the project area. These assumptions provided for future coverage of the proposed action under the MSCP if the specific features of the proposed action fell within the assumptions included in the MSCP analysis. The MSCP Final Biological Assessment (BA) was completed on December 17, 2004. The Biological and Conference Opinion on the Lower Colorado River Multi-Species Conservation Program, Arizona, California, and Nevada (BCO) was completed on March 4, 2005. The BCO determined that, with the ranges analyzed in the BA, proposed future federal actions including the adoption of shortage criteria, the extension of the ISG, and changes to points of diversion (i.e., due to water transfers and other activities) are not likely to jeopardize the continued existence of listed, candidate, or other covered species, and are not likely to destroy or adversely modify designated or proposed critical habitat.

A complete description including program documents cited in this Attachment, and current status of the MSCP are available at http://www.lcrmscp.gov/.

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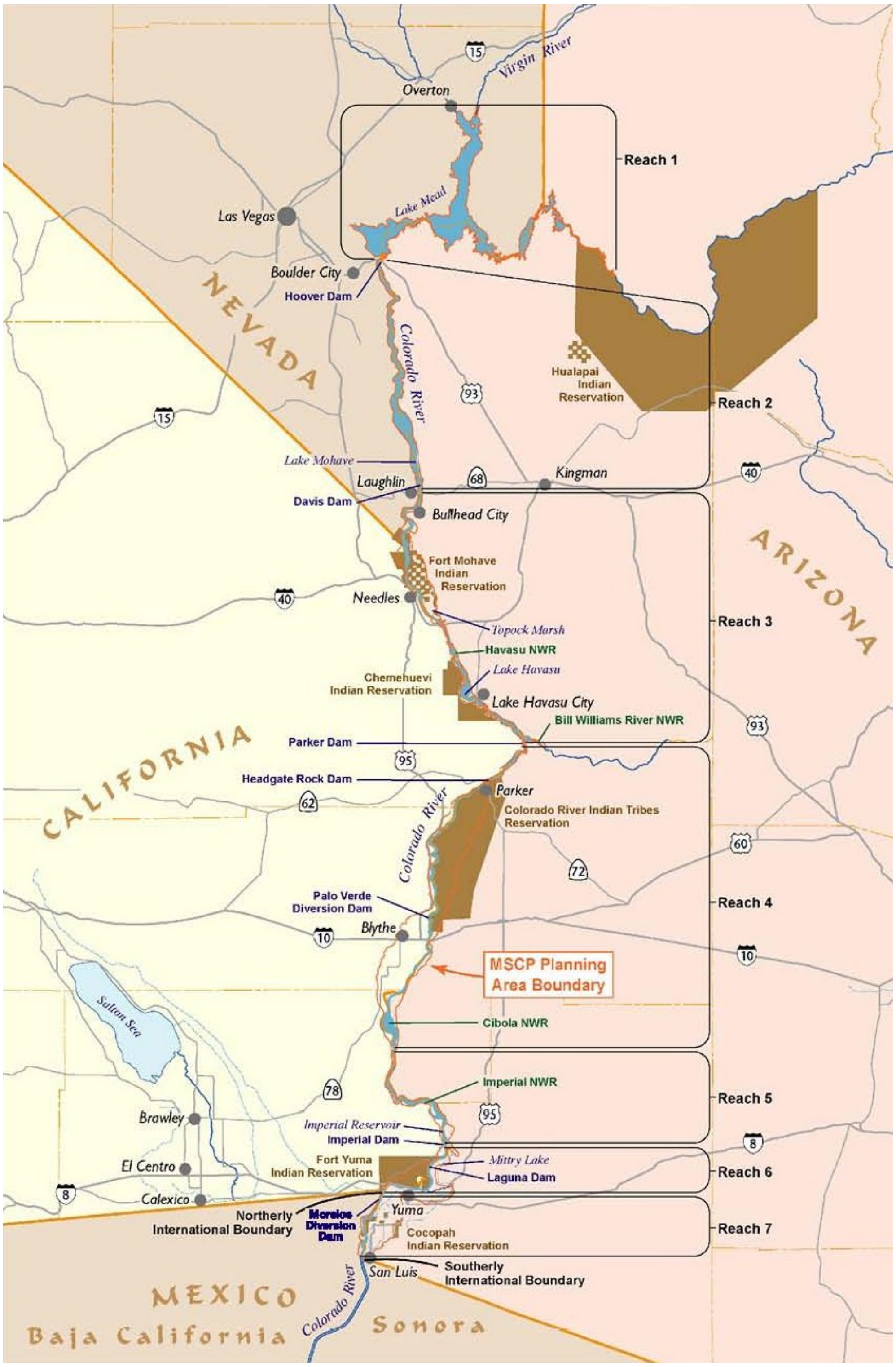
[4] During 2017 through 2026, the distribution of Domestic Surplus water would be limited as follows: 1) for use by MWD, 250 kafy in addition to the amount of California's basic apportionment available to MWD; 2) for use by SNWA, 100 kafy in addition to the amount of Nevada's basic apportionment available to SNWA; and 3) for use in Arizona, 100 kafy in addition to the amount of Arizona's basic apportionment available to Arizona contractors.

Figure 1
Lower Colorado River MSCP Planning Area and River Reaches



A.4 Existing MSCP Coverage for the Following Identified Elements of the Proposed Action

The flow-related, future federal actions covered under the MSCP include activities that could result in reductions in flows from Hoover Dam to Imperial Dam, changes in reservoir operations of Lake Mead including shortage and surplus determinations, and changes in flows in excess of Mexico's water order reaching Morelos Diversion Dam. Existing coverage of the potential effects on species within the MSCP planning area boundary of the proposed action is determined by comparison with the range of operations analyzed in the MSCP BA and BCO as well as the other relevant MSCP program documents. All modeling assumptions used in the following comparisons for both the proposed action and the No Action Alternative are fully described in Section 4.2 and Appendix A of the Final EIS.

A.4.1 Reductions in Flow

Flow related impacts covered under the MSCP included the impacts of flow reductions below Hoover Dam to Davis Dam (Reach 2, Figure 1) of up to 845 kaf per year (kafy), below Davis Dam to Parker Dam (Reach 3, Figure 1) of up to 860 kafy, and flow reductions of up to 1.574 maf per year below Parker Dam to Imperial Dam (Reach 4 and 5, Figure 1). For the proposed action, changes in points of diversion due to conservation activities (i.e., the creation of ICS credits) and shortage conditions would contribute to potential flow reductions.

Figures 2, 3, and 4 display the probability of flow reductions for Reaches 2, 3, 4, and 5 for the duration of the proposed action. For comparison purposes, the results for the No Action Alternative used in the Final EIS are also shown. These figures show that the proposed action will not exceed the flow reductions analyzed and are within the range of the reductions anticipated under the MSCP.

Flow reductions result in lower water surface elevations in the main channel of the river and its associated backwaters. The reduced water surface elevations also result in lower groundwater levels. The river stage along the river is correlated directly with discharge.

Therefore, because the discharge below each of the dams is not expected to be reduced below that which the MSCP has coverage, the range of effects resulting from the proposed action is covered by the MSCP BCO.

Figure 2
Hoover to Davis Reach Reductions
Comparison of Preferred Alternative to No Action Alternative
Percent of Values Greater than or Equal to 845 kaf

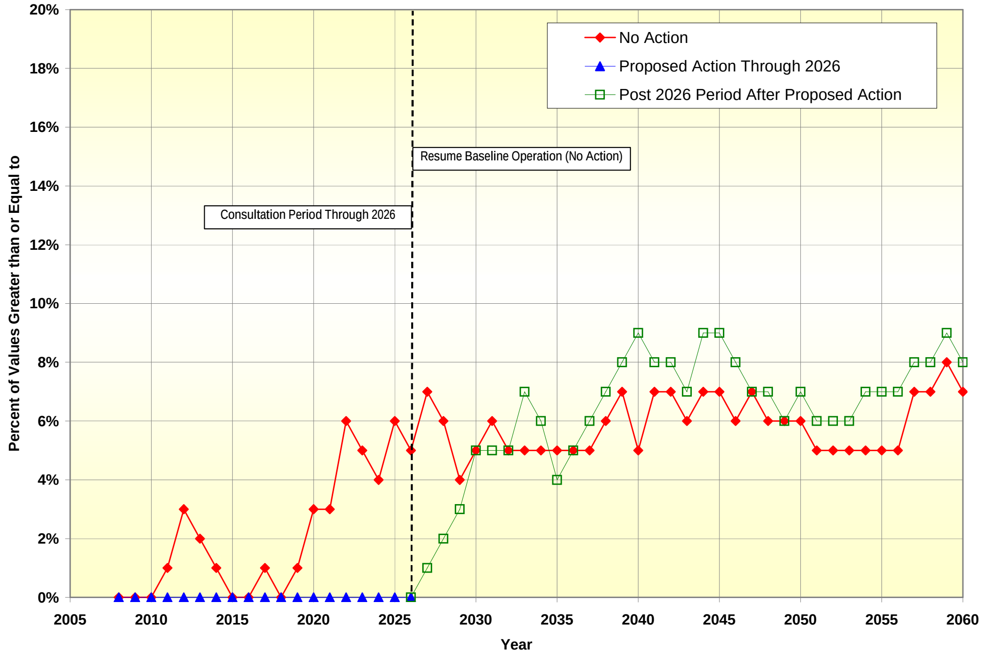


Figure 3
June 2007 24-Month Study Initial Conditions Davis to Parker Reach Reductions
Comparison of Preferred Alternative to No Action Alternative
Percent of Values Greater than or Equal to 860 kaf

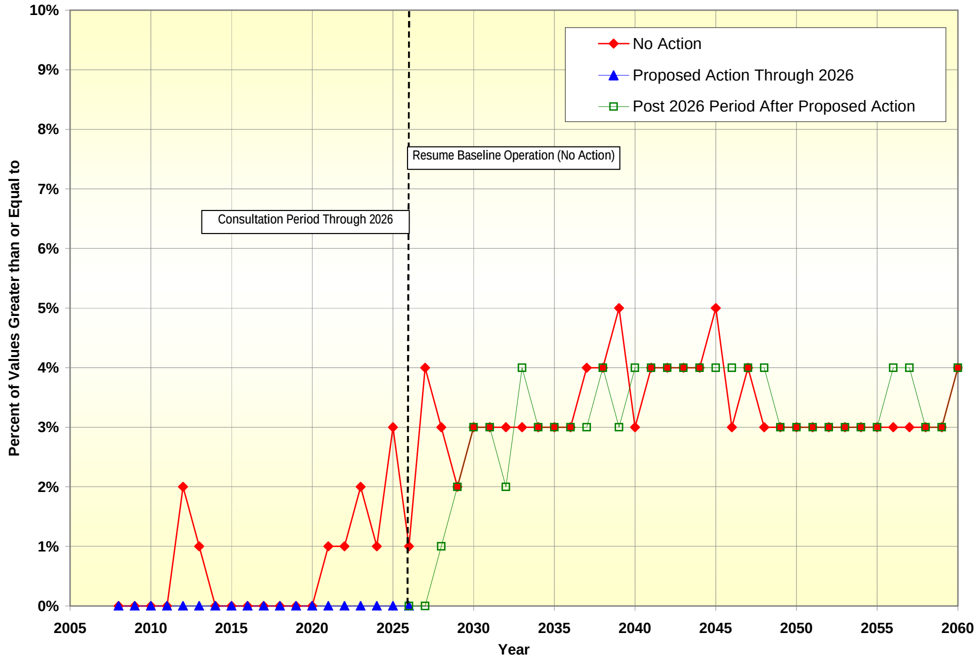
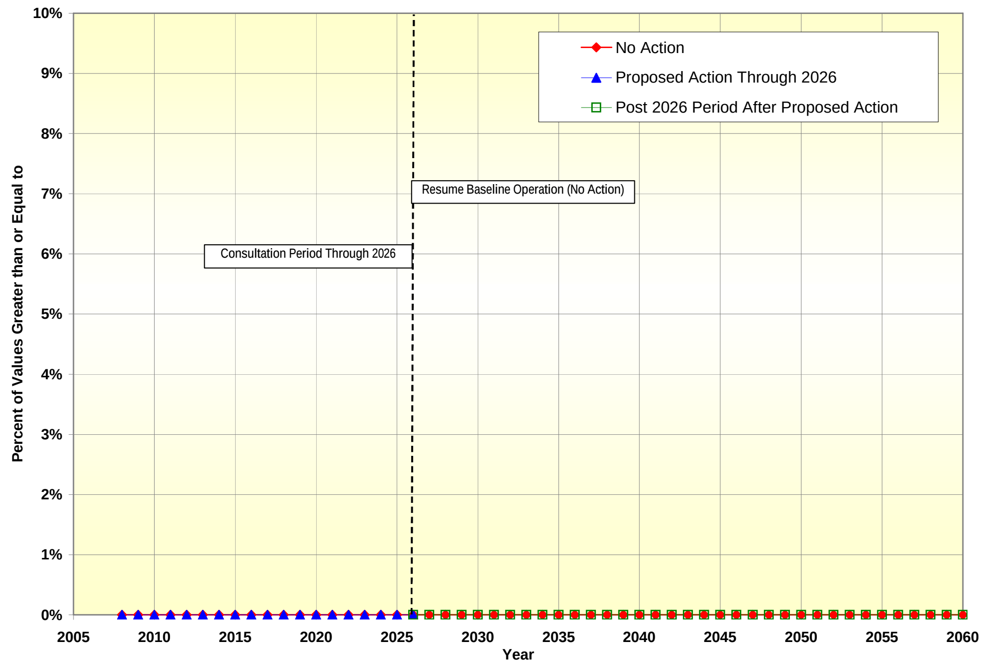


Figure 4
Parker to Imperial Reach Reductions
Comparison of Preferred Alternative to No Action Alternative
Percent of Values Greater than or Equal to 1574 kaf



A.4.2 Reservoir Operations

The proposed action includes the imposition of discrete levels of shortage volumes associated with Lake Mead reservoir elevations and extending and modifying the ISG through 2026, the effects of which were analyzed in and accordingly are covered by the MSCP BCO and described below.

The MSCP analysis assumed that under a first level shortage, elevation 1,050 msl would be protected with an approximate 80 percent probability. In a given year, a shortage that ranges from approximately 350 to 500 kaf would be imposed when the projected January 1 Lake Mead elevation is below a trigger elevation for that year. Under a second level shortage, shortages would be imposed by amounts required to maintain the Lake Mead water elevation at or above 950 feet msl. In comparison, the proposed action includes shortage reductions to United States water users of 333, 417, and 500 kaf imposed at elevations 1,075, 1,050, and 1,025 feet msl, respectively. Additionally, the modeling assumed a 500 kaf shortage to United States users was imposed at or below elevation 1,025 feet msl. As previously mentioned, modeling of the proposed action includes the assumption that Mexico would also incur water delivery reductions proportional to reductions to Untied States users at the same Lake Mead elevations, resulting in total water delivery reductions of 400, 500, and 600 kaf at elevations 1,075, 1,050, and 1,025 feet msl, respectively.

The MSCP analyzed and covered the extension of the ISG through 2051. Since the proposed Lower Basin shortage guidelines are anticipated to be implemented through 2026, extending the ISG establishes an operational strategy for the full range of reservoir operations - high and low - at Lake Mead. It should also be noted that the extended ISG have been modified by eliminating the Partial Domestic Surplus Condition in 2008 and limiting the amount of water available under a Full Domestic Surplus Condition during the period 2017 through 2026. These modifications reduce the amount of surplus water that could be made available and leaves more water in storage to reduce the frequency and severity of future shortages.

Although the proposed action proposes reductions in deliveries based on specific reservoir elevations (as compared to the assumptions in the MSCP analysis that assume absolute protection of elevation 950 feet msl), analysis of the proposed action shows that Lake Mead elevations are within the range of effects analyzed in the MSCP BCO. Figure 5 shows the probability of Lake Mead elevations less than 1,050 feet msl during the interim period. Figure 6 shows the probability that Lake Mead elevation will be less than 950 feet msl during the interim period. For comparison purposes, the No Action Alternative from the Final EIS has been displayed in Figures 5 and 6.

Figure 5
Lake Mead End-of-December Water Elevations
Percent of Values Less than or Equal to Elevation 1,050 feet msl

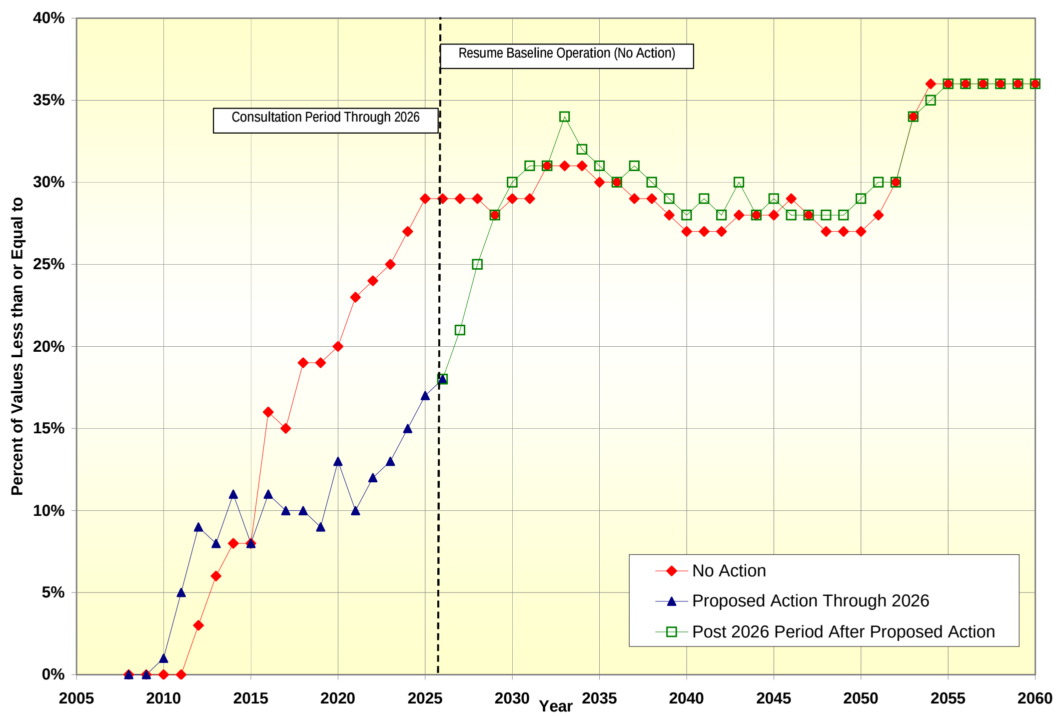
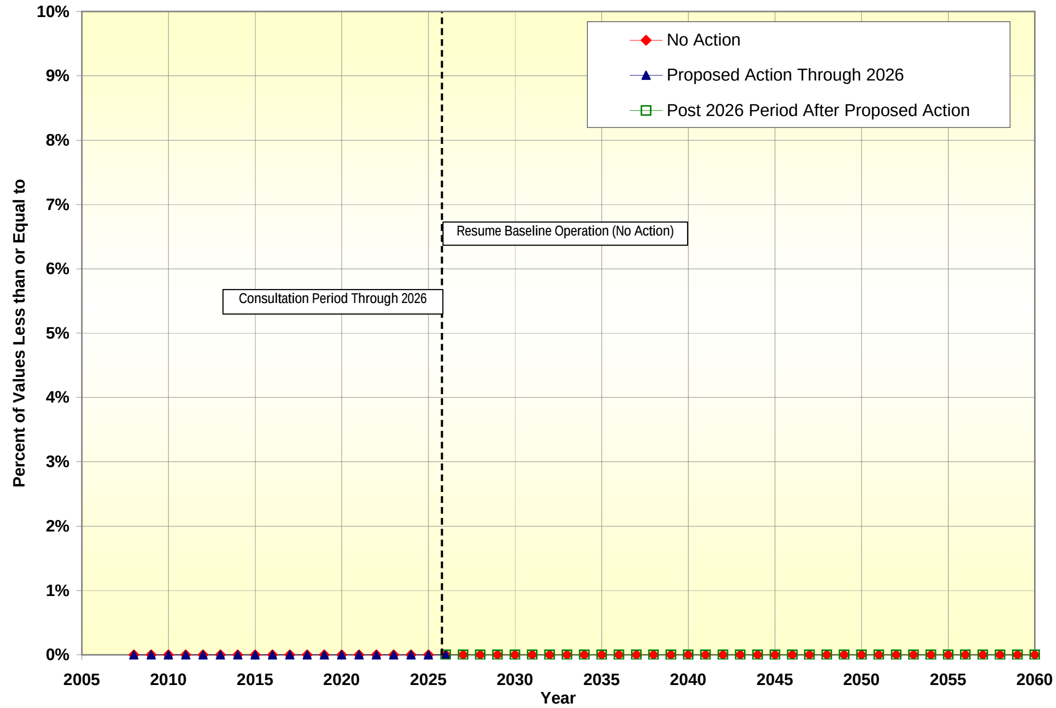


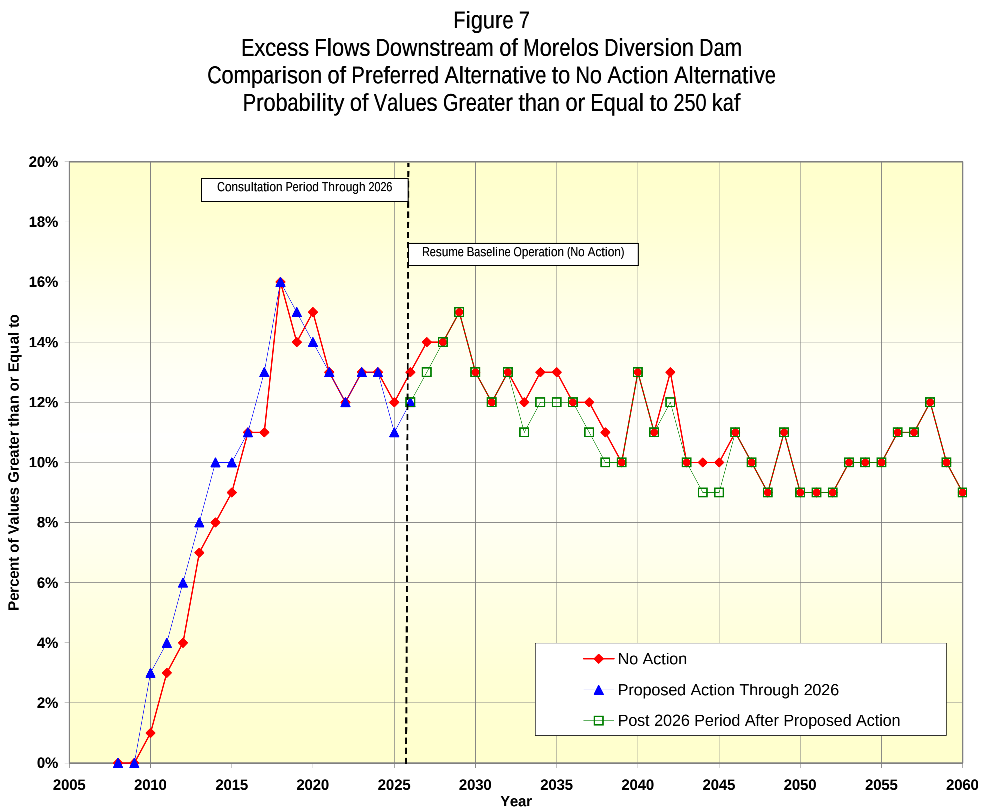
Figure 6
Lake Mead End-of-December Water Elevations
Percent of Values Less than or Equal to Elevation 950 feet msl



A.4.3 Effects of Proposed Action on Beneficial Flows past Morelos Diversion Dam - Limitrophe Reach

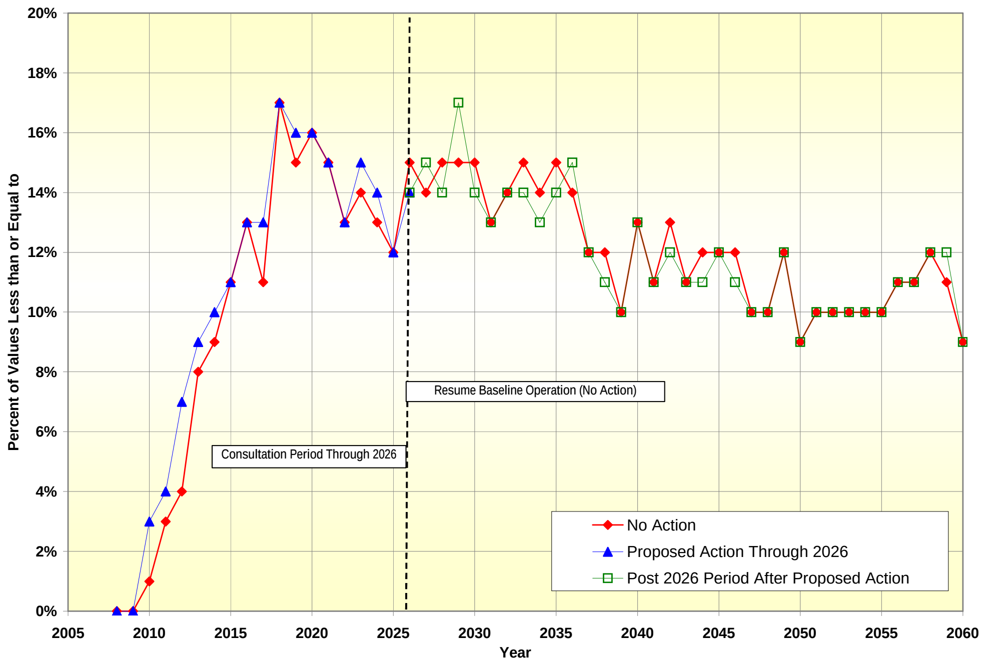
The MSCP BCO included the effects of the covered actions and activities on beneficial flows arriving at Morelos Diversion Dam.

Beneficial flows were defined as flows exceeding 250 kafy in excess of Mexico's water order arriving at Morelos Diversion Dam (MSCP Appendix L). Other ongoing activities including the proposed lower Colorado River Drop 2 Storage Reservoir Project and the Laguna Reservoir Restoration Project would not affect flows arriving at Morelos Diversion Dam exceeding 250 kafy. The MSCP analysis determined that there would be no significant effects on beneficial flows below Morelos Diversion Dam as a result of MSCP covered actions and activities. Figure 7 presents a comparison of the probability of beneficial flows exceeding 250 kafy for the No Action Alternative and the proposed action. Under the proposed action there is a slight increase in probability of beneficial flows over the consultation period (Figure 7) as compared to the No Action Alternative from the Final EIS due primarily to the conservation element of the proposed action. However, this increase is not deemed to be a significant change in the probability of these beneficial flows.



The probabilities of any excess flows of any magnitude arriving at Morelos Diversion Dam were also analyzed. These probabilities showed the same trend in flows of greater than 250 kafy arriving at Morelos Diversion Dam in excess of Mexico's water order (Figure 8).

Figure 8
Excess Flows Downstream of Morelos Diversion Dam
Comparison of Preferred Alternative to No Action Alternative
Probability of Occurrence



It is noted that with the exception of extremely high mainstream Colorado River flows from 1983 to 1985, the beneficial flows arriving at Morelos Diversion Dam since the 1970s have largely been a result of Gila River flows. Gila River flows are unaffected by the proposed action. Tributary inflows from the Gila River to the mainstream are very sporadic, occur very seldom, and when they do, are typically of high magnitude. These flows were not included in the analysis of excess flows arriving at Morelos Diversion Dam prepared for the MSCP or in the analysis presented herein. Therefore, the timing and benefits from those flows reaching Morelos Diversion Dam are not considered in this analysis.

A.5 Conclusion

The MSCP BCO stated, “At the time the shortage guidelines are adopted, Reclamation will complete an analysis to determine if the effects are within the range of effects analyzed in the BA. If they are not, additional consultation may be required.” Based on the analysis herein, Reclamation concludes that the potential effects of the proposed action that fall within the MSCP BCO planning area boundary were covered in the previous consultation for the MSCP, and no significant new information exists that would require additional consultation for the proposed action.

Attachment B

Evaluation of Interrelated/Interdependent Effects of Tributary Conservation Intentionally Created Surplus Projects

This attachment to Appendix R describes the analysis of the effects of the interrelated/interdependent action of Southern Nevada Water Authority's proposed Virgin River and Muddy River tributary conservation Intentionally Created Surplus (ICS) projects.

B. Evaluation of Interrelated/Interdependent Effects of Tributary Conservation Intentionally Created Surplus Projects

B.1 Overview

Between 2000 and 2007, the Colorado River experienced the worst drought in approximately 100 years of recorded history. Currently, the Bureau of Reclamation (Reclamation) does not have specific guidelines to address the operation of Lake Powell and Lake Mead under drought and low reservoir conditions. To address this situation, the Secretary of the Interior (Secretary), acting through Reclamation, proposes to adopt interim Colorado River guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead (proposed federal action). The federal action is proposed in order to provide a greater degree of certainty to Colorado River water users and managers of the Colorado River Basin by providing more detailed objective guidelines for the operation of Lake Powell and Lake Mead, thereby allowing water users in the Lower Basin to know when, and by how much, water deliveries will be reduced during drought and other low reservoir conditions.

The Preferred Alternative, the proposed federal action, identified during development of the Environmental Impact Statement (EIS) includes the adoption of a mechanism to encourage and account for augmentation and conservation of water supplies, e.g., fallowing of land, canal lining and other system efficiency improvements, and introduction of tributary and non-system water in the Lower Basin. The mechanism, referred to as Intentionally Created Surplus (ICS), provides for creating credits for the conserved or imported water and delivering the water at a later date. Tributary conservation is a form of ICS where water rights on Colorado River tributaries within the Lower Basin that have been used for a significant period of years and were created prior to Congress' adoption of the Boulder Canyon Project Act of 1929 (BCPA) could be retired and allowed to flow into the Colorado River mainstream. The Lower Division state or contractor that provides such tributary conservation ICS could then recover the amount of water contributed through tributary conservation ICS for municipal or industrial purposes. Additional modeling details of the ICS mechanism are described in the main body of this Biological Assessment (BA) to which this analysis is attached.

B.1.1 Proposed Action

The proposed federal action to be analyzed in the BA is the adoption and implementation of interim Colorado River guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead. One of the components of the proposed federal action is the adoption of guidelines for creating and delivering conserved Colorado River system and non-system water in Lake Mead, referred to as ICS. The Southern Nevada Water Authority (SNWA) has proposed a project which would be implemented under this component of the proposed federal action. The SNWA proposal would allow pre-BCPA water rights on the Virgin and Muddy Rivers to be retired from their current use and would cause the water secured by SNWA through this process to flow into Lake Mead for crediting and delivery for municipal and industrial purposes. The SNWA proposal is interrelated/interdependent with the proposed federal adoption of ICS component element of the interim guidelines. Without the proposed federal action, the SNWA proposal for tributary conservation ICS would not go forward as described herein. Specifically, this section of the BA analyzes the interdependent/interrelated effects of the SNWA proposal.

B.1.2 Scope

B.1.2.1 Action Area

The entire action area for the SNWA proposal includes the channel of the Lower Virgin River and its floodplains and the channel of the Muddy River and its floodplains. The action area in the Lower Virgin River extends from the Nevada/Arizona border, to the confluence of Lake Mead (Figure 1). The action area in the Muddy River begins south of the headwaters at Warm Springs and extends to the confluence of Lake Mead (Figure 2).

B.1.2.2 Scope of Biological Assessment

This section of the BA analyzes the potential effects in the action area of allowing water rights perfected before the effective date of the BCPA to flow down through irrigation company systems and/or the channels and floodplains of the Lower Virgin River and Muddy River to Lake Mead. This portion of the BA does not analyze the potential effects of flow from the Virgin and Muddy Rivers after it enters Lake Mead. Those effects have been analyzed and addressed as part of the Lower Colorado River Multi-Species Conservation Program (MSCP) (USBR 2004a:2-18). Further, the effects of the Lower Basin shortage guidelines and coordinated operations of Lakes Powell and Mead (Lake Powell to Lake Mead) are analyzed in a separate BA to which this analysis is attached.

B.2 Project Description

Water rights on the Virgin and Muddy Rivers that were perfected prior to the effective date of the BCPA (1929) are not subject to provisions in the BCPA and have priority over any water rights appropriated on the Virgin and Muddy Rivers after 1929. The SNWA has been purchasing pre-BCPA water rights on the Virgin and Muddy Rivers since 1997, in an effort to reduce SNWA’s dependence on the Colorado River and develop additional water supplies for Southern Nevada. Water rights historically used for agriculture along these rivers are being voluntarily sold or leased to willing buyers, including buyers not associated with SNWA. Sometimes the water rights are leased back for agricultural use with a provision that at the end of the lease term, the water rights will be retired and allowed to return to the river system. SNWA's purchase and retirement of pre-BCPA water rights will allow for assured flows within the entire Muddy River and the portion of the Virgin River below the Mesquite and Bunkerville Irrigation Companies by using flows that were historically consumptively used off channel by agriculture for the creation of tributary conservation ICS.

Pre-BCPA water rights on the Virgin River have a priority date of pre-1905 and were decreed by the Nevada Supreme Court in 1927. The decree allocated 17,785 acre-feet per year (afy) to the

Bunkerville and Mesquite Irrigation Companies. SNWA currently owns shares in the Bunkerville Irrigation Company representing approximately 3,700 afy of surface water rights. On the Muddy River, water rights were decreed in 1920 and that decree allocated the entire flow of the Muddy River. On the Lower Muddy River, the entire flow of the river is diverted by the Muddy Valley Irrigation Company (MVIC) for agricultural use. SNWA currently owns shares in the MVIC representing approximately 7,000 afy of surface water rights and leases approximately 1,000 afy from the LDS Church. The LDS Church lease is for a term of 20 years, with the option to renew the lease for an additional 20 years.

SNWA anticipates acquiring a total of approximately 30,000 afy of pre-BCPA water rights from entities with rights on the Virgin and Muddy Rivers. Approximately one-third of this amount is expected to come from the Virgin River and two-thirds from the Muddy River. This is consistent with the flow volumes that were analyzed in the Final EIS for the shortage and coordinated reservoir operations guidelines and in the analysis for Lake Mead for the MSCP.

As of July 1, 2007, SNWA has acquired water rights from Virgin and Muddy River sources that will yield an average annual water supply of approximately 11,700 afy. The anticipated method of conveying these water supplies through the Virgin and Muddy Rivers to the Overton Arm of Lake Mead is described in Table 1 below. It is anticipated that the additional water supplies to be secured by SNWA (the remainder of the 30,000 afy analyzed here) will be conveyed through the Virgin and Muddy Rivers, via the Overton Arm to Lake Mead through a similar process. SNWA will pursue acquiring water rights on both the Upper Muddy River and on the Lower Muddy River from MVIC; however it is much more likely that the remaining acquisitions on the Muddy River will be from MVIC shareholders. It is unknown at this time from exactly which sources on the Virgin River SNWA will acquire these additional water supplies.

The retired agricultural water rights will be conveyed to Lake Mead via the Overton Arm in one of two fashions. The water will be diverted from the river through its historic point of diversion, flow through irrigation company ditches, and return to the mainstem of the river further downstream if the flow is necessary in the irrigation company ditches to avoid impacts to the irrigation company's operations or wildlife, such as southwestern willow flycatcher and other bird species that may rely on agricultural returns to support their habitat. This is the proposed operation for waters thus far acquired in the Bunkerville Irrigation Company and MVIC. Alternatively, if the water is not associated with an irrigation company or not required for the purposes described above, it will remain in the mainstem of the river. The conveyance of SNWA's water rights can be flexible, based on the irrigation company operating requirements and wildlife needs. To accommodate these needs, the water rights may be diverted at different places or during different times of the year.

Table 1
Example of Conveyance of Tributary Conservation ICS from Virgin and Muddy Rivers to Lake Mead

River	Irrigation Company/Water Right Holder	SNWA's current ownership/leases (approximate values in afy)[a]	SNWA's potential range of acquisitions (approximate values in afy)[b]	SNWA's total future potential ownership/leases (approximate values in afy)[c]	Method of Conveyance
Virgin	Mesquite Irrigation Company	0	0-3,000	Up to 3,000	Remain in river at historic point of diversion
Virgin	Bunkerville Irrigation Company	3,700	4,300 - 6,300	Up to 10,000	Diverted at the historic point of diversion and flow through irrigation company ditches before returning to the river further downstream
Muddy	MVIC	7,000	8,500 - 12,000	Up to 20,000	Diverted at the historic point of diversion and flow through irrigation company ditches before returning to the river further downstream
Muddy	LDS Church Lease	1,000	0 – 1,000	Up to 2,000	Remain in river at the historic point of diversion
Muddy	Other Users	0	0 – 2,500	Up to 2,500	Remain in river at the historic point of diversion

a – Based on conveyance of 11,700 afy water supply secured as of June 1, 2007

b – Based on future potential conveyance of additional 18,300 afy water supply

c - In aggregate supplies will not exceed 30,000 afy however, it is difficult to predict how much water will be purchased from the separate right holder

B.3 Environmental Baseline

B.3.1 Geology and Soils

The project action area is within the Colorado River Regional Flow System (CRRFS) within the southern Great Basin, a sub-province of the Basin and Range Physiographic Province. Land surface elevations in this part of the basin range between approximately 500 feet above mean sea level in the vicinity of Laughlin to approximately 11,900 feet above mean sea level at Charleston Peak in the Spring Mountains. Mountain ranges in this region generally follow northwest southeast trends and the basins are filled with valley-fill sediments, including some volcanic deposits. There are 27 hydrographic areas within the CRRFS. Of these twenty-seven hydrographic areas, five occur within the proposed action area. They are the Lower Meadow Valley Wash, Muddy River Springs Area, California Wash, Lower Moapa Valley (includes the Muddy river), and Virgin River Valley (includes the Virgin River). Other characteristics of the CRRFS include minimal precipitation, intermittent streams, large internal surface drainages, and sparsely distributed springs (BLM 1998).

The CRRFS is located in the southern part of the Great Basin and has an area of about 12,376 square miles (BLM 1998). The region includes part of Clark, Lincoln, Nye and White Pine counties and extends to the south to California, borders the Colorado River to the south and east and extends into the state of Arizona and Utah to the east.

Several periods of regional deposition, uplift, igneous activity and erosion have occurred since the Paleozoic. Thick sequences of marine sedimentary deposits accumulated throughout Paleozoic and Mesozoic times. Approximately 50 million years ago, thick volcanic materials extruded over broad areas of the region, then were uplifted and deformed by faulting.

Soils in the area of the proposed project are classified as "Shallow-Moderately Deep Rocky Gravelly Coarse Textured, Badlands, Shallow-Deep Medium Gravelly Textured, and Shallow-Very Shallow Gravelly Coarse Textured."

B.3.2 Hydrology

B.3.2.1 Lower Virgin River

The Virgin River occupies a 6,000 square mile watershed situated between the Colorado Plateau, the Great Basin, and the Mojave Desert, within the states of Nevada, Arizona, and Utah. The Virgin River is tributary to the Colorado River and discharges to Lake Mead approximately 60 miles upstream of Hoover Dam. The river begins in Washington County, Utah, at an elevation of approximately 10,000 feet above mean sea level (AMSL), some 150 miles from its mouth.

Flows in the Virgin River are principally influenced by snowmelt in the mountains in southwestern Utah and flooding from summer monsoonal storms. The Littlefield gage is located upstream of the Bunkerville and Mesquite Irrigation Companies. Gage flows are highly variable as seen in Table 2. A maximum discharge of 36,500 cubic feet per second (cfs) was recorded in 2005 and a minimum daily flow of 40 cfs was recorded in 1966. Currently, there is no operational gage below the Bunkerville and Mesquite diversions and their respective agricultural return flows. However, the Halfway Wash Gage was operated from 1977 to 1983 and in 1985. The gage record for this site was reconstructed by Bache et al. in 2006 and shows an annual average flow of 144,800 afy. This is approximately 30,000 afy lower than the flow at the Littlefield Gage (see Table 2).

B.3.2.2 Muddy River

The Muddy River watershed is located in Nevada, immediately northeast of the Las Vegas Valley. The Muddy River discharges to Lake Mead approximately 60 miles upstream of Hoover Dam. Before the construction of the dam and the subsequent flooding of the Colorado and Virgin River Valleys, the Muddy River discharged to the Virgin River, upstream of the confluence of the Virgin and Colorado Rivers.

The highest point in the watershed is Hayford Peak at elevation 9,912 ft AMSL in the Desert National Wildlife Refuge, north of the Las Vegas Valley. The headwaters of the Muddy River's longest tributary are in Lincoln County, at an elevation of approximately 7,300 ft AMSL near the Utah border, nearly 100 miles upstream of Lake Mead. The watershed includes the Pahranagat Valley near Alamo. The Pahranagat Wash flows through the Pahranagat Valley and southward into Coyote Spring Valley, where it joins the Muddy River. The Muddy River continues to the southeast, passing through Arrow Canyon, before it heads southeast, emerging into the Moapa Valley. In its lower reach, the Muddy River passes the towns of Moapa, Glendale (at Interstate-15), Logandale, Glassand, and Overton before discharging to Lake Mead. Glendale is located about 4 miles upstream of the existing Bowman Reservoir, a 4,000 acre-feet surface storage reservoir. Several washes contribute flow to the River along its course, the largest of which is Lower Meadow Valley Wash. Lower Meadow Valley wash joins the river near the intersection of the river and Interstate-15 in Glendale.

Irrigated agriculture is practiced along the flood plain of the lower Muddy River near Moapa and further downstream between Logandale and Overton.

Unlike the Virgin River, which gains the majority of its flow from snow melt and rainfall events, a substantial portion of the Muddy River flows are from spring discharges in the Warm Springs area northwest of Moapa. Because of this, the Muddy River has a more stable base flow and has less variance in annual discharge; however, floods from the Pahranagat River or Lower Meadow Valley Wash can cause large spikes in river flow. The USGS maintains a series of gaging stations on the Muddy River shown in Figure 2. Table 3 summarizes data of three USGS gaging station located along the river.

The Muddy River is generally divided into two portions when addressing surface water rights, the area above Wells Siding Diversion (Upper Muddy River) and the area below (Lower Muddy River). The Muddy River decree allocated between 4,000 and 5,000 afy to users upstream of the Wells Siding Diversion (Upper Muddy River) and the entire remaining flow of the river at the Wells Siding Diversion to the MVIC. SNWA's current ownership on the Upper Muddy River is limited to a 1,000 afy lease from the LDS Church. This water was historically used primarily upstream of the Moapa Gage, but some of the leased water currently flows in the river channel. In recent years, the lands along the Upper Muddy River have been used for livestock, not active farming, resulting in a lower water use than what was historically used and decreed.

Table 2
USGS Gage Record on Virgin River

USGS ID	Common Name	Period of Record		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
				Virgin River												
9415000	Littlefield	1930-2006	Mean (af)	9,470	11,426	13,713	15,988	17,829	22,260	24,161	26,380	8,688	6,641	10,638	8,926	**176,422**
			Max (af)	38,372	32,849	76,682	143,094	129,413	110,995	82,420	132,948	66,591	23,429	60,017	43,858	
			Year of Max	2005	1947	1967	2005	1980	1995	1969	2005	1983	1932	1932	1939	
			Min (af)	3,284	6,010	6,826	6,641	5,999	5,251	3,666	3,068	2,785	3,173	3,062	3,172	
			Year of Min	1965	1991	1964	1964	2002	1977	1934	1990	1964	1965	2002	1964	

Table 3
USGS Gage Records on Muddy River

				Muddy River												
9416000	Moapa	1913-2006	Mean (af)	2,423	2,476	2,638	2,687	2,438	2,650	2,452	2,515	2,291	2,349	2,411	2,386	**29,727**
			Max (af)	3,806	3,666	3,376	3,407	3,255	3,290	3,118	2,982	2,743	3,474	3,757	5,427	
			Year of Max	1973	1961	1960	1960	1914	1958	1965	1958	1957	1984	1990	1967	
			Min (af)	1,396	1,601	1,722	1,759	1,683	1,753	1,845	1,968	1,750	1,765	1,679	1,506	
			Year of Min	2004	2002	2002	2004	1997	2005	2003	2006	2004	2004	1995	2003	
9419000	Glendale	1950-2006.	Mean (af)	2,275	2,636	2,779	3,241	2,971	3,210	2,517	2,324	1,988	2,017	2,454	2,428	**30,886**
			Max (af)	3,751	12,437	5,989	22,998	12,775	14,574	5,951	2,952	3,011	3,167	8,363	13,390	
			Year of Max	1973	1961	2005	2005	1993	1983	1969	1991	1965	1961	1981	1998	
			Min (af)	1,464	1,773	1,882	1,906	1,777	1,814	1,631	1,734	1,404	1,433	1,482	1,464	
			Year of Min	1997	1996	1997	2004	1997	1989	1989	1997	1997	1990	2001	1996	
9419507	Overton	1998-2004	Mean (af)	965	905	658	547	794	996	899	689	483	603	581	1,113	**9,254**
			Max (af)	1,457	1,262	1,088	756	1,833	1,537	1,214	1,039	821	1,304	1,138	3,344	
			Year of Max	1999	2000	1999	2000	1998	2000	1998	1999	1999	1998	2000	1998	
			Min (af)	595	470	489	439	349	627	514	536	350	313	362	436	
			Year of Min	2002	2002	2002	2004	2004	2003	2002	2003	2004	2004	2004	2001	

In the Lower Muddy River, the surface flows are measured at the Overton Gage which averages approximately 9,000 afy. The Overton Gage is very near the top of full pool elevation in Lake Mead (1,229 ft-AMSL). Therefore, this gage is believed to reflect surface water flows reaching Lake Mead. While there have been no studies confirming irrigation system losses to the alluvium, it is believed that there is water bypassing the Overton gage as underflow from irrigation system losses.

B.3.3 Lower Virgin River Vegetation

The riparian corridor of the Lower Virgin River is comprised of several plant vegetation types. The major types of vegetation include screwbean mesquite (*Prosopis pubescens*), salt cedar (*Tamarisk sp*.), cottonwood/willow (*Populus fremontii, Salix sp.*), arrowweed (*Pluchea sericea*), honey mesquite (*Prosopis glandulosa*), iodine bush (*Allenrolfea occidentalis*), atriplex (*Atriplex sp*), and marsh. Along the edges of the floodplain and transitioning into upland habitats creosote (*Larrea tridentata*) and lycium (*Lycium sp.*) vegetation types occur (Bio-West Inc. 2001:13-18). The main channel of the river is void of vegetation because of recent erosional or depositional events within the floodplain during a January 2005 flooding event and consists of open water islands, sandbars, and gravel bars. Substrate consists of coarse sands and gravels. However, the main channel has begun to re-incise itself and site visits have indicated vegetation has begun to sprout from the re-worked sediments. The following is a brief description of the major vegetation types within the Virgin River floodplain:

- **Salt Cedar –** The exotic, non-native salt cedar vegetation type is the most common throughout the floodplain and a co-dominant species with most of the plant communities. The salt cedar vegetation type is dominated by salt cedar and has a dense to moderately dense canopy depending on the maturity of the population and has very little herbaceous cover in the under story. The salt cedar vegetation type is found throughout the floodplain but most often appears to be associated with a fine sand and clay substrate.

- **Screwbean Mesquite –** The screwbean mesquite vegetation type is composed of almost entirely screwbean mesquite with some degree of salt cedar component or arrowweed, and is also found as a co-dominant within other vegetation types. This plant vegetation type occurs on all substrates within the area except bedrock.

- **Cottonwood/Willow –** The cottonwood/willow vegetation type is dominated by cottonwood and varied species of willow including coyote willow (*Salix exigua*), and gooding's or black willow (*Salix goodingii*).

- **Arrowweed –** The arrowweed vegetation type is dominated by arrowweed, a low to medium shrub. The arrowweed habitat is low in plant density and diversity. Arrowweed is found throughout the floodplain on sandy sites near or in old channels adjacent to the present river channel. Single stands of arrowweed are uncommon and the populations usually have co-dominant species of screwbean mesquite or are a co-dominant of other communities.

- **Honey Mesquite –** The honey mesquite vegetation type is similar to the screwbean mesquite vegetation type but is very limited within the area.

- **Iodine Bush –** The iodine bush vegetation type is dominated by iodine bush with occurrences of pickleweed (*Salicornia sp.*) and bush seepweed (*Sueda moquinii*). Iodine bush has a limited occurrence in the area. This vegetation type is found on low areas where water slowly evaporates with saline soil conditions.

- **Atriplex –** The atriplex vegetation type is dominated by various atriplex species and when it does occur it is usually a co-dominant of other communities. This vegetation type is found on low areas where water slowly evaporates with saline soil conditions.

- **Marsh –** The marsh vegetation types vary from areas of prolonged inundation or shallow water with dense cover of cattails (*Typha domingensis*) and bulrush (*Scirpus pungens*) to barely vegetated sand bars with young plants of various species just beyond the seedling stage. The marsh vegetation type is common within the area with smaller size communities in the northern portion of the river and larger areas to the south closer to Lake Mead.

- **Creosote –** The creosote vegetation type is dominated by creosote with occurrences of typical upland species found in Mojave Desert scrub habitats. This vegetation type is found along the edge of the flood plain.

- **Lycium –** The lycium vegetation type is dominated by box thorn (*Lycium sp.*) and is found along the edges of the flood plain. This vegetation type and species are also found within the creosote vegetation type.

B.3.4 Muddy River Vegetation

The major types of vegetation on the Muddy River include screwbean mesquite, salt cedar, cottonwood/willow, arrowweed, honey mesquite, atriplex, Acacia (*Acacia sp.*), mulefat (*Baccharis salicifolia*) and marsh (Provencher 2005:86-92). The Muddy River channel is incised in most areas and has been modified for flood control and agricultural purposes. A majority of the river is adjacent to agricultural lands. The only portion of the river that does not have some adjacent agricultural lands is the portion of the river below the Overton Wildlife Management Area. The banks of the river are dominated by tamarisk with pockets of marsh. The following is a brief description of the major vegetation types within the Muddy River floodplain that are not already described above:

- **Acacia –** The Acacia vegetation type is monotypic being dominated by Acacia and has very limited occurrence within the floodplain. This vegetation type is also a co-dominant within saltcedar and Atriplex vegetation types.

- **Mulefat –** The mulefat vegetation type is monotypic dominated by mulefat and has very limited occurrence in the floodplain. This vegetation type is also a co dominant within the saltcedar vegetation type.

B.3.5 Wildlife

B.3.5.1 Riparian and Aquatic Obligate Wildlife

Lower Virgin River Bird Species. The various riparian habitats along the floodplain of the Lower Virgin River support a variety of wildlife species. The riparian habitats are important sources of water, cover and foraging for many species. Probably the most diverse wildlife that uses this habitat is bird species. Bird species that occur are both year-round residents and migratory. Some of the birds observed along the Virgin River include cedar waxwing (*Bombycilla cedrorum*), lesser nighthawk (*chordeiles acutipennis*), western kingbird (*Tyrannus verticalis*), white-throated swift (*Aeronautes saxatalis*), yellow warbler (*Dendroica petechia*), and yellow-breasted chat (*Icteria virens*) (Braden 2006:21-28).

Lower Virgin River Endangered Bird Species. Two federally listed bird species are known to occur within the Lower Virgin River: southwestern willow flycatcher (*Empidonax trailli extimus*) and Yuma clapper rail (*Rallus longirostris yumanensis*). The southwestern willow flycatcher was listed as endangered in 1995. The species is known to breed in dense, mesic riparian habitats throughout the Southwest, including the Lower Virgin River. Streams of lower gradient and/or more open valleys with a wide/broad floodplain support southwestern willow flycatcher breeding habitat in Southern Nevada. Nesting habitat is largely associated with perennial stream flow that supports thickets of trees and shrubs ranging in height from two to thirty meters. Southwestern willow flycatcher food availability may be largely influenced by the presence of moist soils, which attracts the insects that southwestern willow flycatchers are known to consume (USFWS 2005:60908-60912). Some of the habitat for southwestern willow flycatcher along the Lower Virgin River is associated with agricultural return flows (SWCA 2007:62-63). Approximately 474 acres of southwestern willow flycatcher habitat has been identified along the Virgin River, occurring around Littlefield, Arizona, Mesquite, Nevada, and Mormon Mesa (SWCA 2007:20-26).

Yuma clapper rail was listed as federally endangered in 1967. It is a marsh obligate species that is found in freshwater habitats along the Colorado River and its associated drainages, including the Lower Virgin River. Preferred Yuma clapper rail habitat consists of mature cattail-bulrush stands in shallow water near high ground. Stands of cattails (*Typha spp.*) and bulrush (*Scirpus spp.*) dissected by narrow channels of flowing water have been observed to support the densest populations of birds (USFWS, 1983:7). The marsh habitat found along the Lower Virgin River that supports Yuma clapper rail is typically dominated by cattail and bulrush (Braden 2006:1). It is estimated that about 412 acres of marsh habitat occur along the Lower Virgin River (USBR 2004b:3.4-17)

In contrast to the Upper Virgin River, the Lower Virgin River is largely unaltered by dams or reservoirs. Some portions of the Lower Virgin River have been known to go dry during the summer months due to upstream water uses combined with the effects of drought and the complex geology and braiding of the channel resulting in underflow. However, the river is susceptible to a natural flood cycle that is unimpeded by dams and reservoirs in the Lower Virgin River. These natural floods may temporarily impact the habitat of southwestern willow flycatcher and Yuma clapper rail (SWCA 2007:21, Braden 2006:2). As mentioned above, a natural flood event in January 2005 did impact habitat along the Lower Virgin River. However, recent surveys have shown that the vegetation is returning and this natural cycle of the Virgin River is not anticipated to have long-term impacts on bird species (SWCA 2007:21).

Based on historical surveys and recent surveys by SWCA Environmental Consultants and the San Bernardino County Museum, the Yuma clapper rail occurs within the Virgin River and have been observed at Littlefield, Mesquite, Mormon Mesa, and the Virgin River Landing (Braden 2006:17-18). The southwestern willow flycatcher has been observed along the Virgin River at Littlefield, Mesquite, and Mormon Mesa (SWCA 2007:20-27).

Brown pelican (*Pelecanus occidentalis*) and the recently delisted bald eagle (*Haliaeetus leucocephalus*) have not been observed on the Virgin and Muddy Rivers. Surveys conducted by San Bernardino County Museum on both rivers from 1999 to 2005 have not detected the species (Braden 2005: 3.24-3.28; Braden 2006: 21-28). In addition, brown pelicans are known to feed by visual detection and plunge diving (Ashmole 1971). Turbid waters, such as the Virgin and Muddy Rivers, are typically avoided by brown pelicans (Ainley 1975; Murphy 1936).

Lower Virgin River Candidate Bird Species. One candidate bird species is known to occur within the Lower Virgin River. The western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) was designated as a candidate species for listing under the Endangered Species Act in 2001 (USFWS 2001:38611). The species is found in stream-side willow habitats along the Lower Virgin River consisting of willow, tamarisk, Fremont cottonwood (*Populus fremontii*), and honey mesquite (Braden 2006:1). Based on historical surveys and recent surveys by the San Bernardino County Museum, western yellow-billed cuckoos occur within the Virgin River and have been observed at Littlefield, Mesquite, Mormon Mesa, and the Virgin River Landing (Braden 2006:17-18).

Lower Virgin River Fish Species. Based on data collected after 1984 and more recent sampling conducted by Bio-West Inc. it appears that the dominant fish populations are non-native species (USFWS 1995: 11-12; Bio-West, Inc. 2007: 16, 19, 22, 24). Non-native fish that occur within the Lower Virgin River include black bullhead (*Ameiurus melas*), channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), western mosquitofish (*Gambusia affinis*), red shiner (*Cyprinella lutrensis*), and blue tilapia (*Oreochromis aureus*) (Bio-West, Inc. 2007:16).

One fish species protected by a conservation agreement is known to occur within the Lower Virgin River. Virgin spinedace (*Lepidomeda mollispinis mollispinis*) was protected by the multi-agency Virgin Spinedace Conservation Agreement and Strategy finalized in 1996. The goal of the agreement is to reestablish and maintain water flows, enhance and maintain spinedace habitats, maintain genetic viability, and monitor populations. The Virgin spinedace is a small silvery minnow no more than two to four inches in length. The species tends to frequent pools with instream vegetation or boulders (Utah Division of Wildlife Resources 2002:4-5). The Virgin spinedace is extremely rare in the Lower Virgin River but one was observed in 2005 (Bio-West Inc. 2007:14).

Lower Virgin River Endangered Fish Species. Two federally endangered fish species are known to occur within the Lower Virgin River: woundfin (*Plagopterus argentissimus*) and Virgin River Chub (*Gila seminuda*). Woundfin was listed as endangered in 1970. The species is a streamlined, silvery minnow that is found within runs and quiet waters adjacent to riffles (USFWS 1995:v). Virgin River chub was listed as endangered in 1989. The species is a silvery, medium-sized minnow that averages 8 inches in total length but can grow as much as 18 inches. Virgin River chubs are most often associated with deep runs or pool habitats of slow to moderate velocities with large boulders or instream cover (USFWS 1995:v).

Bio-West Inc. has observed limited numbers of native fish species. In Fall 2005, 49 flannelmouth suckers (*Catostomus latipinnis*), 46 desert suckers (*Catostomus clarki*), 321 speckled dace (*Rhinichthys osculus*), four woundfin, 57 Virgin River Chub, and one Virgin spinedace were documented (Bio-West Inc. 2007:14, 18, 20, 23). Competition and predation from non-native fish species, drought, increased water temperature, and increased water clarity, are all identified as impacts to native fish species within the Virgin River (Bio-West, Inc. 2007:1). Although non-native fish species are found throughout the Lower Virgin River, they tend to be more prevalent below the Bunkerville Diversion (Bio-West, Inc. 2007: 16, 19, 22, 24). The Bunkerville Diversion is considered to be acting as a partial fish barrier for non-native species moving upstream from Lake Mead.

Muddy River Bird Species. The various riparian habitats along the floodplain of the Muddy River within the proposed action area support a variety of wildlife species. Overall, the same bird species found on the Virgin River are also found on the Muddy River. The riparian habitats are important sources of water, cover and foraging for many species. Probably the most diverse wildlife to use the habitat is bird species. Bird species that occur are both year-round residents and migratory.

Muddy River Candidate Bird Species. The candidate bird species, western yellow-billed cuckoo, is also known to occur on the Muddy River. The species is found in stream-side willow habitats along the Muddy River consisting of willow, tamarisk, Fremont cottonwood (*Populus fremontii*), and honey mesquite (Braden 2006:1). Western yellow-billed cuckoos have been observed in the Muddy River area on Warm Springs Ranch near the headwaters of the river and at Honeybee Pond within the Overton Wildlife Management Area (Braden 2006:17-18).

Muddy River Endangered Bird Species. The Muddy River provides habitat for the same endangered bird species that occur on the Lower Virgin River. Much of the habitat requirements are also the same. However, on the Muddy River, southwestern willow flycatcher habitat is not associated with agricultural return flows.

Based on historical surveys and recent surveys by the San Bernardino Museum, Yuma clapper rails have been observed in the Muddy River area at Honeybee Pond within the Overton Wildlife Management Area and within Maverick ditch behind the Maverick gas station on South Moapa Valley Boulevard just north of Lewis Avenue. Southwestern willow flycatchers have been observed within Overton Wildlife Management Area (SWCA 2007:27). It is estimated about 390 acres of riparian habitat that may support southwestern willow flycatcher is located within the Overton Wildlife Management Area (USFWS 2005: 60922).

Muddy River Fish Species. Based on historical data and more recent sampling conducted by Bio-West Inc., it appears that the dominant fish populations are non-native species (Bio-West Inc. 2005:9). Fish that occur within the Muddy River include black bullhead, channel catfish, common carp, green sunfish, largemouth bass, western mosquitofish, red shiner, and blue tilapia (Bio-West Inc. 2005:7).

Virgin River chub is also found on the Muddy River, however, when the Virgin River chub was listed in 1989, the Muddy River population was excluded from the listing. Therefore, the Virgin River chub found within the Muddy River is not currently protected under the Endangered Species Act (USFWS 1995:v).

Bio-West Inc. collected six Virgin River Chub just below the Wells-siding Diversion in May 2004, four at Cooper Road and one at Lewis Avenue. In addition one speckled dace was collected at the Wells-siding Diversion and one at Gubler Road (Bio-West Inc. 2005:9).

Muddy River Endangered Fish Species. The only endangered fish species in the Muddy River is the Moapa dace (Moapa coricea). Moapa dace was listed as endangered in 1967. It occupies approximately 6 miles of stream habitat in the thermal headwaters of the Muddy River, known as Warm Springs. The species can only successfully reproduce in the thermal spring outflows of the Muddy River headwaters which range from 85- 90 ºF in temperature (USFWS 1996:ii). In February 2007, 1,172 Moapa dace were counted within the upper Muddy River (S. Goodchild, personal communication February 22, 2007).

B.3.5.2 Critical Habitat

Lower Virgin River Endangered Fish Species. On January 26, 2000, the U.S. Fish and Wildlife Service (USFWS) listed critical habitat for woundfin and Virgin River chub within the Virgin River flood plain from the confluence of Ash and La Verkin creeks, Utah to Halfway Wash, Nevada (USFWS 2000:4141). Figure 3 shows the critical habitat designated within the action area. Competition and predation from non-native fish species, drought, increased water temperature, and increased water clarity, are all identified as impacts to native fish species within the Virgin River (Bio-West, Inc. 2007:1).

Muddy River Endangered Fish Species. No critical habitat has been designated for Moapa dace.

Lower Virgin River and Muddy River Endangered Bird Species. On October 19, 2005, the USFWS designated 73.8 miles of the Virgin River as critical habitat for the southwestern willow flycatcher (USFWS 2005:60922). Critical habitat on the river is contiguous from the Washington Field diversion impoundment in Washington County, Utah, downstream through the town of Littlefield, Arizona, and ends at the upstream boundary of the Overton State Wildlife Area in Clark County, Nevada. Figure 3 shows the critical habitat designated within the action area.

No critical habitat has been designated for the Yuma Clapper Rail.

B.4 Species Accounts for Potentially Affected Federally Listed and Candidate Species

This section describes further detail on those plant and animal species that are listed by the USFWS as threatened, endangered or candidate that may occur in the project area.

B.4.1 Virgin River Chub (*Gila seminuda*)

Federal Status: *Endangered* (Virgin River Population)

The Virgin River population of the Virgin River chub has been classified as endangered by the USFWS. Recent genetic studies of the Virgin River Chub on the Muddy River have concluded it is genetically identical to the Virgin River Chub on the Virgin River. The USFWS is currently undergoing status review of the Muddy River Population of the Virgin River Chub to determine whether that population is proposed for listing. This section describes both populations.

Table 4
Summary of Federally Listed and Candidate Species That May Occur in the Project Area

Species	Status	Range and Habitat of Species	Occurrence in Action Area
Fish			
Virgin River Chub (Virgin River Population) (Gila seminude)	E CH	Occurs within the virgin River in deep runs or pools of slow to moderate velocities with large boulders and in stream cover.	The Virgin River Chub is currently distributed within the Virgin River from La Verkin Springs, Utah to the diversion at Mesquite, Nevada USFWS 1970). The species has occurred in Halfway Wash but not downstream to Lake Mead. Critical habitat is from Utah to Halfway Wash.
Virgin River Chub (Muddy River Population) (Gila seminude)	E	Occurs within the Muddy River in deep runs or pools of slow to moderate velocities with sand, large rocks, and cover in the form of overhanging banks and tree roots.	This species has occurred historically from Warm Springs to Logandale. Based on recent surveys this species has been collected just below the Wells-siding diversion to several miles downstream.
Moapa Dace (Moapa coriacea)	E	Occur in spring pools, tributaries and the main portion of the Muddy River, but only reproduces in tributary thermal spring outflows.	This species is restricted to the upper Muddy River because of its affinity for warmer water. It is not expected to occur below the Wells-siding Diversion.
Woundfin (Plagopterus argentissimus)	E CH	Occurs in the Virgin River in run and quiet water regimes adjacent to riffles with sand substrate.	Occurs within the Virgin River from La Verkin Springs to just below Halfway Wash in Nevada. Critical habitat is from La Verkin to Halfway Wash.
Birds			
Western Yellow-billed Cuckoo (Coccyzus americanus occidentalis)	C	Occurs in mature cottonwood willow habitat in the southwestern United States	The western yellow-billed cuckoo occurs along the Muddy River and Virgin River within the project area.
Southwestern Willow Flycatcher (Empidonax traillii extimus)	E	Occurs in many locations in southwestern United States. Preferred habitat within NV is desert riparian habitats along rivers, and streams supporting willows, mulefat, or other riparian vegetation.	The southwestern willow flycatcher occurs within the project area along the Virgin River and Muddy Rivers.
Yuma Clapper Rail (Rallus longirostris yumanensis)	E	Occurs in freshwater marshes and requires regenerating marsh for foraging ad mature stands of cattail and bulrush for nesting.	The Yuma clapper rail occurs within the project area along the Virgin and Muddy Rivers.

E – Federally endangered T – Federally threatened C – Federal candidate for listing CH – Critical Habitat has been designated for species within action area

Species Biology. The Virgin River chub is in the minnow family. Although the typical individual is approximately 8 inches in length, the species can reach up to 18 inches in length (USFWS 2006d). Adults and juveniles inhabit deep runs or pools with slow to moderate velocities (up to 2.5 ft/s) over sand and having instream cover such as boulders. It is not present in water above 30°C (90°F) (USFWS 2006d). The Virgin River chub is omnivorous, eating algae, terrestrial and aquatic insects, organic detritus, and crustaceans; young fish feed primarily on invertebrates while adults eat algae and debris (USFWS 2006d). The species has a high tolerance for turbidity and salinity. Factors that currently limit the Virgin River chub include habitat loss and modification, and non-native fish (USFWS 2006d).Periods of spawning have not been well documented, but appear to coincide with the spawning periods for the woundfin.

Species Habitat and Range. Its distribution was thought to be restricted to the Virgin River, but more recent work has found that the roundtail chub found in the Muddy River is also the Virgin River chub. The current distribution of the Virgin River chub in the Virgin River is from Pah Tempe Springs in Utah to at least the Mesquite diversion near the Arizona-Nevada border (USFWS 2000). It historically was collected in the Virgin River from La Verkin Springs, Utah to the confluence of the Virgin River into the Colorado River. It also was collected in the Muddy River in Nevada. The fish is most often associated with deep runs or pools within the river.

Current Conditions Range Wide. The Virgin River chub is currently restricted to the Virgin and Muddy Rivers. It seems stable in those habitats; although the species is vulnerable to impact due to its limited distribution, increase of non-native species, water diversions and other disturbances.

Occurrence in Project Area. The Virgin River Chub is currently distributed within the Virgin River from La Verkin Springs, Utah to the diversion at Mesquite, Nevada (USFWS 1995). The Virgin River has been sampled most recently by Bio-West Inc. and by the Virgin River Fishes Recovery Team (VRFRT).

Distinct sample sites have been located at Halfway Wash, the Overton Wildlife Management Area (OWMA), and Virgin River Bowl and just above Lake Mead. Data collected from 2001 to 2004 indicates that the Virgin River Chub may no longer be present below Halfway Wash. The reason for the possible loss of this species is the long-term drought conditions and the dominance of non-native fish species. Recent data collected indicates that non-native species of fish are dominant in the lower portion of the river below Halfway Wash (Bio-West, Inc. 2007).

The Muddy River Population of the Virgin River chub was isolated from the Virgin River population by the construction of Hoover Dam and the filling of Lake Mead (USFWS 1996). The Virgin River chub Muddy River population has historically occurred in most abundance between the Warm Springs area and Logandale. The chub was rarely found below the I-15 Freeway and not below the Wells-siding diversion dam (USFWS 1996). Field studies by Bio-West, Inc. (2005) in 2004 found 31 Virgin River chub in there May survey. Surveys were conducted from the Wells-siding Diversion downstream to Lake Mead. Sample sites included

Wells-siding diversion, above Route 169, Route 169, below Route 169, Gubler Road, Yamashita road, Cottonwood road, Cooper road, Lewis Road, OWMA Diversion Dam, and the end of the river channel. With the exception of a year old fish, all were young of the year. Most of the fish caught were immediately below the Wells-siding Diversion, but 4 were found at Cooper Road and another at Lewis Road. In September 2005 Golden and Holden collected twelve adult and one young of the year immediately below the Wells Siding Diversion.

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, the City of Mesquite is developing the Virgin River Habitat Conservation and Recovery Program (VRHCRP) as a requirement to the Mesquite Lands Act. The VRHCRP is intended to provide coverage for impacts associated with the development of the Mesquite area and proposes to address Virgin River chub on the Virgin River.

Currently, Coyote Springs Investment (CSI), the Moapa Band of Paiutes, the Moapa Valley Water District, USFWS and SNWA are developing the Muddy River Recovery Implementation Program (MRRIP) to provide coverage for future groundwater development in Coyote Spring Valley. The MRRIP proposes to address the Muddy River population of the Virgin River chub.

Designated Critical Habitat. Approximately 140.1 km (87.5 mi) of the Virgin River within the 100-year flood plain from the confluence of Ash and La Verkin creeks, Utah to Halfway Wash, Nevada has been designated as Critical Habitat for the Virgin River population of this species (65 FR 4140-4156). This area is the last remaining occupied habitat for this species.

B.4.2 Moapa Dace (*Moapa coriacea*)

Federal Status: *Endangered*

Species Biology. The Moapa dace is federally-listed as endangered (USFWS 2006e). Moapa dace can grow to 4.7 inches. Adults prefer the main stem of the river as well as tributaries while juveniles prefer tributaries and areas with increasing velocity as they grow. Reproduction occurs all year but peaks in the spring. Threats to the species include non-native fish species and fish parasites brought in with the non-native fish. Moapa dace spawn year round with peak spawning activity in spring and a smaller peak in fall. Sexual maturity occurs in approximately one year. Moapa dace have only been found to successfully breed in warm water ranging between 86 and 89.6 degrees F (USFWS 1996). The dace is omnivorous eating a wide variety of aquatic insects and plants.

Species Habitat and Range. Moapa dace are endemic to the upper Muddy River and tributary thermal spring systems within the Warm Springs Area. Historically, the fish may have occupied as many as 25 springs and 10 miles of river habitat. Cooler water in the middle and lower Muddy River were likely a natural barrier to downstream movement of Moapa dace (USFWS 1996). The species currently occupies approximately 5.9 miles of stream habitat with five springs. This habitat ranges downstream to near the Warm Springs Road Bridge.

Cady Lamb, Baldwin, Muddy, Apcar, and Pederson Springs provide the warm water flows to this habitat.

Current Conditions Range Wide. The species appears relatively stable in its present distribution.

Occurrence in Project Area. The species is restricted to the upper Muddy River due to its affinity for warmer water, which is produced by the stream complex feeding the Muddy River. Therefore, it would not occur at or below the Wells Crossing Diversion Structure. Fish surveys did not find the species below the Warm Springs Road bridge (Bio-West, Inc. 2005).

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, Coyote Springs Investment (CSI), the Moapa Band of Paiutes, the Moapa Valley Water District, USFWS and SNWA are developing the MRRIP to provide coverage for future groundwater development in Coyote Spring Valley. The MRRIP proposes to address Moapa dace.

Designated Critical Habitat. No critical habitat has been designated for this species.

B.4.3 Woundfin (*Plagopterus argentissimus*)

Federal Status: *Endangered*

Species Biology. The woundfin is a small (less than 3.5 inches) fish in the minnow family with a life span of up to 4 years (NatureServe 2006). Adults are generally found in water less than 1.4 feet deep with velocities between 0.8 and 1.6 ft/s while juveniles occur in slower and deeper waters (USFWS 2000). Both use runs and quiet waters over sand or gravel adjacent to riffles. Larvae are found along the stream margin and in backwaters, often being associated with filamentous algae. Spawning occurs from April to July when water flows are declining (USFWS 2006c) over cobbles to gravel (NatureServe 2006). Woundfin are omnivorous, feeding on filamentous algae, detritus, tamarisk seeds, and insects (USFWS 2006c). Current threats to the species include habitat loss and degradation, competition from non-native fish, and predation. Spawning occurs in the spring months when the water levels are high and water temperatures rather low. Species survival tends to be dependent upon flow conditions and water temperature.

Species Habitat and Range. The woundfin historically ranged within the Colorado River from Yuma to the Virgin River in Nevada, Utah and Arizona. It also extended from the confluence of the Salt and Verde Rivers to the mouth of the Gila River near Yuma. A single individual was collected in the Muddy (Moapa) River (formerly a tributary of the Virgin River but now flows into the Overton Arm of Lake Mead) in the late 1960s, but it has not been found there since then (USFWS 2000). The woundfin has been extirpated from almost all of its historic range except for the Virgin River. Woundfin presently range from Pah Tempe (La Verkin) Springs, Utah on the main stem of the Virgin River and the lower portion of La Verkin Creek, Utah downstream to Lake Mead, Nevada (USFWS 1995).

Woundfin adults and juveniles are normally collected from runs and quiet waters adjacent to riffles. Juveniles generally use areas that are slower and deeper than those areas used by adults. Adults prefer water temperatures near 64 degrees F (USFWS 1995).

Current Conditions Range Wide. As described above, the woundfin is now restricted to the Virgin River.

Occurrence in Project Area. The Virgin River has been sampled most recently by Bio-West Inc. and by the VRFRT. Distinct sample sites have been located at Halfway Wash, OWMA, Virgin River Bowl and just above Lake Mead. They have both found that the woundfin is distributed as far downstream as Halfway Wash. The woundfin has been collected historically, but sporadically at Halfway Wash. The last known record of this species at Halfway Wash or downstream from there is in 1999 when two woundfins were collected by the VRFRT at Halfway Wash (Bio-West, Inc. 2005). No other woundfin have been collected at Halfway Wash or downstream with the most recent sampling event conducted by Bio-West in 2004.

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, the City of Mesquite is developing the VRHCRP as a requirement to the Mesquite Lands Act. The VRHCRP is intended to provide coverage for impacts associated with the development of the Mesquite area and proposes to address woundfin.

Designated Critical Habitat. Approximately 140.1 km (87.5 mi) of the Virgin River within the 100-year flood plain from the confluence of Ash and La Verkin creeks, Utah to Halfway Wash, Nevada has been designated as Critical Habitat for the species (65 FR 4140-4156). This area is the last remaining occupied habitat for this species.

B.4.4 Western Yellow-Billed Cuckoo (*Coccyzus americanus occidentalis*)

Federal Status: Candidate

Species Biology. The western yellow-billed cuckoo breeding season occurs in late May through early August. Nests are constructed of a variety of plant material and are concealed in a bush or tree at 2 to 20 feet from the ground. A clutch is generally 3 to 4 eggs and is incubated by the female for 9 to 11 days, with occasional help from the male. Nestlings are tended to by both parents and can fly about 21 days after hatching.

Species Habitat and Range. Western yellow-billed cuckoo is generally found in streamside cottonwood/willow and alder groves, open woodlands, parkland, gardens and orchards. Within the United States their breeding range includes areas of Idaho, Utah, California, Arizona and southern Nevada, and throughout most of the continent east of the Rocky Mountains to the Atlantic Coast. In Nevada, the western yellow-billed cuckoo is considered a rare and transient resident.

Current Conditions Range Wide. More information is needed on population size and occurrences of this species. The species is being reduced because of the loss of suitable habitat.

Occurrence in Project Area. Western yellow-billed cuckoo is currently known to occupy areas along the Muddy and Virgin Rivers in Southern Nevada with suitable habitat occupied intermittently among the years.

Surveys for western yellow-billed cuckoo have been conducted on the Muddy and Virgin rivers by the San Bernardino County Museum (Braden 2006). Eleven study sites were surveyed on the Virgin River and 5 sites were surveyed on the Muddy River. Survey sites on the Virgin River included three sites at Littlefield, Arizona, three sites near Mesquite, Nevada, three sites below Mormon Mesa and a site at Fisherman's Cove and at the Virgin River Landing (Braden 2006). Based on historical surveys and recent surveys by the San Bernardino County Museum, western yellow-billed cuckoos occur within the Virgin River and have been observed at Littlefield, Mesquite, Mormon Mesa, and the Virgin River Landing (Braden 2006:17-18).

The five sites surveyed on the Muddy River included Warm Springs Ranch near Glendale, Nevada, three sites near Overton, Nevada, and one site at Logandale, Nevada.

Western yellow-billed cuckoos have been observed in the Muddy River area on Warm Springs Ranch near the headwaters of the river and at Honeybee Pond within the Overton Wildlife Management Area (Braden 2006:17-18).

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, the City of Mesquite is developing the VRHCRP as a requirement to the Mesquite Lands Act. The VRHCRP is intended to provide coverage for impacts associated with the development of the Mesquite area and proposes to address western yellow-billed cuckoo.

Designated Critical Habitat. No critical habitat for the western yellow-billed cuckoo has been identified.

B.4.5 Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

Federal Status: *Endangered*

Species Biology. The southwestern willow flycatcher is a small bird with an almost exclusive diet of insects. It usually nests in close proximity to water or very saturated soils. Often the habitat will dry up during the nesting season, but there still must be enough water to support riparian vegetation.

The species migrates into the area and normally nests in dense willow and salt cedar. After nesting is completed and young have fledged, individuals may disperse into other riparian areas.

Species Habitat and Range. The southwestern willow flycatcher is a small passerine bird that occupies riparian areas in southern California, New Mexico, southern Nevada, south central Colorado, Utah, west Texas and Arizona. The subspecies species usually nests in riparian habitat along rivers, streams, open water, cienegas, marshy seeps and or saturated soil where sense growth of riparian habitat occurs. The areas are typically dense growth of willows, baccharis, arrow weed, and salt cedar sometimes with an overstory of cottonwood. (Sogge, et al. 1997). The species typically nests in dense riparian areas with canopies 13-23 feet tall. Historically, the species nested primarily in dense willow habitat, but is now found in mixed habitats containing salt cedar.

Current Conditions Range Wide. The willow flycatcher is a riparian obligate species. Riparian habitat within its range has declined for a number of reasons including large-scale loss of wetlands, and degradation of riparian habitat through invasion of introduced plant species such as salt cedar. Brood parasitism by brown-headed cowbirds is also a major threat to nesting success.

Occurrence in Project Area. The southwestern willow flycatcher nests in a number of locations on the Lower Virgin River. Surveys are conducted on a yearly basis by SWCA, Inc. for the U.S. Department of Interior, Bureau of Reclamation (BOR) (SWCA 2007).

The following sites were surveyed along the Virgin River:

1) **Littlefield, Arizona.** The Littlefield site consist of two study areas, Littlefield North and South near the confluence of the Virgin River with Beaver Dam Wash. These sites include a stand of cottonwood with an understory of willow, salt cedar and Russian olive. No willow flycatchers were detected at either location in 2006.

2) **Mesquite, Nevada.** The Mesquite site consists of two study areas, Mesquite West and East. The Mesquite sites consisted of a mosaic of bulrush and cattail marshes separated by strips of willow and salt cedar. This vegetation is supported by runoff from two golf courses immediately adjacent to the site. Twenty-four resident breeding flycatchers were located at Mesquite West in 2006. One pair was detected at Mesquite East in 2006.

3) **Mormon Mesa North, Nevada.** This site is the farthest north of 6 sites located in the 15 km segment upstream from Lake Mead. This area is in a wide (1km) floodplain of the Virgin River. The area consists of a mosaic of habitat including salt cedar and willow forest, cattail forest and mixed native and exotic forests. No flycatchers were detected at Mormon Mesa North in 2006.

4) **Mormon Mesa South, Nevada.** Vegetation in this area consists of salt cedar with patches of willow and cattail. One willow flycatcher was detected at this location in 2006.

5) **Virgin River #1, Nevada.** This site consisted of areas of dense salt cedar with other areas containing a mixture of willows and salt cedar. One pair and two unpaired males were detected at this site in 2006.

6) **Virgin River #2, Nevada.** This site is a monotypic stand of dense salt cedar. In 2006, 11 resident breeding willow flycatchers, seven unpaired males were detected at this site.

One study site has been maintained on the lower Muddy River on the OWMA. The site consisted primarily of salt cedar with some willow. Ten resident breeding willow flycatchers and one unpaired male were detected in 2006.

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, the City of Mesquite is developing the VRHCRP as a requirement to the Mesquite Lands Act. The VRHCRP is intended to provide coverage for impacts associated with the development of the Mesquite area and proposes to address southwestern willow flycatcher.

Designated Critical Habitat. On October 19, 2005 the USFWS designated 73.8 miles of the Virgin River as critical habitat for the southwestern willow flycatcher (FR70 60886 – 61009). Critical habitat on the river is contiguous from the Washington Field diversion impoundment in Washington County, Utah, downstream through the town of Littlefield, Arizona, and ends at the upstream boundary of the Overton State Wildlife Area in Clark County, Nevada. The Critical habitat within the project area is within the Virgin Management Unit – Virgin River, NV/AZ/UT that is within the Lower Colorado Recovery Unit – Nevada, California/Arizona Border, Arizona, and Utah

The OWMA while having features essential to the southwestern willow flycatcher is being excluded from the critical habitat designation. The reason for the exclusion is the area is already being managed by the state of Nevada for wildlife and riparian habitat for the flycatcher.

B.4.6 Yuma clapper rail (*Rallus longirostris yumanensis*)

Federal Status: *Endangered*

Species Biology. The breeding season for the Yuma Clapper Rail occurs in March through August. Nests are built with plant stems and grasses within the marsh on elevated ground. Live vegetation is often pulled over the nest to form a canopy and conceal the nest. A clutch is generally made up of 8 to 11 eggs. Males and females incubate the eggs for 20 to 24 days. Nestlings are independent of the parents in 35 to 42 days and able to fly 63 to 70 days after hatching.

Species Habitat and Range. The Yuma Clapper Rail is a marsh obligate species found in freshwater habitats along the Colorado, Muddy, and Virgin Rivers as well as isolated portions of the Salton Sea, California (Braden 2006).

Current Conditions Range Wide. More information is needed on population size and occurrences of this species. The species is being reduced because of the loss of suitable habitat.

Occurrence in Project Area. Yuma Clapper Rail is currently known to occupy areas along the Muddy and Virgin Rivers in Southern Nevada with suitable habitat occupied intermittently among the years.

Surveys for Yuma clapper rail have been conducted on the Muddy and Virgin Rivers by the San Bernardino County Museum (Braden 2006). Eleven study sites were surveyed on the Virgin River and 5 sites were surveyed on the Muddy River. Survey sites on the Virgin River included three sites at Littlefield, Arizona, three sites near Mesquite, Nevada, 3 sites below Mormon Mesa and a site at Fisherman's Cove and at the Virgin River Landing (Braden 2006). The five sites surveyed on the Muddy River included Warm Springs Ranch near Glendale, Nevada, three sites near Overton, Nevada, and one site at Logandale, Nevada. The following is brief description of the current survey sites within the project area.

- Virgin River:
  - Mormon Mesa (Big Marsh, East Marsh and Long Marsh)
    1) Big Marsh is located along the northwestern bank of the Virgin River near Mormon Mesa. The marsh is fed by a springs and inflow from the river. Habitat in the marsh consists of dense stands of cattail with limited amounts of water.
    2) East Marsh is a small area east of the Virgin River and northeast of long marsh. East Marsh inflows are from spring runoff from the river.
    3) Long Marsh is a linear marsh habitat that parallels the river channel and is on the west side of the river. The habitat consists of cattail, tamarisk, and various willows.
  - Virgin Delta (Virgin River Landing and Fisherman's Cove)
    1) Virgin River Landing and Fisherman's Cove prior to 2003 were inundated by Lake Mead. In 2004 the sites supported dense stands of cattail with black willow and some tamarisk.
- Muddy River
  - Logandale (Bowman Canal, and Grant Bowler Park)
    1) Bowman Canal an overflow and runoff catchment for Bowman reservoir. The canal supports patches of cattails.
    2) Grant Bowler Park is located in Grant Bowler Park in downtown Logandale. The survey area is a stretch of the Muddy River that is adjacent to the park. The area consists of cattails with patches of tamarisk and willow.

3) Overton (Maverick Ditch)

4) The Maverick Ditch is located in the ton of Overton near the intersection of Cooper and Jones Streets. The site is dominated by cattail, bulrush, tamarisk, and yerba mansa.

5) OWMA (Honeybee Pond)

6) Honeybee Pond is located on the OWMA. The habitat is composed of cattail, and reeds surrounded by water impoundments.

Yuma clapper rail have been recorded sporadically over the last five years along the Virgin River within the Littlefield, Mesquite, Mormon Mesa and Virgin River Delta (Braden 2006). They have never occurred in large numbers and in many instances occur infrequently. Floods in January of 2005 have altered the habitat for these species, especially in the Mesquite area. In 2004 one rail was detected at Big Marsh and 2 rails were detected at the Virgin River Landing. This is the first year individuals were observed since the site emerged in 2002 (Braden 2006).

Yuma clapper rail have been recorded sporadically over the last five years at Honeybee Pond and Maverick Ditch in the Overton area of the Muddy River (Braden 2006). The Muddy River also experienced flooding during January of 2005, altering habitat for the Yuma clapper rail.

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, the City of Mesquite is developing the VRHCRP as a requirement to the Mesquite Lands Act. The VRHCRP is intended to provide coverage for impacts associated with the development of the Mesquite area and proposes to address Yuma clapper rail.

Designated Critical Habitat. No critical habitat for the Yuma clapper rail has been identified.

B.5 Effects Analysis

B.5.1 Effects to Lower Virgin River Hydrology

Tributary conservation ICS flows of 10,000 afy of water on the Virgin River, if averaged monthly, would equate to approximately 830 acre-feet per month and 30 acre-feet per day. These numbers represent averages and may not correspond to actual diversion schedules for the irrigation company water rights being used for tributary conservation since irrigation company schedules do not allow water users to take a constant stream of water and the schedules change throughout the season and from year to year. This makes it difficult to estimate a precise schedule for delivery of tributary conservation flows. However, assuming water is delivered at least weekly, the average weekly water contribution from tributary conservation would be approximately 210 acre-feet per week. If a gage were installed directly below the lowest return point of the retired water it would probably not reflect an increase of the entire 210 acre-feet per week due to complex geology and underflow that occurs in the floodplains and along the entire Virgin River. Additionally, the gage would have a margin of error of at least 10% and the 10,000 afy of tributary conservation represents less than 7% of the historic annual flow in the Virgin River at Halfway Wash. Therefore, any change measured by the gage would be within the gage's margin of error, so the accuracy of any gage measurement of tributary conservation flows would be questionable. Finally, surface water rights in Nevada are not subject to forfeiture (NRS 533.060(2)), so purchasers of water rights are not required to divert and use this water to guard against forfeiture. Therefore, the water rights that SNWA purchased may have already been regularly fallowed or out of production at the time they were acquired by SNWA. This means that water SNWA would be accounting for as tributary conservation may already be flowing in the river, so a response in a streamflow gage from tributary conservation flows may not be detected. Due to all of the factors mentioned above, 10,000 afy of tributary conservation is not likely to result in a noticeable change to flows on the Virgin River from the current conditions listed in Table 2.

B.5.2 Effects to Muddy River Hydrology

Tributary conservation flows of 20,000 afy of water on the Muddy River, if averaged monthly, would equate to approximately 1,700 acre-feet per month and 55 acre-feet per day. These numbers represent averages and may not correspond to actual diversion schedules for the irrigation company water rights being used for tributary conservation since irrigation company schedules do not allow water users to take a constant stream of water and the schedules change throughout the season and from year to year. This makes it difficult to estimate a schedule for delivery of tributary conservation flows. However, assuming water is delivered at least monthly, the average monthly water contribution from tributary conservation would be approximately 1,700 acre-feet. The Overton gage probably would not reflect an increase of the entire 1,700 acre-feet per month due to complex geology and underflow that occurs before the Overton gage on the Muddy River. Additionally, surface water rights in Nevada are not subject to forfeiture (NRS 533.060(2)), so purchasers of water rights are not required to divert and use this water to guard against forfeiture. Therefore, the water rights that SNWA purchased may have already been regularly fallowed or out of production at the time they were acquired by SNWA. This means that water SNWA would be accounting for as tributary conservation may already be flowing in the river, so a response in the streamflow gage from tributary conservation flows may not be detected.

Upper Muddy River surface water flow is measured at the Moapa and Glendale gages, which average approximately 30,000 afy. The current leased SNWA water rights in the Upper Muddy River (1,000 afy) represent approximately 3% of the gages' flow, well within a typical gage margin of error of 10% and virtually undetectable.

In the Lower Muddy River, the surface flows are measured at the Overton Gage which averages approximately 9,000 afy. The Overton Gage is very near the top of full pool elevation in Lake Mead (1,229 ft-AMSL). Therefore, this gage is believed to reflect surface water flows reaching Lake Mead. While there have been no studies confirming irrigation system losses to the alluvium, it is believed that there is water bypassing the Overton gage as underflow. Because of irrigation system losses and substantial underflow bypassing the gage, simply subtracting the Moapa-Glendale gage readings from the Overton gage readings will not provide an accurate accounting of the volume of tributary conservation flow reaching Lake Mead. Like the Virgin River and Upper Muddy River, the complex geology, gaging accuracies, and historic use of this water will make it difficult to see a marked increase in the Overton Gage from tributary conservation flows. In addition, the limited period of record for the Overton Gage when compared with the Glendale Gage, and uses between the two gages suggests large volumes of water bypass the gage as underflow. Due to all the factors mentioned above, 20,000 afy of tributary conservation is not likely to result in a noticeable change to flows on the Muddy River from the current conditions listed in Table 3.

B.5.3 Effects to Species

As discussed above, flooding has the potential to periodically impact riparian habitat, resulting in naturally occurring impacts to bird species (SWCA, 2007:21). However, the tributary conservation water associated with the proposed action (approximately 1,700 acre-feet per month on the Muddy River and 830 acre-feet per month on the Virgin River) should not cause flood flows or exacerbate natural flood events because the capacity of the two river systems has been determined to be more than adequate to accommodate the proposed tributary conservation flows. Given that the mean monthly gage flow for the Virgin River at Littlefield Arizona ranges from 6,641 acre-feet to 26,380 acre-feet, an additional 830 acre-feet per month is minimal compared to the overall flows in the river. Similarly, on the Muddy River the mean monthly gage flow at the Overton gage ranges from 483 acre-feet to 1,113 acre-feet, and the 1,700 acre-feet per month of tributary conservation water is not anticipated to exacerbate flood flows because of the complex underflow system on the Muddy River. In general, tributary conservation flows are expected to have a beneficial, albeit minor, effect on any marsh or riparian habitat associated with the southwestern willow flycatcher, Yuma clapper rail, or yellow-billed cuckoo located along the Muddy River or within the Mormon Mesa area on the Virgin River. No effect is anticipated for southwestern willow flycatcher, Yuma clapper rail, or yellow-billed cuckoo on the Virgin River above the Bunkerville Irrigation Company service area, as tributary conservation will take place below this area.

Drought has been identified as one type of event that could create conditions that can impact sensitive fish species on the Lower Virgin River and the Muddy River. The assured flows in the Virgin and Muddy Rivers proposed by the SNWA tributary conservation program are expected to have a minor beneficial effect on the endangered and candidate fish and bird species because they may help lessen the effects of drought (Bio-West Inc. 2007:1). While drought tends to decrease river flows, the tributary conservation flows are expected to act as an assured baseflow for sensitive fish and bird species on the Muddy River and below the Bunkerville Irrigation Company service area on the Virgin River. There is a concern that additional flows on the Virgin River may connect the Virgin River to Lake Mead for more days during the year, possibly allowing more non-native species to move up the Virgin River from Lake Mead. However, the small amount of additional flow possible (830 acre-feet per month in tributary conservation versus 6,641 acre-feet to 26,380 acre-feet per month average river flow), coupled with the complex geology of the Virgin River and braiding of the river in that location suggests that a more permanent connection will not be made between the Virgin River and Lake Mead because much of the minor additional flow will reach Lake Mead as underflow. Therefore, this project may affect, but is not likely to adversely affect the endangered and candidate bird and fish species in the Lower Virgin and Muddy Rivers because the potential positive effects are expected to be difficult to meaningfully measure or detect and are therefore insignificant (See hydrology discussion in Sections 5.1 and 5.2) .

B.5.3.1 Southwestern Willow Flycatcher

Riparian habitat that may support southwestern willow flycatcher tends to form at the agricultural returns along the banks of the Lower Virgin River (SWCA 2007:62-63). Potential effects to southwestern willow flycatcher may occur on the Lower Virgin River if the water conserved through tributary conservation is no longer routed through the Bunkerville Irrigation Company ditch systems because this change in operations would result in a loss of agricultural returns that may support the habitat in some areas. However, Bunkerville Irrigation Company will need the tributary conservation water to remain in the ditch systems, even if it is not used for agricultural purposes, because the water is needed to maintain head within the ditch systems so water can be withdrawn for irrigation. If the tributary conservation water is not retained in the ditch systems, Bunkerville Irrigation Company would need to upgrade the ditches to accommodate less flow. On July 21, 2005, the SNWA Board of Directors agreed to keep SNWA water rights used for tributary conservation in the ditches to avoid impacts to southwestern willow flycatcher habitat and to Bunkerville Irrigation Company operations. Therefore, the project will have no effect on the southwestern willow flycatcher within the ditch system of the Bunkerville Irrigation Company because there will be no change in ditch flows from this project.

Flows that were historically consumptively used off channel by agriculture will be used for the creation of tributary conservation. Though this may result in a small positive effect on river flows and underflow along the Muddy and Virgin River, which could benefit the riparian habitats of the southwestern willow flycatcher, these flow effects will be difficult to meaningfully measure or detect as indicated in Sections 5.1 and 5.2. This project is not expected to result in take of southwestern willow flycatcher. Therefore, this project may affect, but is not likely to adversely affect the southwestern willow flycatcher because the effects are expected to be insignificant downstream of the agricultural returns from the Bunkerville Irrigation Company service area in Mormon Mesa and along the Muddy River to Lake Mead.

Southwestern Willow Flycatcher Critical Habitat. As mentioned previously, riparian habitat that may support southwestern willow flycatcher tends to form at the agricultural returns along the banks of the Lower Virgin River (SWCA 2007:62-63). Some of these riparian habitat areas may occur within critical habitat for the southwestern willow flycatcher. There is potential to affect critical habitat for the species if the water conserved through tributary conservation is no longer routed through the Bunkerville Irrigation Company ditch systems because the agricultural returns that support the habitat will cease. However, as noted above, effects to southwestern willow flycatcher critical habitat will be by retaining the tributary conservation water within the ditch systems of the irrigation company. Based on this, it is anticipated that there will be no destruction or adverse modification to southwestern willow flycatcher critical habitat on the Lower Virgin River, and thus no impact to recovery opportunities.

There is no critical habitat for the southwestern willow flycatcher designated on the Muddy River. However, there is Southwestern willow flycatcher habitat on the Muddy River within the Overton Wildlife Management Area (OWMA) that was excluded from the designation of critical habitat since this area is already being managed for wildlife and riparian habitat by the State of Nevada. Assured flows associated with tributary conservation are likely to have a minor beneficial effect on the development and maintenance of southwestern willow flycatcher habitat in the OWMA. For the reasons indicated in Section 5.3.1, this project may affect, but is not likely to adversely affect the southwestern willow flycatcher.

Southwestern Willow Flycatcher Recovery Plan. The Southwestern Willow Flycatcher Recovery Plan has an overall recovery objective to attain a population level and an amount and distribution of habitat sufficient to provide for the long-term persistence of metapopulations (USFWS 2002a: 77). The recovery plan states that there are currently an estimated 40 known territories within the Virgin River. In order to downlist the species from endangered to threatened, a minimum of 100 known territories needs to be present on the Virgin River (USFWS 2002a: 87). No such recovery goal exists for the Muddy River.

Tributary conservation flows in both the Virgin and Muddy Rivers will help maintain and/or develop southwestern willow flycatcher habitat and will assist with meeting the recovery goals for the species. As described above, the assured flows from tributary conservation in the Muddy River and in the Virgin River below the Bunkerville Irrigation Company service area may help support existing southwestern willow flycatcher habitat or develop new habitat because flows that were historically consumptively used by agriculture will be used for tributary conservation. It is anticipated that there will be no destruction or adverse modification to southwestern willow flycatcher habitat on the Lower Virgin River or Muddy River, and thus no adverse impact to recovery opportunities. Because tributary conservation will help to maintain or create additional habitat, it is consistent with the recovery plan goals.

B.5.3.2 Yuma Clapper Rail

Yuma clapper rail occupies marsh habitat along the Virgin and Muddy Rivers which is maintained by river flow and not agricultural returns. Since tributary conservation water will be a part of the river flows that support the habitat, no adverse effects to Yuma clapper rail have been identified on either river for the proposed action. Consequently, the project is not expected to result in take of Yuma clapper rail. Tributary conservation may benefit the Yuma clapper rail by assuring flows, thereby maintaining existing habitat and potentially developing new habitat areas in the Muddy River and in the Virgin River below the Bunkerville Irrigation Company service area. However, the potential changes in flows in the Muddy and Virgin Rivers will be difficult to measure or detect (Sections 5.1 and 5.2). Therefore, this project may affect, but is not likely to adversely affect the Yuma clapper rail because the effects are expected to be insignificant.

No critical habitat has been designated for the Yuma Clapper Rail.

Yuma Clapper Rail Recovery Plan. The primary objective of the Yuma Clapper Rail Recovery Plan is to assure the continued survival of a total breeding population of 700-1,000 Yuma clapper rails in the United States. Consideration for delisting the Yuma clapper rail will be based on an assessment of the population in both the United States and Mexico (USFWS 1983: 12). A five-year status review of the species was conducted in 2006. In that review the USFWS was unable to determine if the primary objective of the recovery plan had been met due to population fluctuations associated with changes in survey effort, survey protocol, observer experience, and habitat changes (USFWS 2006a: 6). However, tributary conservation on the Virgin and Muddy Rivers will assure flows and thereby help maintain existing habitat and potentially develop new habitat areas for the Yuma Clapper Rail in the Muddy River and the Virgin River below the Bunkerville Irrigation Company service area, which is consistent with recovery plan goals.

B.5.3.3 Western Yellow-Billed Cuckoo

Western yellow-billed cuckoo habitat along the Virgin and Muddy Rivers is maintained by river flow and not agricultural returns. As described above, the assured flows from tributary conservation in the Muddy River and the Virgin River below the Bunkerville Irrigation Company service area may help support existing western yellow-billed cuckoo habitat. Consequently, the project is not expected to result in take of yellow-billed cuckoo. However, the potential changes in flows in the Muddy and Virgin Rivers will be difficult to measure or detect (Sections 5.1 and 5.2). Therefore, this project may affect, but is not likely to adversely affect the western yellow-billed cuckoo because the effects are expected to be insignificant.

There is no designated critical habitat for the western yellow-billed cuckoo.

B.5.3.4 Woundfin and Virgin River Chub

In the Virgin River non-native fish species are more prevalent downstream from the Bunkerville Diversion, although they do occur throughout the Lower Virgin River (Bio-West Inc. 2007:16, 19, 22, 24). There is a concern that the higher flows coupled with a possible change in maintenance or operation of the Bunkerville Division will allow additional non-native species to move upstream, which may impact the woundfin and Virgin River chub in the Virgin River. However, SNWA has agreed that its water will continue to be diverted and flow through the ditch systems of the irrigation company, so no change in the operation or maintenance of the Bunkerville Diversion is anticipated as part of the tributary conservation project. It is anticipated that the Bunkerville Diversion will continue to function as a partial barrier to upstream movement of non-native fish during low flows. Although the Bunkerville Diversion is a less effective fish barrier during high flows, the movement of non-native fishes past the Bunkerville Diversion is not expected to increase from current conditions because the possible additional flows are minor and may be manifested as underflow (See Sections 5.1 and 5.2). The small amount of additional flow (830 acre-feet per month in tributary conservation versus 6,641 acre-feet to 26,380 acre-feet per month average river flow), coupled with the complex geology of the Virgin River and braiding of the river at that location suggests that a more permanent connection will not be made between the Virgin River and Lake Mead because much of the minor additional flow will reach Lake Mead as underflow. Consequently, this project is not expected to adversely affect woundfin and Virgin River Chub in the Virgin River by increased opportunity for non-native fish movement upstream of the Bunkerville Diversion. In addition, the Virgin River Fishes Recovery Team and the Lower Virgin River Recovery Implementation Team are developing plans for a fish barrier at Halfway Wash. If installed, the fish barrier will effectively stop most, if not all, upstream movement of non-native fishes from Lake Mead.

Before 2007, woundfin had not been observed below the Bunkerville Irrigation Company service area along the Virgin River since 2001 (Bio-West, Inc. 2007: 23). However, in 2007, Bio-West, Inc. did document one woundfin within the Riverside reach below the Bunkerville Irrigation Company service area (B. Albrecht, personal communication July 12, 2007). It is anticipated that the tributary conservation water in the system may have a minor beneficial effect on the woundfin by providing assured flows below the Bunkerville Irrigation Company service area. However, as indicated in Sections 5.1 and 5.2, these additional flows will be difficult to meaningfully measure or detect. No additional predation by non-native fish species is anticipated because the minor additional flows will not provide enough water to result in a more permanent connection between the Virgin River and Lake Mead. Given the complex geology of the Virgin River at Lake Mead and the fact that the river channel is braided in that area, it is likely that the minor flows associated with tributary conservation will be manifested as underflow where the Virgin River meets Lake Mead. Therefore, this project may affect, but is not likely to adversely affect the woundfin because the potential effects are expected to be insignificant.

In the Virgin River, no effect to the Virgin River chub is anticipated because the tributary conservation flows will only be below the Mesquite and Bunkerville Irrigation Company service areas and Virgin River chub have not been collected below the Mesquite Diversion since the late 1970's (USFWS 1995: 9). As indicated in Section 5.2, flows from SNWA leased water in the Upper Muddy River will be virtually undetectable and therefore are not likely to adversely affect Virgin River Chub here because the flow effects are insignificant.

Woundfin and Virgin River Chub Critical Habitat. The critical habitat for the woundfin and Virgin River chub has historically been impacted by low flows on the Virgin River (USFWS 2000:4142). tributary conservation on the Virgin River is anticipated to have a beneficial, though minor, effect on critical habitat for the woundfin and Virgin River chub. To the extent that tributary conservation flows are not manifested as underflow below the Bunkerville Irrigation Company service area, tributary conservation may provide assured flows that can create additional species habitat and help lessen the effects of drought. Even if no beneficial effect on critical habitat is created from tributary conservation, degradation of critical habitat is not expected. No destruction or adverse modification to designated woundfin or Virgin River chub critical habitat is anticipated and, thus there will be no impact to recovery opportunities.

Virgin River Fishes Recovery Plan. The Virgin River Fishes Recovery Plan contains recovery goals for both the Virgin River chub and woundfin. The objective of the plan is to downlist both of the species from endangered to threatened. In order to meet the requirements for downlisting the following criteria must be met: (1) Virgin River flows essential to survival of all life stages are protected; (2) degraded Virgin River from Pah Tempe Springs to Lake Mead is upgraded and maintained to allow continued existence of all life stages at viable population levels; and (3) barriers to upstream migration of introduced fishes are established, red shiner is eliminated, and other nonnative species which present a major threat to the continued existence of the fish community are reduced (USFWS 1995:v). No additional predation by non-native fish species is anticipated to result from tributary conservation because the minor additional flows will not provide enough water to result in a more permanent connection to Lake Mead. Given the complex geology of the Virgin River at Lake Mead and the fact that the river channel is braided in that area, it is likely that the minor flows associated with tributary conservation will be manifested as underflow where the Virgin River meets Lake Mead. Tributary conservation may help meet the first criteria for downlisting by providing a minor amount of assured flows for woundfin, which have been recently found below the Bunkerville Irrigation Company service area, therefore the project is consistent with recovery plan goals.

B.5.3.5 Moapa Dace

Moapa dace is limited to the Warm Springs area along the Muddy River because of the temperature requirements of the species. The species has only been found within the first 6 miles of the river system (USFWS 1996:4). Assured water flows in that area via tributary conservation will consist of water from the water rights lease between SNWA and the LDS Church and possible purchases from other users. Part of the 1,000 afy of tributary conservation obtained through a lease in the upper portion of the Muddy River is already flowing unused in the Muddy River system. No additional changes are proposed as part of the tributary conservation project in the upper Muddy River and, therefore, no effect on the Moapa dace is anticipated as part of this project.

There is no critical habitat designated for the Moapa dace.

Recovery Plan for Rare Aquatic Species of Muddy River Ecosystem. The Recovery Plan for Rare Aquatic Species of the Muddy River Ecosystem contains recovery goals for the Moapa dace. The objective of the plan is to downlist the Moapa dace from endangered to threatened. In order to meet the requirements for downlisting, the following criteria must be met: (1) existing instream slows and historical habitat in three of the five spring systems in the upper Muddy River have to be protected through conservation agreements, easements, or fee title acquisitions; (2) 4,500 adult Moapa dace must be present among the five spring systems in the upper Muddy River; and (3) the Moapa dace population must be comprised of three or more age-classes, and reproduction and recruitment is documented from three spring systems (USFWS 1996: 33-34). Tributary conservation may help meet the second and third criteria for downlisting by counteracting the effects of low flows on the species. Therefore, this project is consistent with the recovery plan goals.

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U.S. Fish and Wildlife Service. 2006d. Virgin River Chub. Available: http://ecos.fws.gov/docs/life_histories/E02A.html. Accessed 5 December 2006.

U.S. Fish and Wildlife Service. 2006e. Moapa Dace. Available: http://ecos.fws.gov/docs/life_histories/E002.html. Accessed 19 October 2006.

Utah Division of Wildlife Resources, 2002. Virgin Spinedace (*Lepidomeda mollispinis mollispinsus*) Conservation Strategy.

Figure 1
Action Area in the Lower Virgin River

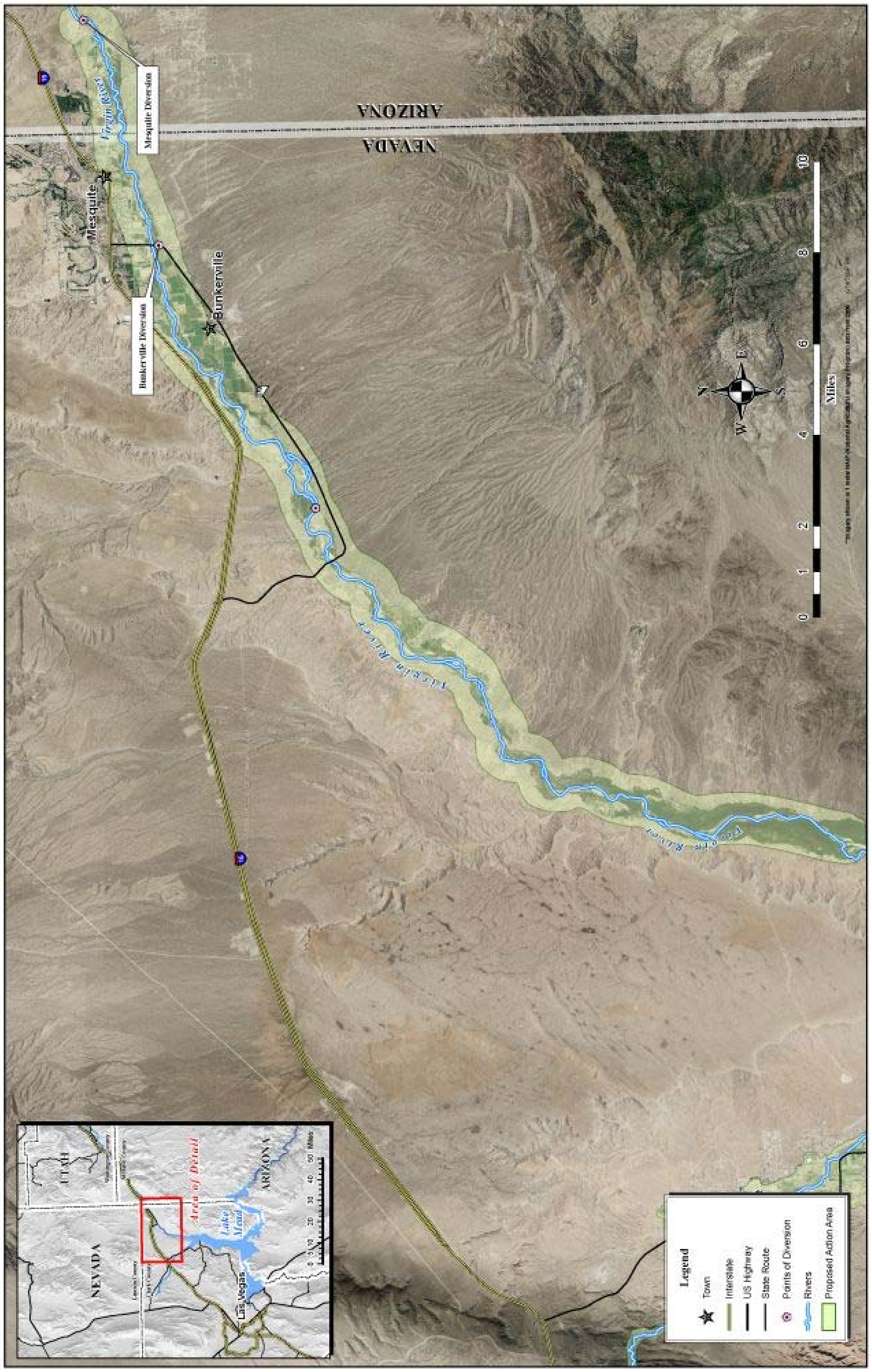


Figure 2
Action Area in the Muddy River

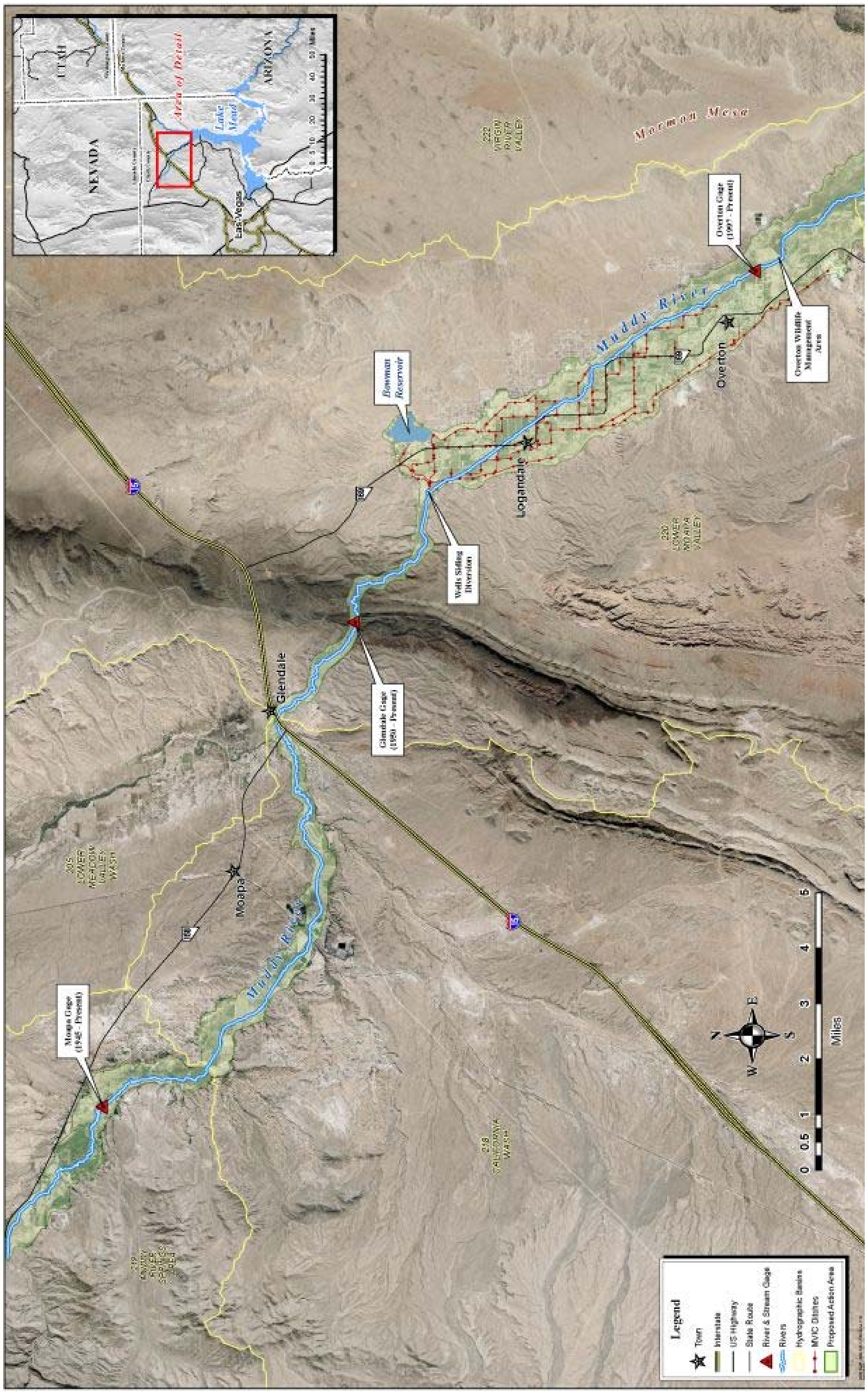
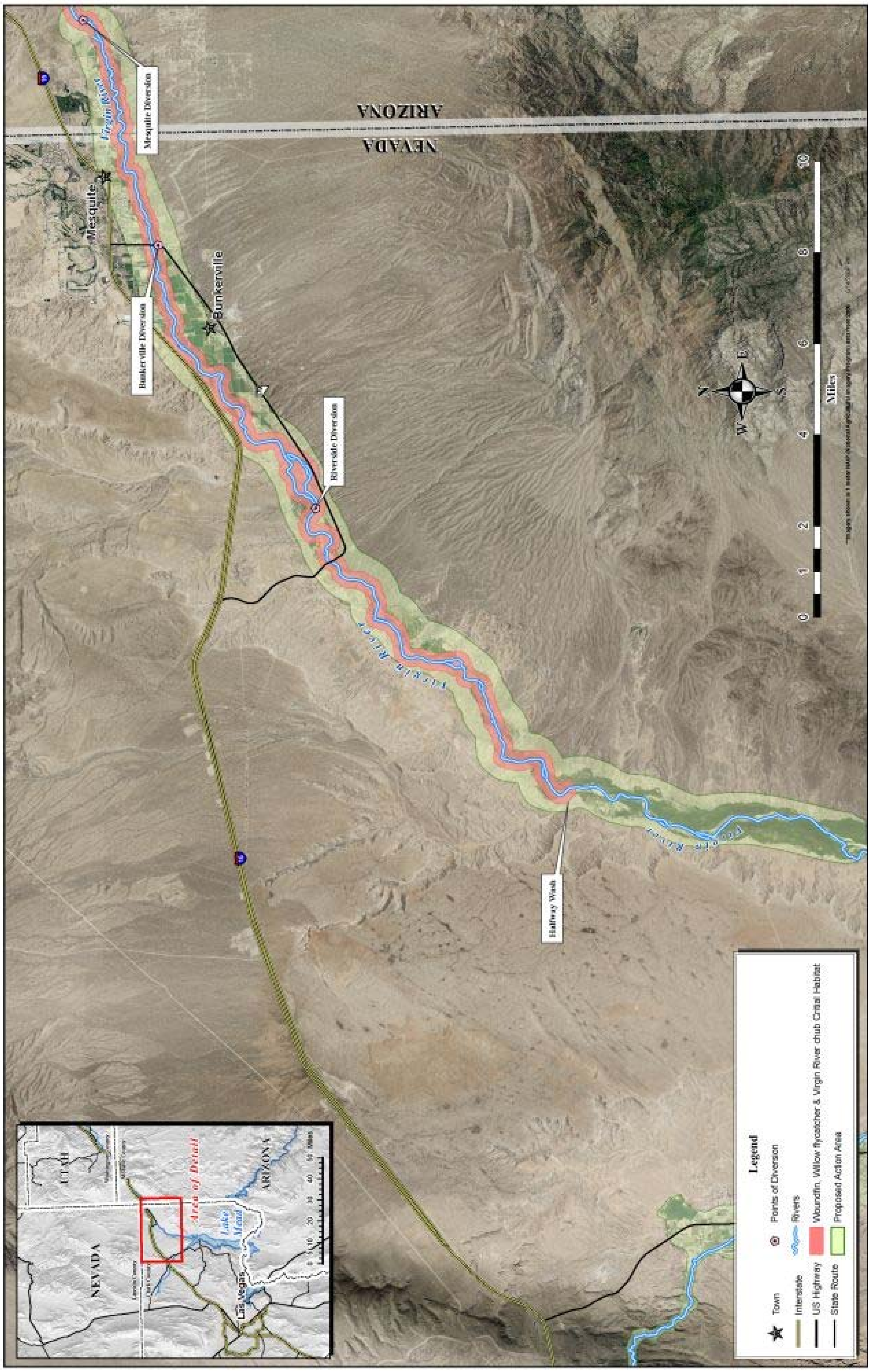


Figure 3
Critical habitat designated for woundfin and Virgin River chub within the Virgin River



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Attachment C

CRSS Model Outputs

This attachment to Appendix R describes the reservoir and river flow modeling outputs used in this biological assessment from Reclamation's Colorado River Simulation System (CRSS), as implemented in the RiverWare™ modeling system.

Figure BA-1
Lake Powell End-of-July Water Elevations
Comparison of Preferred Alternative to No Action Alternative
Percent of Values Greater than or Equal to Elevation 3,660 feet msl

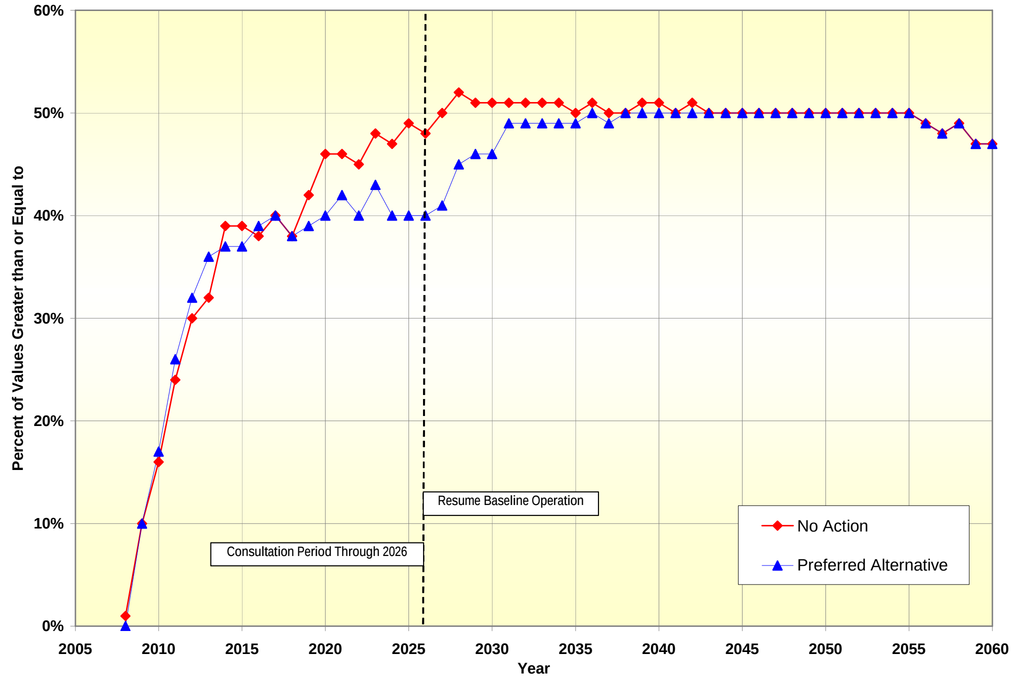

Figure BA-2
Lake Powell End-of-March Water Elevations
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

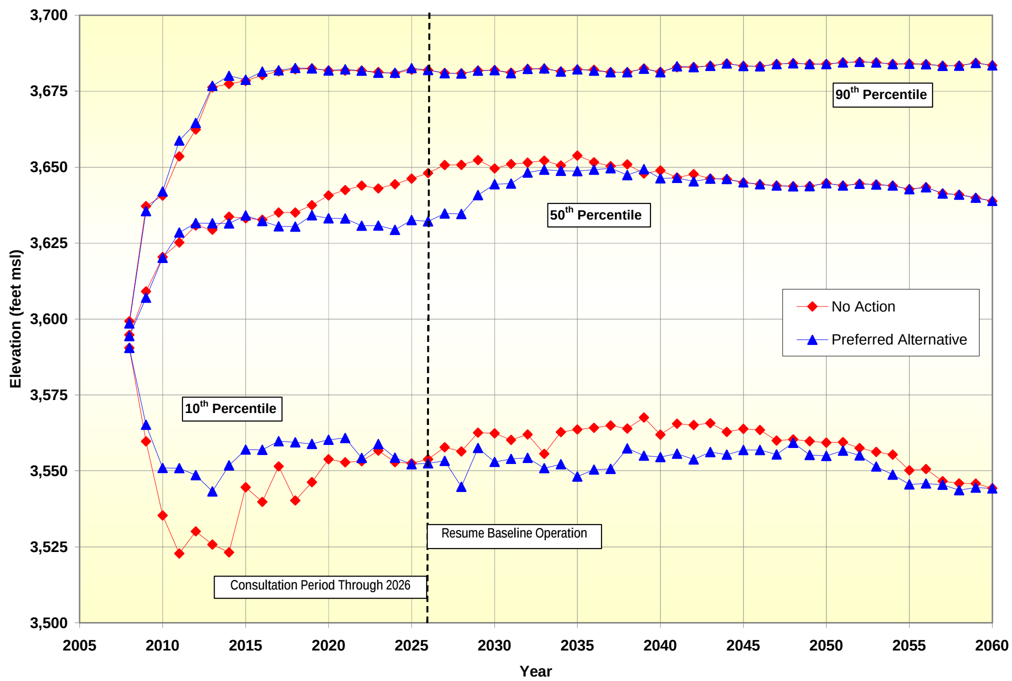

Figure BA-3
Lake Powell End-of-December Water Elevations
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

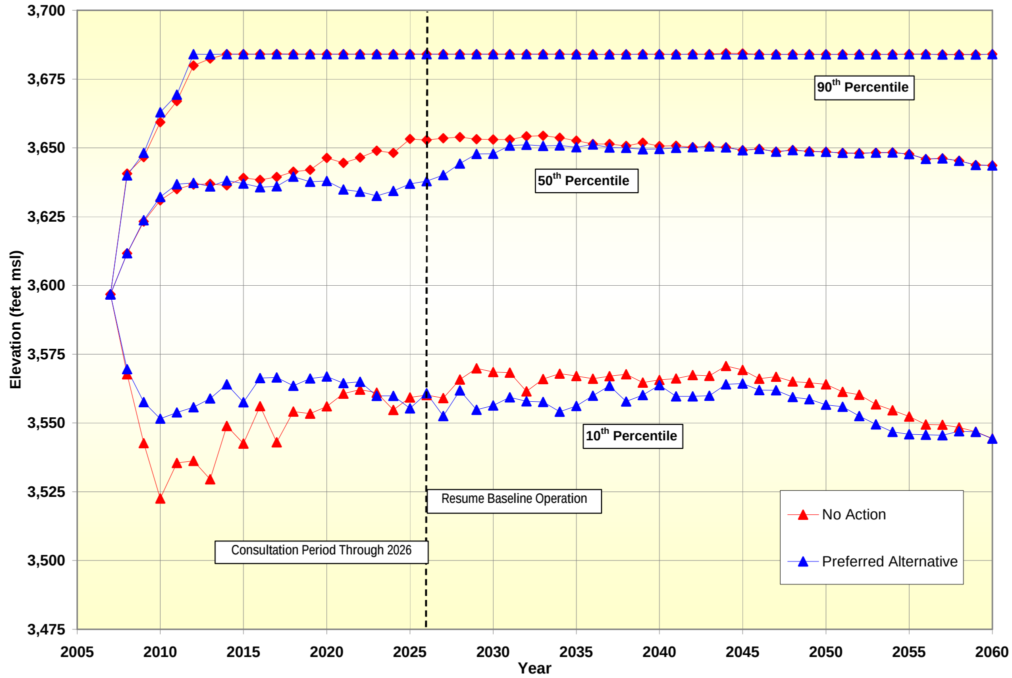

Figure BA-4
Lake Powell End-of-July Water Elevations
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

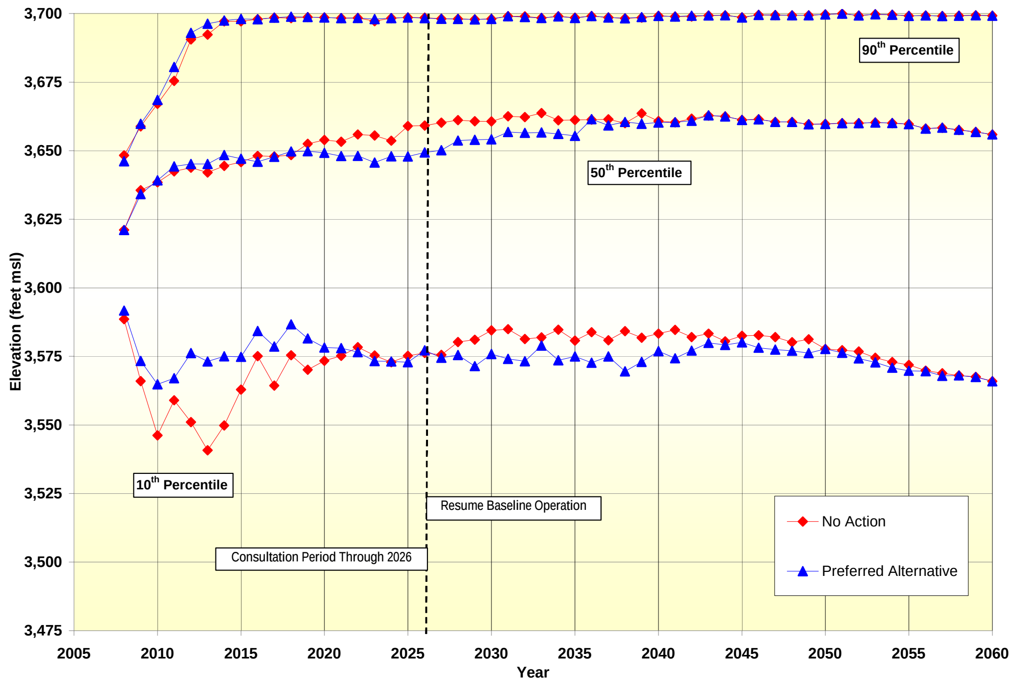

Figure BA-5
Lake Powell End-of-September Water Elevations
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

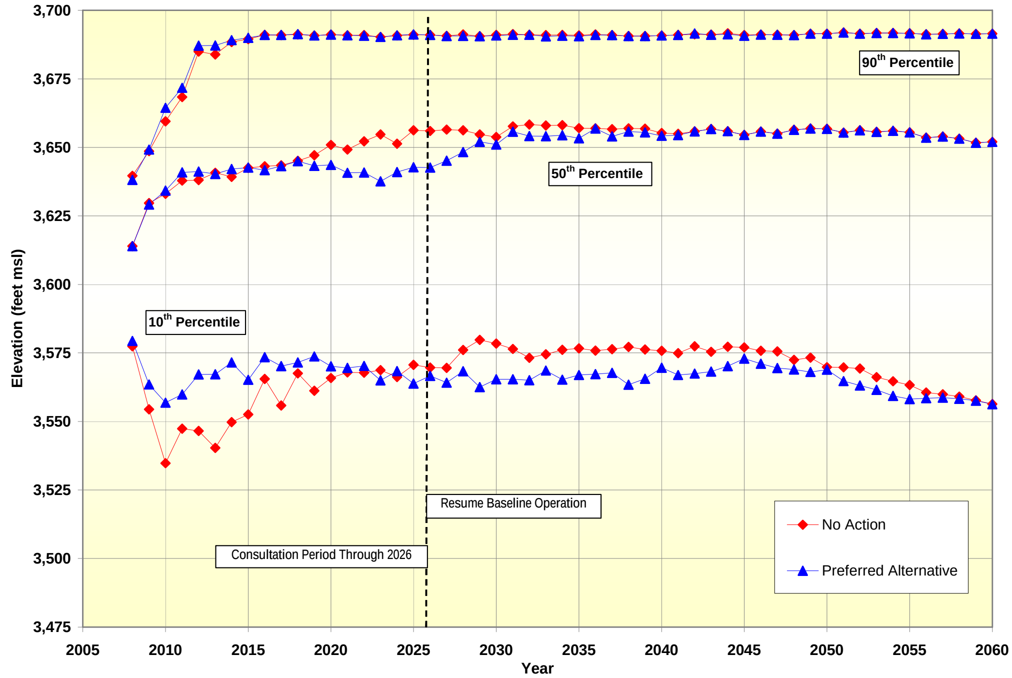

Figure BA-6
Glen Canyon Dam January Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

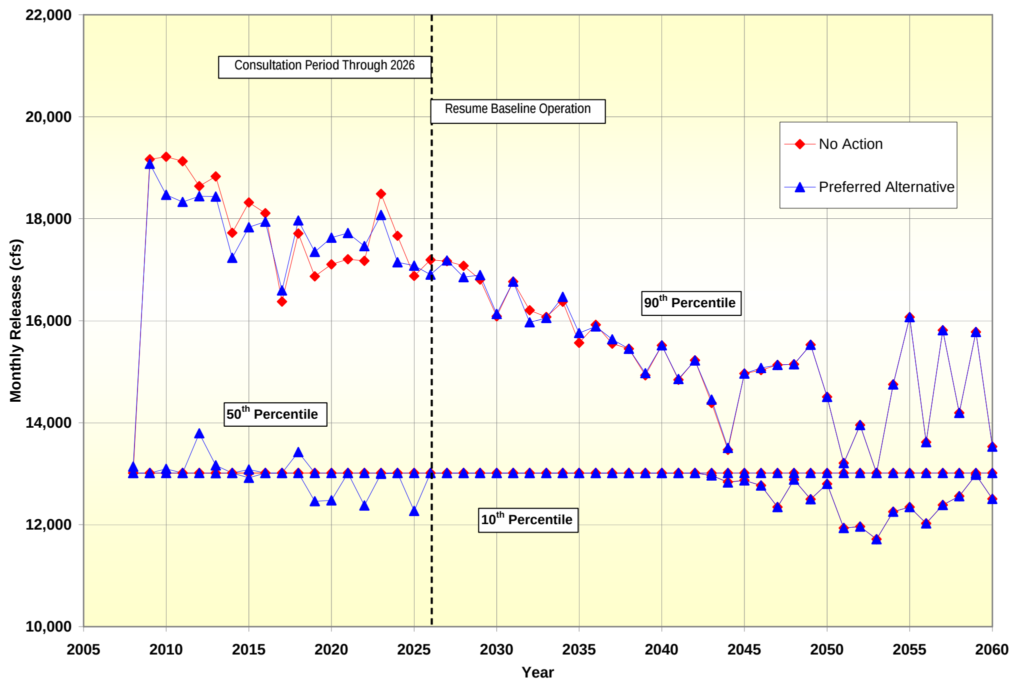

Figure BA-7
Glen Canyon Dam February Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

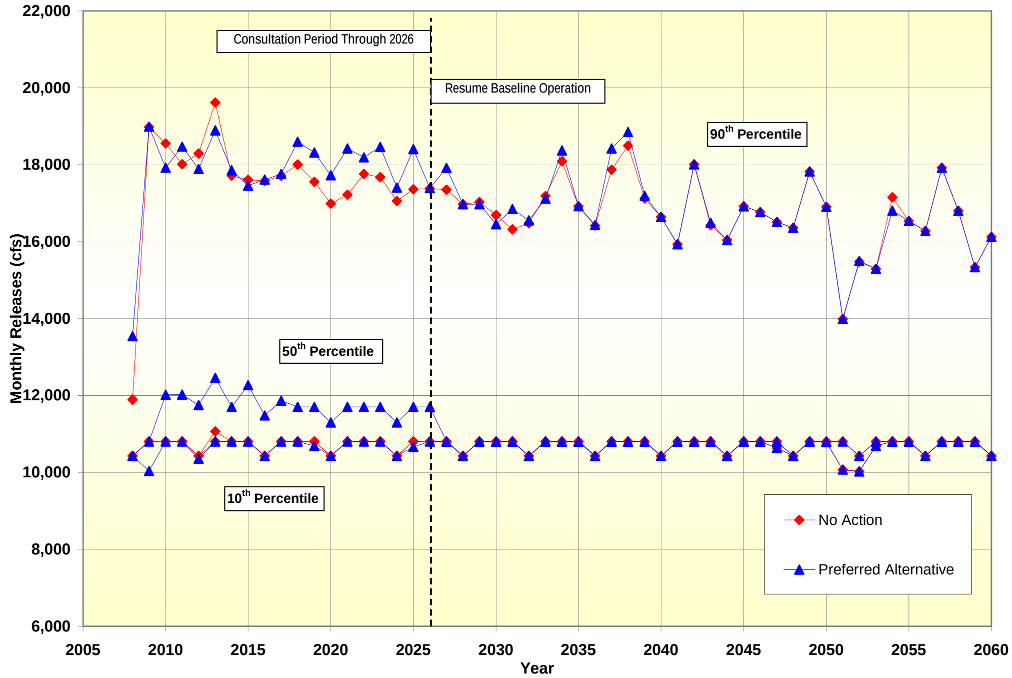

Figure BA-8
Glen Canyon Dam March Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

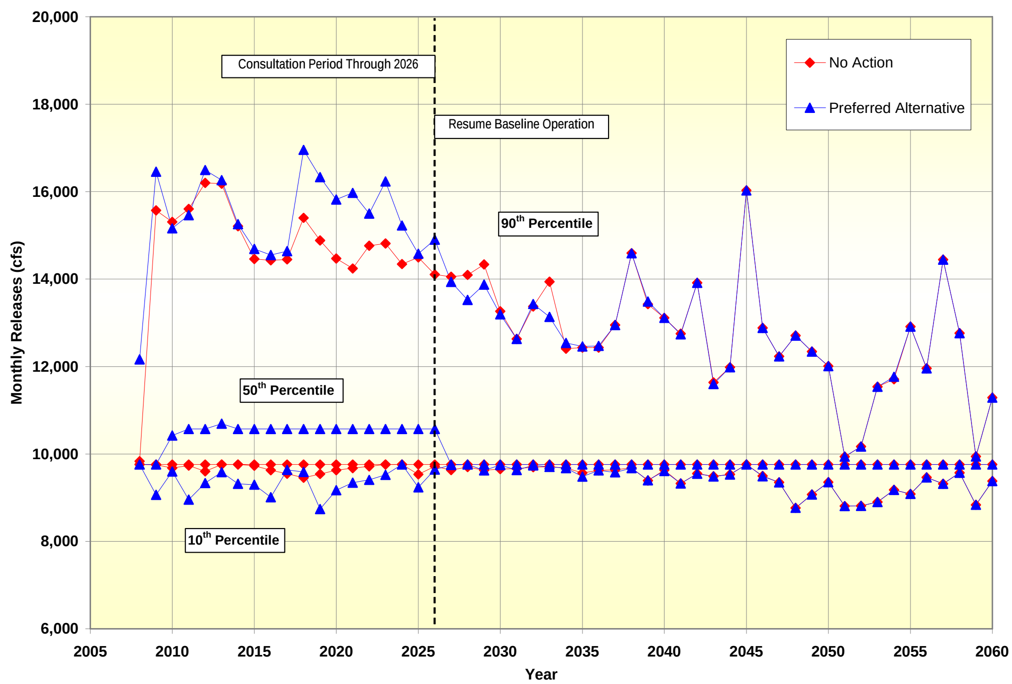

Figure BA-9
Glen Canyon Dam April Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

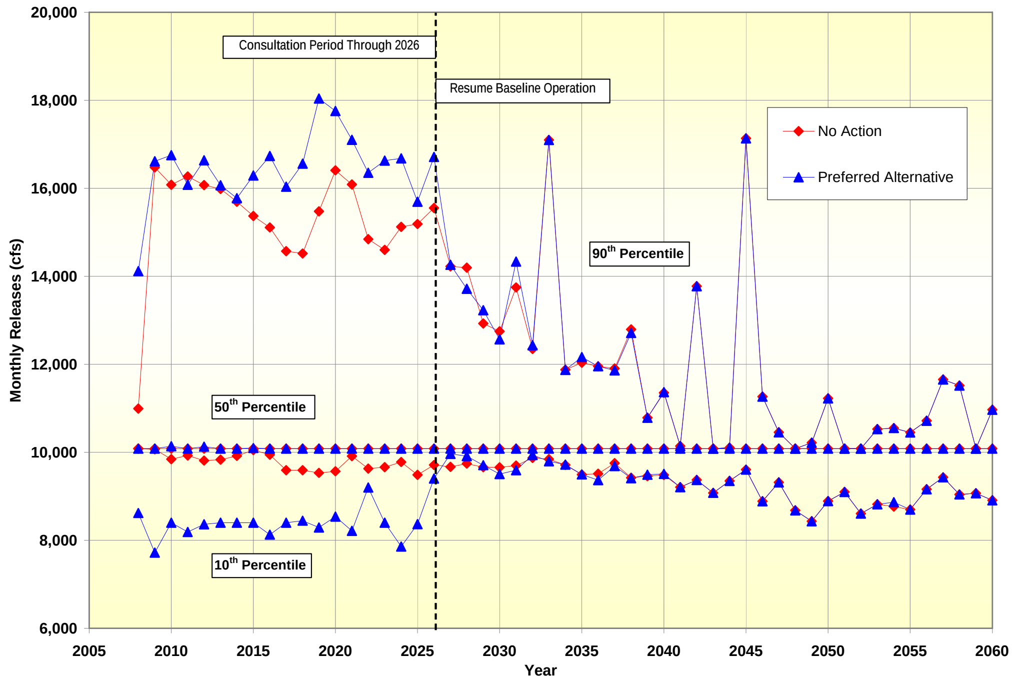

Figure BA-10
Glen Canyon Dam May Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

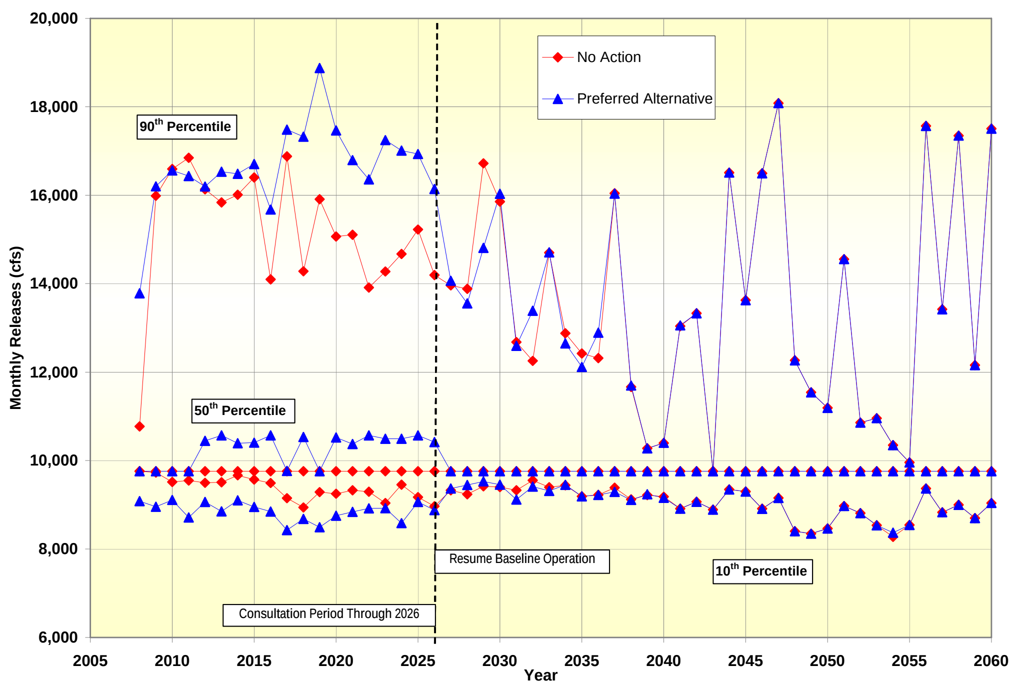

Figure BA-11
Glen Canyon Dam June Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

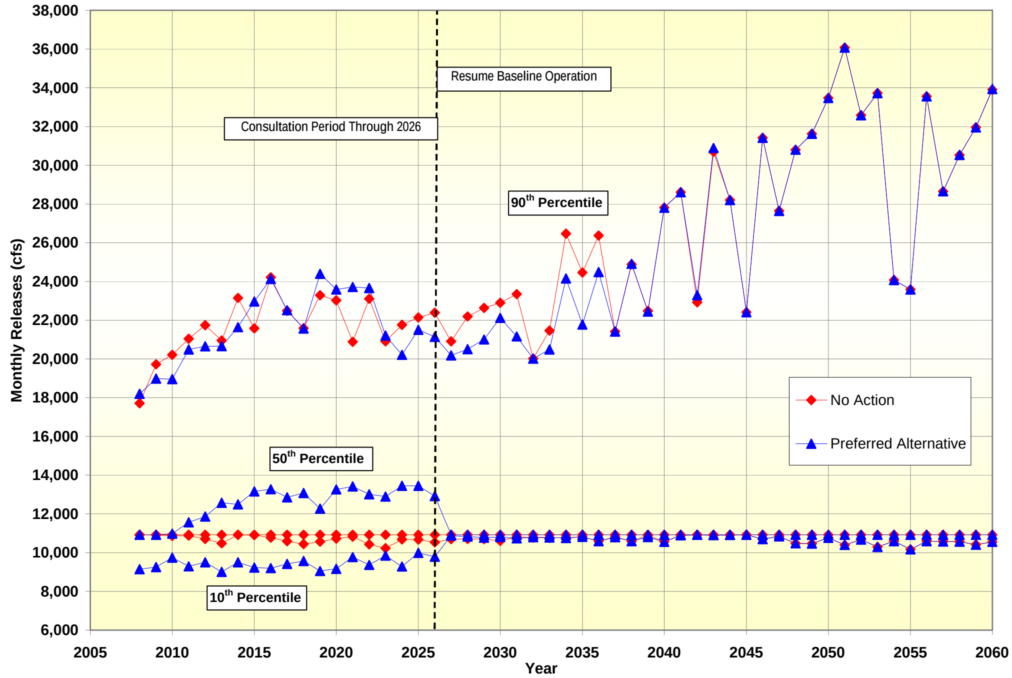

Figure BA-12
Glen Canyon Dam July Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

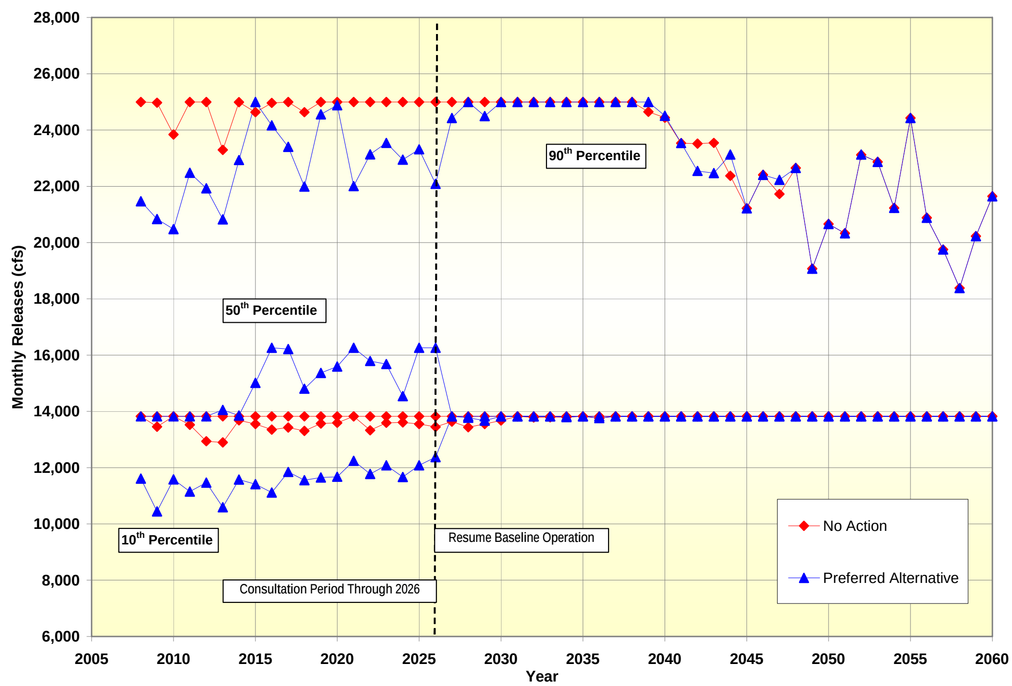

Figure BA-13
Glen Canyon Dam August Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

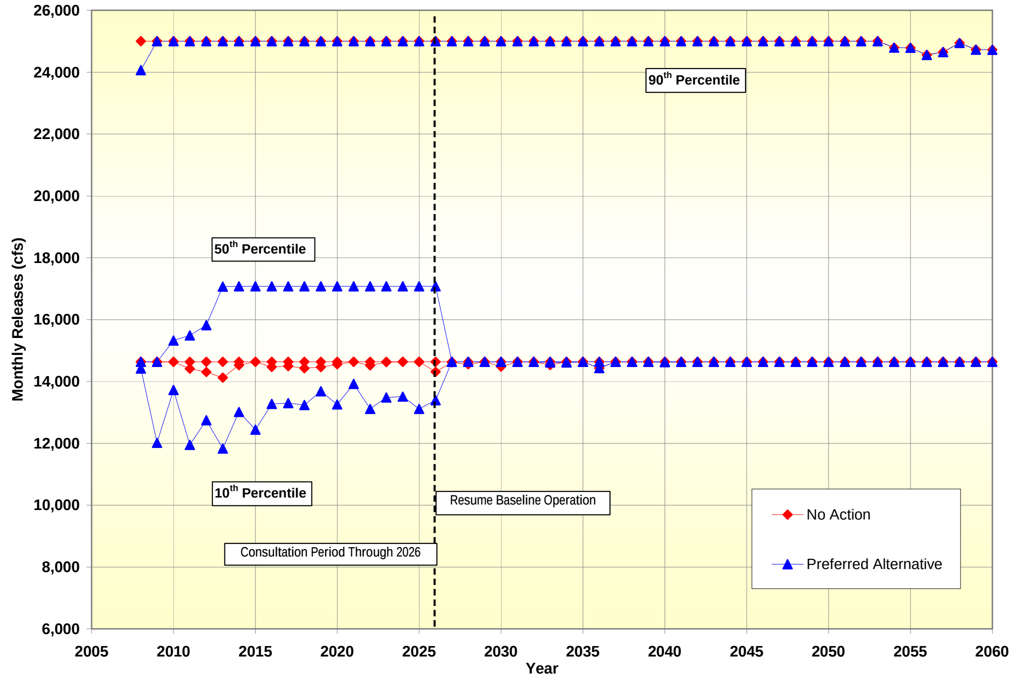

Figure BA-14
Glen Canyon Dam September Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

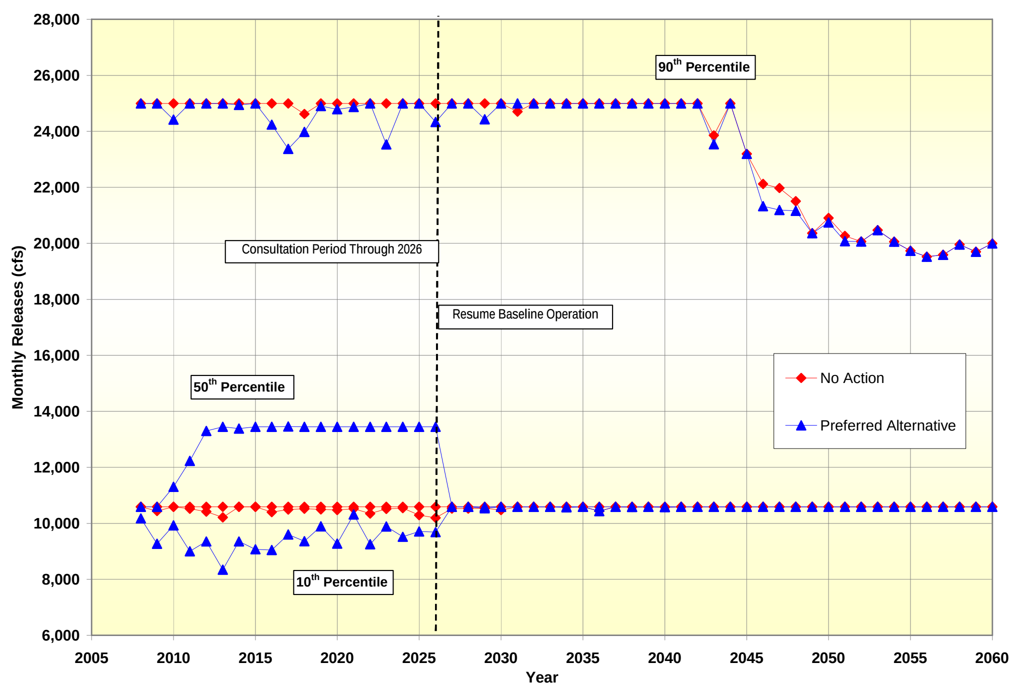

Figure BA-15
Glen Canyon Dam October Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

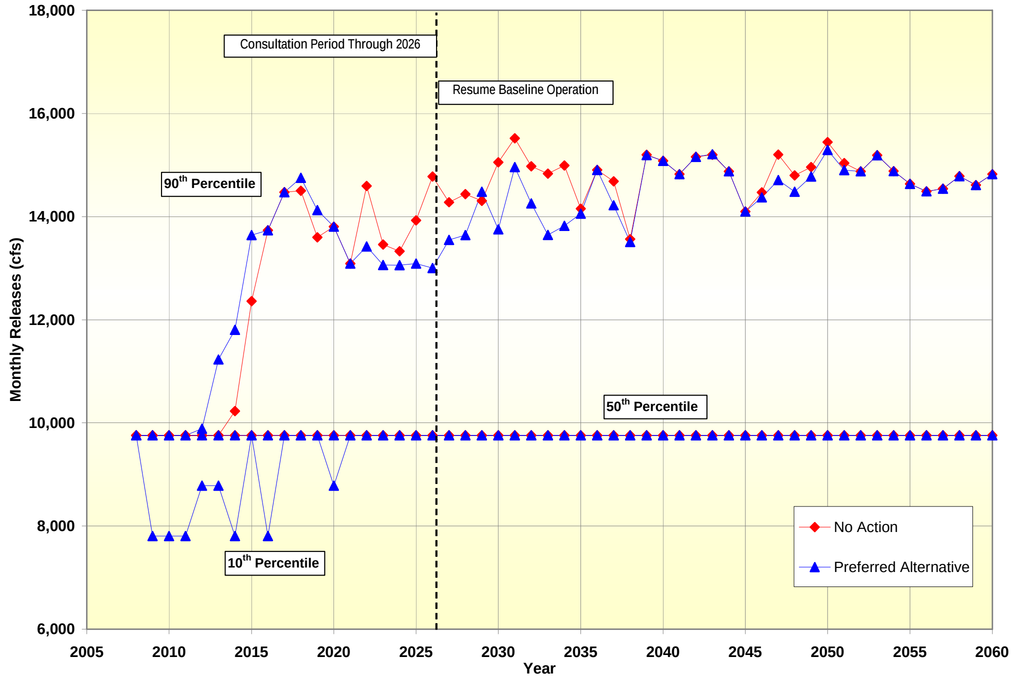

Figure BA-16
Glen Canyon Dam November Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

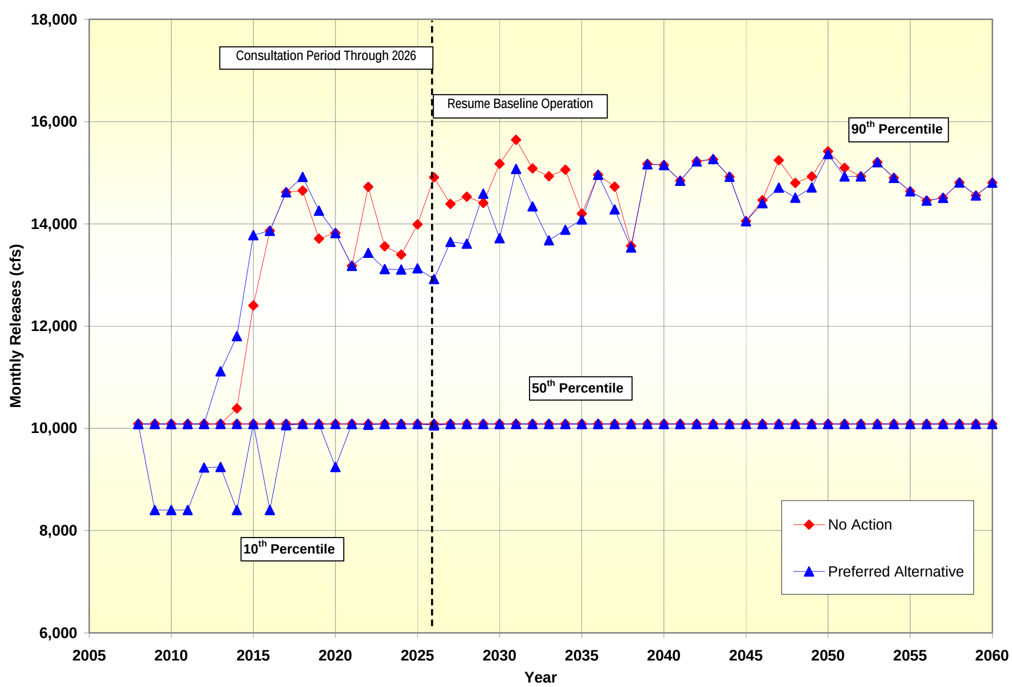

Figure BA-17
Glen Canyon Dam December Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th and 10th Percentile Values

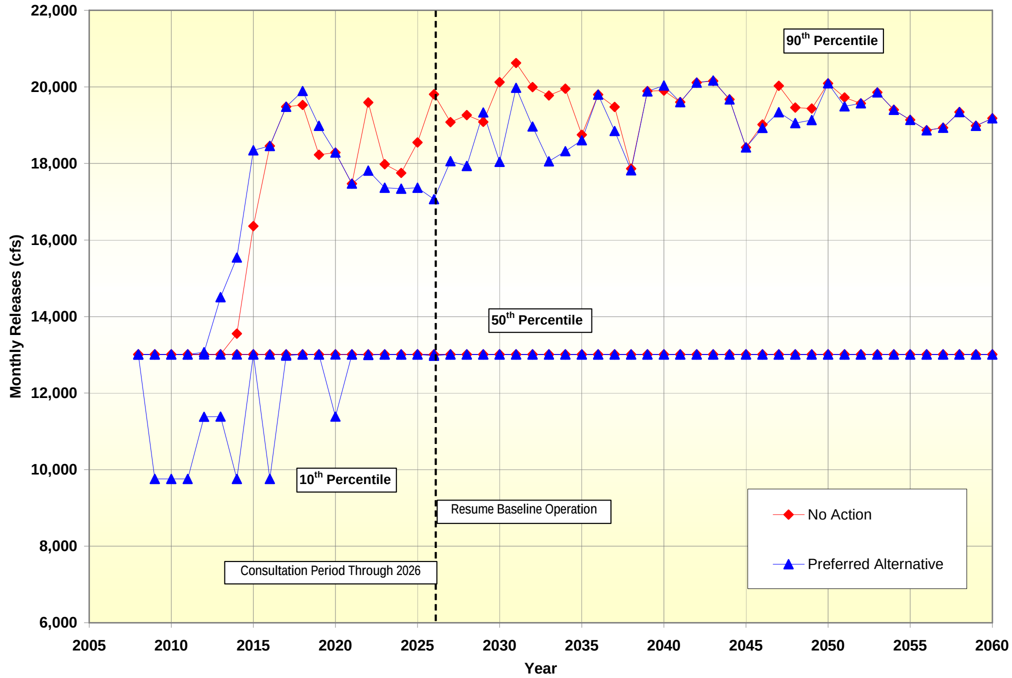

Figure BA-18
Colorado River at Lees Ferry
90th Percentile Temperatures
Upper and Lower Bound

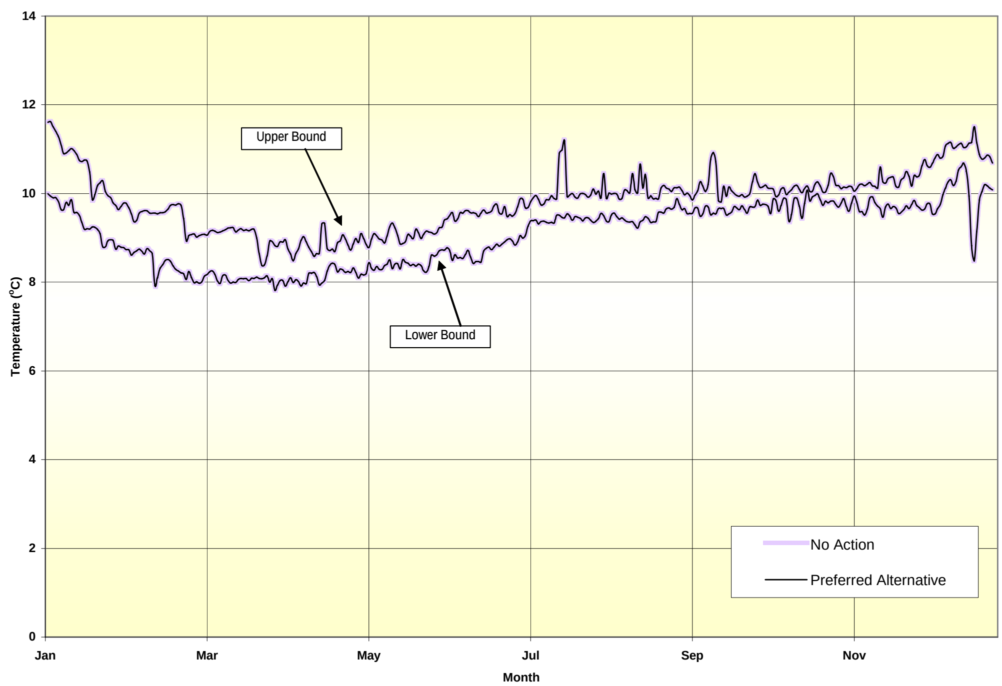

Figure BA-19
Colorado River at Lees Ferry
50th Percentile Temperatures
Upper and Lower Bound

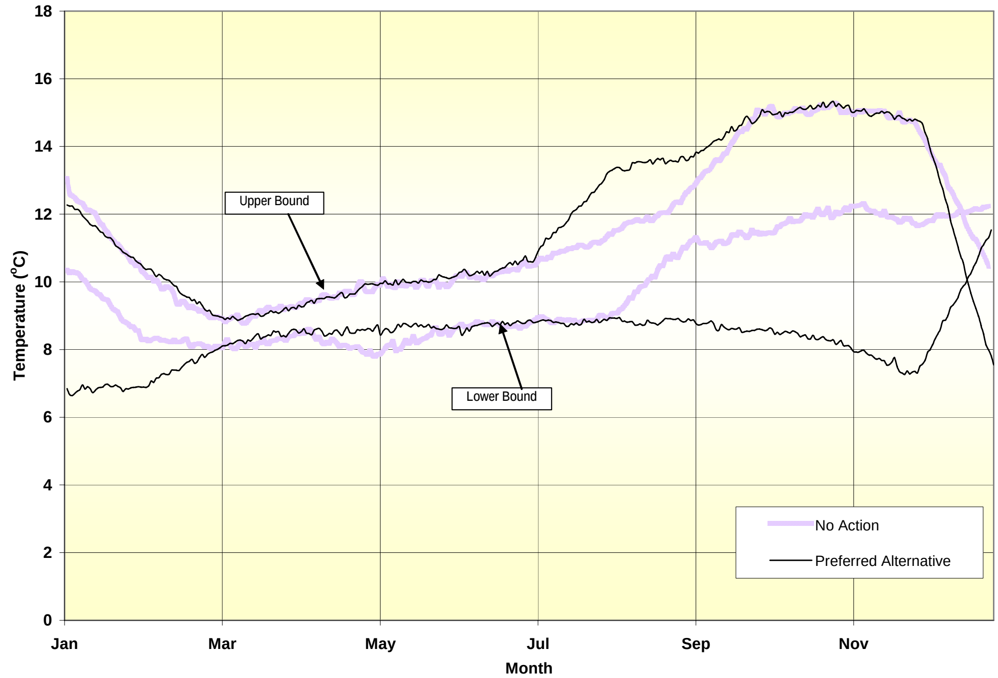

Figure BA-20
Colorado River at Lees Ferry
10th Percentile Temperatures
Upper and Lower Bound

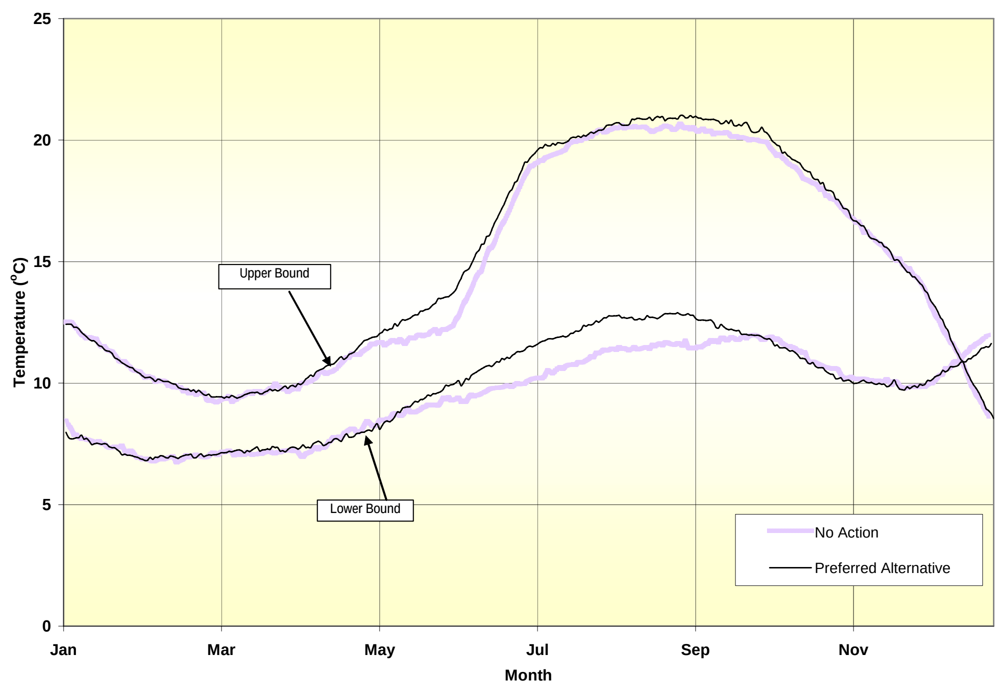

Figure BA-21
Colorado River Below Little Colorado Confluence
90th Percentile Temperatures
Upper and Lower Bound

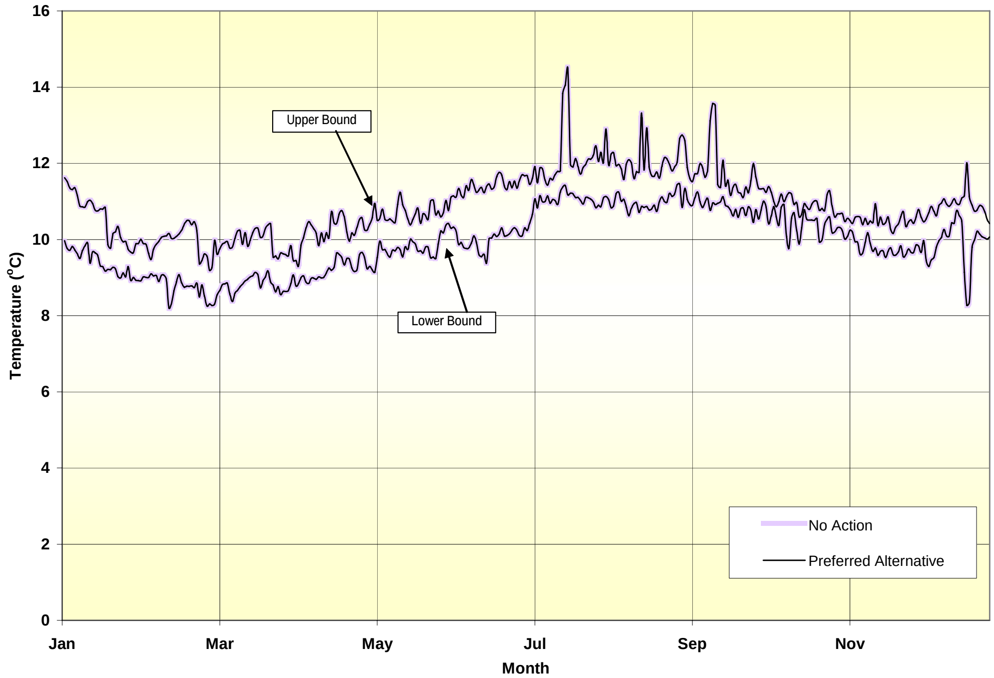

Figure BA-23
Colorado River Below Little Colorado Confluence
50th Percentile Temperatures
Upper and Lower Bound

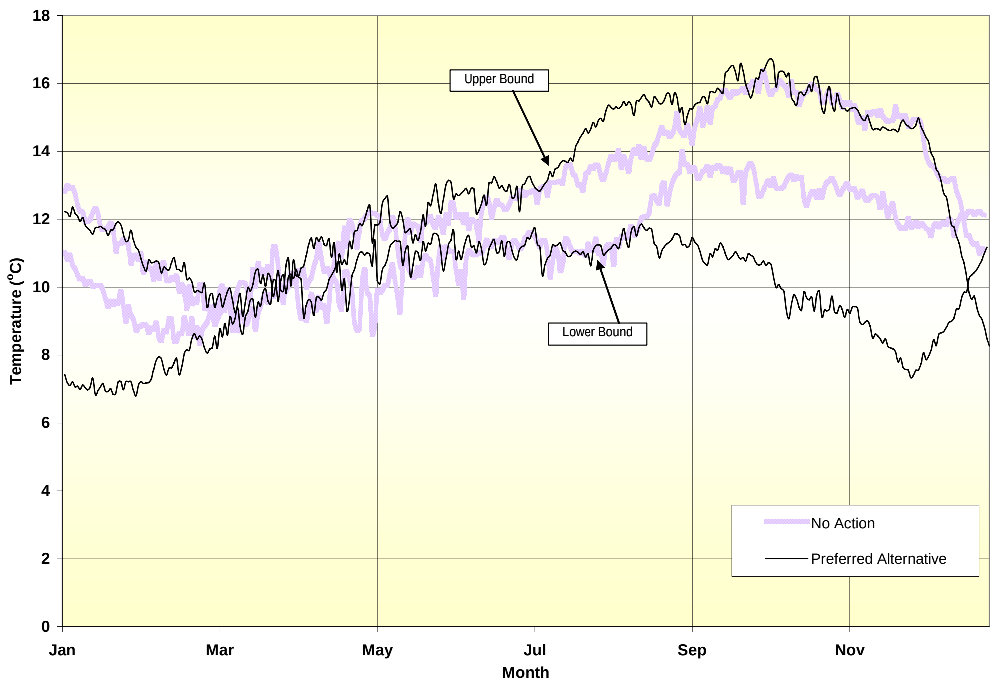

Figure BA-24
Colorado River Below Little Colorado Confluence
10th Percentile Temperatures
Upper and Lower Bound

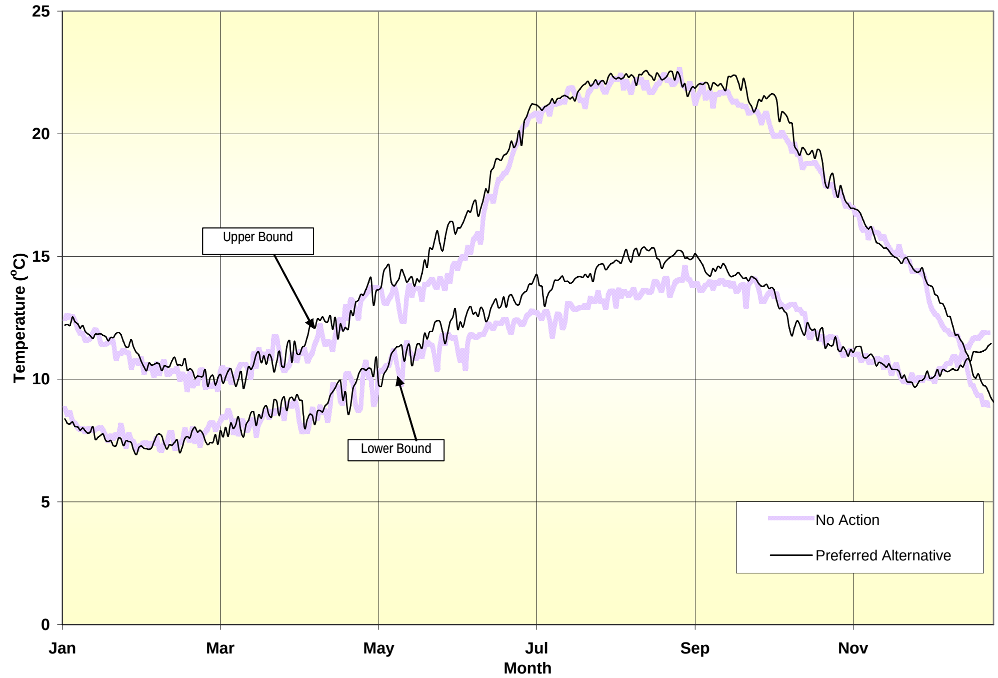

Figure BA-25
Colorado River Near Diamond Creek
90th Percentile Temperatures
Upper and Lower Bound

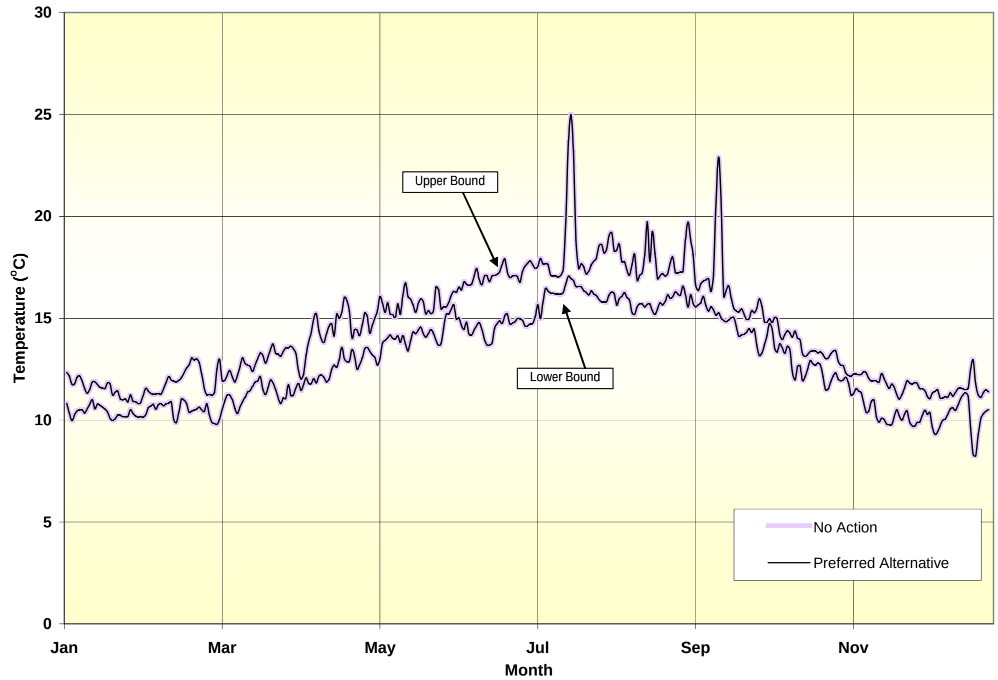

Figure BA-26
Colorado River Near Diamond Creek
50th Percentile Temperatures
Upper and Lower Bound

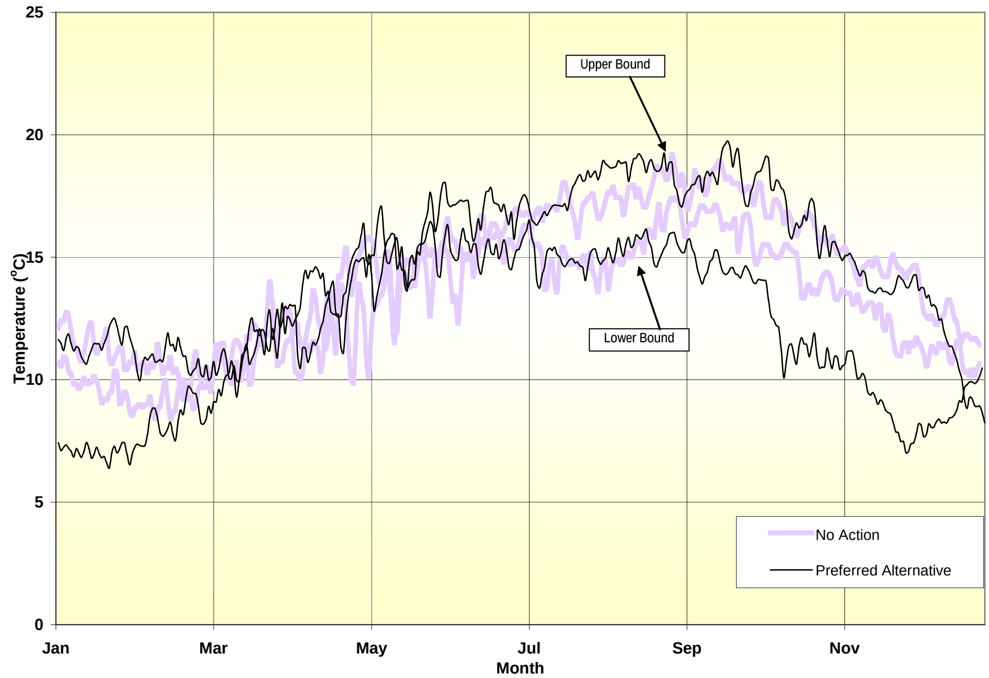

Figure BA-27
Colorado River Near Diamond Creek
10th Percentile Temperatures
Upper and Lower Bound

Table BA-1
Average Daily Glen Canyon Dam Releases (cfs)
Corresponding to Various Annual Release Volumes

	7.0 maf	7.48 maf	7.8 maf	8.23 maf	9.0 maf	9.5 maf	9.5 to 11.0 maf	11.0 to 16.0 maf
Oct	9,758	7,806	9,758	9,758	9,758	9,758	10,775	11,518
Nov	10,083	8,403	10,083	10,083	10,083	10,083	11,048	11,806
Dec	13,011	9,758	9,758	13,011	13,011	13,011	14,309	15,094
Jan	10,759	13,011	13,011	13,011	13,011	13,824	15,286	16,654
Feb	9,724	10,804	10,804	10,804	11,704	11,704	14,722	17,347
Mar	7,319	9,758	9,758	9,758	10,571	10,571	12,376	14,634
Apr	7,563	8,403	10,083	10,083	10,083	10,924	12,127	15,226
May	7,319	9,758	9,758	9,758	10,571	13,011	11,523	15,449
Jun	9,076	10,083	10,083	10,924	13,444	15,125	14,485	22,385
Jul	11,711	13,011	13,011	13,824	16,263	17,077	16,202	22,281
Aug	11,711	13,011	13,011	14,637	17,077	17,890	19,201	24,355
Sep	7,866	10,083	10,083	10,588	13,444	14,285	17,780	22,563

Table BA-2
Minimum Hourly Glen Canyon Dam Releases (cfs)
Corresponding to Various Annual Release Volumes

	7.0 maf	7.48 maf	7.8 maf	8.23 maf	9.0 maf	9.5 maf	9.5 to 11.0 maf	11.0 to 16.0 maf
Oct	6,458	5,006	6,458	6,458	6,458	6,458	7,475	8,218
Nov	6,783	5,603	6,783	6,783	6,783	6,783	7,748	8,506
Dec	8,711	6,458	6,458	8,711	8,711	8,711	10,009	10,794
Jan	7,459	8,711	8,711	8,711	8,711	9,524	10,986	12,354
Feb	6,924	7,504	7,504	7,504	8,404	8,404	10,422	13,047
Mar	5,000	6,458	6,458	6,458	7,271	7,271	9,076	10,334
Apr	5,000	5,603	6,783	6,783	6,783	7,624	8,827	11,926
May	5,000	6,458	6,458	6,458	7,271	8,711	8,223	11,149
Jun	6,276	6,783	6,783	7,624	9,144	10,825	10,185	17,000
Jul	8,411	8,711	8,711	9,524	11,963	12,777	11,902	17,000
Aug	8,411	8,711	8,711	10,337	12,777	13,590	14,901	17,000
Sep	5,066	6,783	6,783	7,288	9,144	9,985	13,480	17,000

Table BA-3
Maximum Hourly Glen Canyon Dam Releases (cfs)
Corresponding to Various Annual Release Volumes

	7.0 maf	7.48 maf	7.8 maf	8.23 maf	9.0 maf	9.5 maf	9.5 to 11.0 maf	11.0 to 16.0 maf
Oct	12,458	10,006	12,458	12,458	12,458	12,458	13,475	14,218
Nov	12,783	10,603	12,783	12,783	12,783	12,783	13,748	14,506
Dec	16,711	12,458	12,458	16,711	16,711	16,711	18,009	18,794
Jan	13,459	16,711	16,711	16,711	16,711	17,524	18,986	20,354
Feb	11,924	13,504	13,504	13,504	14,404	14,404	18,422	21,047
Mar	10,000	12,458	12,458	12,458	13,271	13,271	15,076	18,334
Apr	10,000	10,603	12,783	12,783	12,783	13,624	14,827	17,926
May	10,000	12,458	12,458	12,458	13,271	16,711	14,223	19,149
Jun	11,276	12,783	12,783	13,624	17,144	18,825	18,185	25,000
Jul	14,411	16,711	16,711	17,524	19,963	20,777	19,902	25,000
Aug	14,411	16,711	16,711	18,337	20,777	21,590	22,901	25,000
Sep	10,066	12,783	12,783	13,288	17,144	17,985	21,480	25,000

Table BA-4
Glen Canyon Dam Water Year Releases
Probability of Occurrence of Different Water Year Release Volumes
Comparison of Action Alternatives to No Action Alternative
Water Years 2008 through 2026

Glen Canyon Dam Release Volumes	Alternative	
	No Action	Preferred Alternative
Greater than 16.00 mafy	3.63%	3.53%
Between 11.01 to 16.00 mafy	17.11%	16.42%
Between 9.01 to 11.00 mafy	14.05%	14.37%
Between 8.51 to 9.00 mafy	4.42%	22.37%
Between 8.24 to 8.50 mafy	2.74%	2.11%
Minimum Objective Release of 8.23 mafy	57.74%	31.16%
Between 7.51 to 8.22 mafy	0.21%	0.68%
Between 7.01 to 7.50 mafy	0.05%	8.11%
Less than or equal to 7.00 mafy	0.05%	1.26%
Total	100.00%	100.00%

Table BA-5
Average Monthly Temperature at Lees Ferry

	No Action			Preferred Alternative		
Month	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
January	9.5	10.5	10	9.5	10.5	10
February	9	8.7	8.5	9	8.7	8.5
March	8.5	8.3	8.2	8.5	8.3	8.2
April	8.5	8.3	8.8	8.5	8.3	8.8
May	8.7	8.9	10	8.7	8.9	10
June	9	9.2	11.5	9	9.2	11.5
July	9.5	9.5	15	9.5	9.5	15
August	10	10.5	16	10	10.5	16
September	10.3	11	16.5	10.3	11	16.5
October	10.5	11.5	15.5	10.5	11.5	15.5
November	10.3	11.5	14	10.3	11.5	14
December	10	11	12	10	11	12

Table BA-6
Average Monthly Temperature Below Little Colorado river

	No Action			Preferred Alternative		
Month	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
January	10.0	10.8	9.7	10.0	9.4	9.7
February	9.4	9.4	8.9	9.4	9.1	9.0
March	9.4	9.8	9.5	9.4	9.7	9.4
April	9.7	10.3	10.5	9.7	10.7	10.8
May	10.2	11.0	12.2	10.2	11.5	12.8
June	10.7	11.7	14.4	10.7	12.0	15.4
July	11.5	12.1	18.0	11.5	12.4	17.8
August	11.5	13.0	17.8	11.5	13.4	18.7
September	11.4	14.4	17.6	11.4	13.4	18.2
October	10.7	14.4	16.0	10.7	12.9	16.1
November	10.2	13.8	13.3	10.2	11.8	13.3
December	10.4	12.4	11.2	10.4	10.5	11.2

Table BA-7
Average Monthly Temperature Near Diamond Creek

	No Action			Preferred Alternative		
Month	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
January	10.9	10.6	9.6	10.9	9.3	9.6
February	11.2	9.8	9.3	11.2	9.6	9.4
March	12.0	11.2	11.0	12.0	11.0	10.9
April	13.4	12.4	12.6	13.4	13.2	13.4
May	14.8	14.2	15.2	14.8	15.2	16.3
June	15.8	15.5	17.7	15.8	16.1	19.1
July	17.2	16.5	20.2	17.2	16.8	20.9
August	16.8	16.6	20.7	16.8	17.1	21.6
September	16.0	17.3	20.0	16.0	16.5	20.5
October	13.4	15.6	16.9	13.4	14.5	17.2
November	11.3	13.7	13.3	11.3	11.9	13.2
December	10.8	11.8	10.8	10.8	10.1	10.7

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Appendix S

Draft Interim Guidelines for the Operation of Lake Powell and Lake Mead

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The information provided in this Appendix S is intended to provide the public with draft information on the structure and content of the type of guidelines that the Department is considering that would implement the proposed federal action. This information is published herein in draft form, and is subject to further modification and refinement. Publication of this information does not represent any final determination by the Department on any of the issues addressed in these draft guidelines. Further, additional and updated information regarding the content and development of the information in these draft guidelines that would be implemented by a Record of Decision is anticipated to be provided to the public through the dedicated project website, (http://www.usbr.gov/lc/region/programs/strategies.html) following publication of this Final Environmental Impact Statement.

I. Introduction

A. Setting

[text to be inserted]

B. Purpose and Need

[text to be inserted]

C. Results of Scoping

[text to be inserted]

D. Scope of Guidelines

[text to be inserted]

II. Operational Setting

A. LROC

[text to be inserted]

B. Interim Surplus Guidelines (ISG)

[text to be inserted]

C. AOP

[text to be inserted]

III. Conditions of Implementation

A. Forbearance

1. Role of Forbearance Agreements within the Context of the Law of the River and Relationship to Intentionally Created Surplus (ICS).

For the purposes of these Guidelines, the term "forbearance agreements" refers to agreements that a party who has a right to surplus Colorado River water could enter into that would provide that party's agreement to forgo (or not exercise) its right to surplus Colorado River water. In any such agreements, the party agrees to "forbear" or refrain from exercising its right to surplus Colorado River water under the specified terms and conditions of the applicable agreement. Through such agreements, increased flexibility of Colorado River water management can be achieved – resulting in greater conservation of water than would otherwise be accomplished.

In Years in which the Secretary determines that sufficient Mainstream water is available for delivery to satisfy annual consumptive use in the Lower Division states in excess of 7.5 maf, Article II(B)(2) of the Consolidated Decree directs the Secretary to apportion such surplus Mainstream water 50% for use in California, 46% for use in Arizona, and 4% for use in Nevada. The Boulder Canyon Project Act and Articles II(B)(2) and II(B)(6) of the Consolidated Decree, taken together, authorize the Secretary to apportion surplus water and to deliver one Lower Division state's unused apportionment for use in another Lower Division state. Pursuant to such authority and for the purpose of increasing the efficiency, flexibility, and certainty of Colorado River management and thereby helping satisfy the current and projected regional water demands, the Secretary determined that it is prudent and desirable to promulgate guidelines to establish a procedural framework for facilitating the creation and delivery of ICS within the Lower Basin.

In the absence of forbearance, surplus water is apportioned for use in the Lower Division states according to the specific percentages provided in Article II(B)(2) of the Consolidated Decree discussed above. In order to allow for management flexibility, the seven Colorado River Basin States have recommended an operational program for the creation and delivery of ICS. In furtherance of this recommendation, numerous major water users within the Lower Basin have identified their willingness, under specified circumstances, to participate in such an operational program. These parties have submitted a draft "Forbearance Agreement," as preliminarily approved by the parties, as part of a package of documents (Appendix J) submitted for consideration by the Secretary as a necessary element to enable implementation of the operations contemplated by the Basin States Alternative. The Secretary has developed a Preferred Alternative based on this information, as well as other information submitted during the NEPA process.

The parties to the Forbearance Agreement have indicated that they intend that the Agreement provide the appropriate legal mechanism to achieve successful implementation of this element of the Preferred Alternative. The parties have indicated that among the conditions on their forbearance, they will forbear only with respect to a specified ICS volume and only to ICS created by projects described in exhibits attached to the Forbearance Agreement or added thereto by written consent of all parties. Given the voluntary nature of the forbearance concept, it is appropriate for the parties to clearly identify the limited conditions upon which their forbearance is granted.

Through adoption and implementation of these Guidelines, the Secretary will only approve the creation, delivery and use of ICS in a manner that is fully consistent with the provisions of the Consolidated Decree, including Articles II(B)(2) and II(B)(6) therein. The Secretary will require forbearance by the State of Arizona, the Colorado River Board of California, and the Colorado River Commission of Nevada for implementation of this element of these Guidelines (regarding ICS). If, in the opinion of the Secretary, the State of Arizona or the Colorado River Board of California or the Colorado River Commission of Nevada, unreasonably withhold forbearance, the Secretary may, after consultation with the Basin States, modify these Guidelines. Moreover, the Secretary will ensure that implementation of the ICS mechanism does not infringe on the rights of any third party who is a Contractor and who is not a party to the Forbearance Agreement.

2. Monitoring Implementation.

Under these Guidelines, Colorado River water will continue to be allocated for use among the Lower Division states in a manner consistent with the provisions of the Consolidated Decree. It is expected that Lower Division states and individual Contractors for Colorado River water have or will adopt arrangements that will affect utilization of Colorado River water during the Interim Period. It is expected that water orders from Colorado River Contractors will be submitted to reflect forbearance arrangements by Lower Division states and individual Contractors. The Secretary will deliver Colorado River water to Contractors in a manner consistent with these arrangements, provided that any such arrangements are consistent with the BCPA, the Consolidated Decree and do not infringe on the rights of third parties. Surplus water will only be delivered to entities with contracts for surplus water. ICS will be delivered pursuant to Section 3.C. of these Guidelines and a Delivery Agreement.

B. Delivery Agreement

Article II(B)(5) of the Consolidated Decree in *Arizona v. California* states that mainstream Colorado River water shall be released or delivered to water users in Arizona, California, and Nevada “only pursuant to valid contracts therefore made with such users by the Secretary of the Interior, pursuant to Section 5 of the Boulder Canyon Project Act or any other applicable federal statute.” Section 5 of the Boulder Canyon Project Act authorizes the Secretary to enter into such contracts.

Numerous Contractors in Arizona, California, and Nevada now hold contracts which entitle them to the delivery of Colorado River water under the circumstances and in the priorities specified in the individual contracts. Contracts entered into prior to the adoption of these Guidelines do not, however, expressly address circumstances in which ICS or DSS might be created or delivered.

To ensure the requirements of Section 5 of the Boulder Canyon Project Act and Article II(B)(5) of the Consolidated Decree are complied with, and to reduce the possibility of ambiguity, the Secretary anticipates entering into delivery contracts with any person or persons intending to create ICS or DSS. Such contracts are expected to address the requirements set forth in the Guidelines for the approval of ICS or DSS plans, the certification and verification of the ICS or DSS created under the plans, the ordering and delivery of ICS or DSS, the accounting for ICS or DSS in the annual report filed with the United States Supreme Court in accordance with Article V of the Consolidated Decree, and such other matters as may bear on the delivery of the ICS or DSS, as for example the point of delivery and place of use, if not already provided for under existing contracts.

C. Mexico

[text to be inserted]

D. Intentionally Created Surplus

Findings - ICS may be created through projects that create water system efficiency or extraordinary conservation or tributary conservation or the importation of non-Colorado River System water into the Colorado River Mainstream. ICS is consistent with the concept that entities may take actions to augment storage of water in the lower Colorado River Basin. The ICS shall be delivered to the Contractor that created it pursuant to both Article II(B)(2) of the Consolidated Decree and Forbearance Agreements. Implementation of these Guidelines for ICS is conditioned upon execution of Forbearance Agreements and Delivery Agreements as further provided for in these Guidelines.

Purposes - The primary purposes of ICS are to: 1) Encourage the efficient use and management of Colorado River water; and to increase the water supply in Colorado River System reservoirs, through the creation, delivery and use of ICS; 2) Help minimize or avoid shortages to water users in the Lower Basin; 3) Benefit storage of water in both Lake Powell and Lake Mead; 4) Increase the surface elevations of both Lake Powell and Lake Mead to higher levels than would have otherwise occurred; and 5) Assure any Contractor that invests in conservation or augmentation to create ICS that no other Contractor will claim the ICS created by the Contractor pursuant to an approved plan by the Secretary.

Quantities - The maximum quantities of Extraordinary Conservation ICS that may be accumulated in all ICS Accounts, at any time, upon the effective date of these Guidelines is limited to the amounts provided in Section 3.B.5.of these Guidelines. The maximum quantities of Extraordinary Conservation ICS that may be created and/or delivered in any given Year are also limited to the amounts provided in Sections 3.B.4. and 3.C.4., respectively. As described in the Final EIS, Reclamation has analyzed ICS amounts in excess of the amounts approved by this Record of Decision and provided in these Guidelines. Any decision by the Secretary to increase the amounts in excess of the amounts provided in these Guidelines would be based on actual operating experience and would require modification of these Guidelines after consultation with the Basin States.

E. Relationship with Existing Law

These Guidelines are not intended to, and do not:

1. guarantee or assure any water user a firm supply for any specified period;

2. change or expand existing authorities under applicable federal law, except as specifically provided herein with respect to determinations under the Long Range Operating Criteria and administration of water supplies during the effective period of these Guidelines;

3. address intrastate storage or intrastate distribution of water, except as may be specifically provided by Lower Division states and individual contractors for Colorado River water who may adopt arrangements that will affect utilization of Colorado River water during the effective period of these Guidelines;

4. change the apportionments made for use within individual States, or in any way impair or impede the right of the Upper Basin to consumptively use water available to that Basin under the Colorado River Compact;

5. affect any obligation of any Upper Division state under the Colorado River Compact;

6. affect any right of any State or of the United States under Sec. 14 of the Colorado River Storage Project Act of 1956 (70 Stat. 105); Sec. 601(c) of the Colorado River Basin Project Act of 1968 (82 Stat. 885); the California Limitation Act (Act of March 4, 1929; Ch. 16, 48th Sess.); or any other provision of applicable federal law;

7. affect the rights of any holder of present perfected rights or reserved rights, which rights shall be satisfied within the apportionment of the State within which the use is made, and in the Lower Basin, in accordance with the Consolidated Decree; or

8. constitute an interpretation or application of the 1944 Treaty between the United States and Mexico Relating to the Utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande (1944 Treaty) or to represent current United

States policy or a determination future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions including consultation with the Basin States regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the International Boundary and Water Commission (IBWC) in consultation with the Department of State.

F. Definitions

For purposes of these Guidelines, the following definitions apply:

1. "24-Month Study" refers to the operational study that reflects the current Annual Operating Plan that is updated each month by Reclamation to project future reservoir contents and releases. The projections are updated each month using the previous month's reservoir contents and the latest inflow and water use forecasts. In these Guidelines, the term "projected on January 1" shall mean the projection of the January 1 reservoir contents provided by the 24-Month Study that is conducted in August of the previous Year.

2. "AOP" shall mean the Annual Operating Plan for the Colorado River System Reservoirs.

3. "BCPA" shall mean the Boulder Canyon Project Act of 1928 (28 Stat. 1057).

4. "Basin States" shall mean the seven Colorado River Basin States of Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming.

5. "Certification Report" shall mean the written documentation provided by a Contractor that provides the Secretary with sufficient information to allow the Secretary to determine whether the quantity of ICS or DSS approved by the Secretary in an approved plan has been created and whether the creation was consistent with the approved plan.

6. "Colorado River System" shall have the same meaning as defined in the 1922 Colorado River Compact.

7. "Consolidated Decree" shall mean the Consolidated Decree entered by the United States Supreme Court in *Arizona v. California*, 547 U.S. 150 (2006).

8. "Contractor" shall mean an entity holding an entitlement to Mainstream water under (a) the Consolidated Decree, (b) a water delivery contract with the United States through the Secretary, or (c) a reservation of water by the Secretary, whether the entitlement is obtained under (a), (b) or (c) before or after the adoption of these Guidelines.

9. "DSS Account" shall mean records established by the Secretary regarding DSS.

10. "Delivery Agreement" shall mean an agreement consistent with these Guidelines entered into between the Secretary of the Interior and one or more Contractors creating ICS.

11. "Developed Shortage Supply ("DSS")" shall mean water available for use by a Contractor under the terms and conditions of a Delivery Agreement and Section 4 of these Guidelines in a Shortage Condition, under Article III(B)(3) of the Consolidated Decree.

12. "Direct Delivery Domestic Use" shall mean direct delivery of water to domestic end users or other municipal and industrial water providers within the contractor's area of normal service, including incidental regulation of Colorado River water supplies within the Year of operation but not including Off-stream Banking. For the Metropolitan Water District of Southern California (MWD), Direct Delivery Domestic Use shall include delivery of water to end users within its area of normal service, incidental regulation of Colorado River water supplies within the Year of operation, and Off-stream Banking only with water delivered through the Colorado River Aqueduct.

13. "Domestic Use" shall have the same meaning as defined in the 1922 Colorado River Compact.

14. "Forbearance Agreement" shall mean an agreement under which one or more Contractors agree to forbear a right to ICS, under a water delivery contract or the Consolidated Decree.

15. "ICS Account" shall mean records established by the Secretary regarding ICS.

16. "ICS Determination" shall mean a determination by the Secretary that ICS is available for delivery.

17. "Intentionally Created Surplus ("ICS")" shall mean surplus Colorado River System water available for use under the terms and conditions of a Delivery Agreement, a Forbearance Agreement, and these Guidelines.

    a. ICS created through extraordinary conservation, as provided for in Section 3.A.1., shall be referred to as "Extraordinary Conservation ICS."

    b. ICS created through tributary conservation, as provided for in Section 3.A.2., shall be referred to as "Tributary Conservation ICS."

    c. ICS created through system efficiency projects, as provided for in Section 3.A.3., shall be referred to as "System Efficiency ICS."

    d. ICS created through the importation of non-Colorado River System Water, as provided for in Section 3.A.4., shall be referred to as "Imported ICS."

18. “Interim Period” shall mean the effective period as described in Section 8.

19. “Long Range Operating Criteria (“LROC”)” shall mean the Criteria for the Coordinated Long Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Pub. L. No. 90-537), published at 35 Fed. Reg. 8951 (June 10, 1970), as amended March 21, 2005.

20. “Lower Division states” shall mean the Colorado River Basin States of Arizona, California, and Nevada.

21. “Mainstream” shall have the same meaning as defined in the Consolidated Decree.

22. “Off-stream Banking” shall mean the diversion of Colorado River water to underground storage facilities for use in subsequent Years from the facility used by a Contractor diverting such water.

23. “ROD” shall mean the Record of Decision issued by the Secretary for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.

24. “Upper Division states” shall mean the Colorado River Basin States of Colorado, New Mexico, Utah, and Wyoming.

25. “Water Year” shall mean October 1 through September 30.

26. “Year” shall mean calendar year.

G. Interim Guidelines for the Operation of Lake Powell and Lake Mead

These Guidelines shall include Sections III.A., B., E., and F. above and this Section III.G. These Guidelines which shall implement and be used for determinations made pursuant to the Long Range Operating Criteria during the effective period identified in Section 8, are hereby adopted:

Section 1. Allocation of Unused Basic Apportionment Water Under Article II(B)(6)

A. Introduction

Article II(B)(6) of the Consolidated Decree allows the Secretary to allocate water that is apportioned to one Lower Division state, but is for any reason unused in that State, to another Lower Division state. This determination is made for one Year only and no rights to recurrent use of the water accrue to the state that receives the allocated water.

B. Application to Unused Basic Apportionment

Before making a determination of a Surplus Condition under these Guidelines, the Secretary will determine the quantity of apportioned but unused water excluding ICS created in that Year from the basic apportionments under Article II(B)(6), and will allocate such water in the following order of priority:

1. Meet the Direct Delivery Domestic Use requirements of MWD and Southern Nevada Water Authority (SNWA), allocated as agreed by said agencies;

2. Meet the needs for Off-stream Banking activities for use in California by MWD and for use in Nevada by SNWA, allocated as agreed by said agencies; and

3. Meet the other needs for water in California in accordance with the California Seven-Party Agreement as supplemented by the Quantification Settlement Agreement.

Section 2. Determination of Lake Mead Operation During the Interim Period

A. Normal Conditions

1. Lake Mead above elevation 1075 feet and below elevation 1145 feet

In Years when Lake Mead elevation is projected to be above 1075 feet and below elevation 1145 feet on January 1, the Secretary shall determine either a Normal Condition, or, under Section 2.B.5., an ICS Surplus Condition.

B. Surplus Conditions

1. Partial Domestic Surplus

[Adopted January 16, 2001; Deleted [insert Month Day, Year]]

2. Domestic Surplus

(Lake Mead at or above Elevation 1145 feet and below the Elevation that Triggers a Quantified Surplus (70R Strategy))

In years when Lake Mead content is projected to be at or above elevation 1145 feet, but less than the amount which would initiate a Surplus under Section 2.B.3., Quantified Surplus, or Section 2.B.4., Flood Control Surplus, on January 1, the Secretary shall determine a Domestic Surplus Condition. The amount of such Surplus shall equal –

a. From the effective date of these Guidelines through December 31, 2015 (through preparation of the 2016 AOP):

1) For Direct Delivery Domestic Use by MWD, 1.250 maf reduced by the amount of basic apportionment available to MWD.

2) For use by SNWA, the Direct Delivery Domestic Use within the SNWA service area in excess of the State of Nevada's basic apportionment.

3) For use in Arizona, the Direct Delivery Domestic Use in excess of Arizona's basic apportionment.

b. From January 1, 2016 (for preparation of the 2017 AOP) through December 31, 2025 (through preparation of the 2026 AOP):

1) For use by MWD, 250,000 af per Year in addition to the amount of California's basic apportionment available to MWD.

2) For use by SNWA, 100,000 af per Year in addition to the amount of Nevada's basic apportionment available to SNWA.

3) For use in Arizona, 100,000 af per Year in addition to the amount of Arizona's basic apportionment available to Arizona contractors.

3. Quantified Surplus (70R Strategy)[1]

In years when the Secretary determines that water should be delivered for beneficial consumptive use to reduce the risk of potential reservoir spills based on the 70R Strategy the Secretary shall determine a Quantified Surplus Condition and allocate a Quantified Surplus sequentially as follows:

a. Establish the volume of the Quantified Surplus. For the purpose of determining the existence, and establishing the volume, of Quantified Surplus, the Secretary shall not consider any volume of ICS as defined in these Guidelines.

b. Allocate and distribute the Quantified Surplus 50 percent to California, 46 percent to Arizona, and 4 percent to Nevada, subject to c. through e. that follow.

c. Distribute California's share first to meet basic apportionment demands and MWD's demands, and then to California Priorities 6 and 7 and other surplus contracts. Distribute Nevada's share first to meet basic apportionment demands and then to the remaining demands. Distribute Arizona's share to surplus demands in Arizona including Off-stream Banking and interstate banking demands. Nevada shall receive first priority for interstate banking in Arizona.

d. Distribute any unused share of the Quantified Surplus in accordance with Section 1.

e. Determine whether MWD, SNWA and Arizona have received the amount of water they would have received under Section 2.B.2., if a Quantified Surplus Condition had not been determined. If they have not, then determine and meet all demands provided for in Section 2.B.2.

4. Flood Control Surplus

In years in which the Secretary makes space-building or flood control releases[2] pursuant to the 1984 Field Working Agreement between Reclamation and the Army Corps of

[1] 70R is a spill avoidance strategy that determines a surplus if the January 1 projected system storage space is less than the space required by the flood control criteria, assuming a natural inflow of 17.4 maf (the 70th percentile non-exceedence flow). See ISG Final EIS at Section 2.3.1.2.

[2] Under current practice, surplus waters pursuant to the 1944 Treaty are made available to Mexico (when Mexico may schedule up to an additional 0.2 maf) when flood control releases are made. These Guidelines are not intended to identify, or change in any manner that practice. Any issues relating to the implementation of the Treaty, including

Engineers (as may be amended), the Secretary shall determine a Flood Control Surplus for the remainder of that Year or the subsequent Year. In such years, releases will be made to satisfy all beneficial uses within the United States, including unlimited Off-stream Banking.

5. ICS Surplus

   a. In Years in which Lake Mead's elevation is projected to be above elevation 1075 feet on January 1, a Flood Control Surplus has not been determined, and delivery of ICS has been requested, the Secretary may determine an ICS Surplus Condition in lieu of other operating conditions that are based solely on the elevation of Lake Mead.

   b. In Years in which a Quantified Surplus or a Domestic Surplus is available to a Contractor, the Secretary shall first deliver the Quantified Surplus or Domestic Surplus before delivering any requested ICS to that Contractor. If available Quantified Surplus or Domestic Surplus is insufficient to meet a Contractor's demands, the Secretary shall deliver ICS available in that Contractor's ICS Account at the request of the Contractor, subject to the provisions of Section 3.C.

C. Allocation of Colorado River Water and Forbearance and Reparation Arrangements

[Content of 2001 ISG Section 2.C., Allocation of Colorado River Water and Forbearance and Reparation Arrangements, is now found at III.A., as modified]

D. Shortage Conditions

1. Deliveries to the Lower Division States during Shortage Condition Years shall be implemented in the following manner:

   a. In Years when Lake Mead content is projected to be at or below elevation 1075 feet and at or above 1050 feet on January 1, a quantity of 7.167 maf shall be apportioned for consumptive use in the Lower Division States of which 2.48 maf shall be apportioned for use in Arizona and 287,000 af shall be apportioned for use in Nevada in accordance with the Arizona-Nevada Shortage Sharing

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any potential changes in approach relating to surplus declarations under the 1944 Treaty, must be addressed in a bilateral fashion with the Republic of Mexico.

Agreement dated February 9, 2007, and 4.4 maf shall be apportioned for use in California.

b. In Years when Lake Mead content is projected to be below elevation 1050 feet and at or above 1025 feet on January 1, a quantity of 7.083 maf shall be apportioned for consumptive use in the Lower Division States of which 2.4 maf shall be apportioned for use in Arizona and 283,000 af shall be apportioned for use in Nevada in accordance with the Arizona-Nevada Shortage Sharing Agreement dated February 9, 2007, and 4.4 maf shall be apportioned for use in California.

c. In Years when Lake Mead content is projected to be below elevation 1025 feet on January 1, a quantity of 7.0 maf shall be apportioned for consumptive use in the Lower Division States of which 2.32 maf shall be apportioned for use in Arizona and 280,000 af shall be apportioned for use in Nevada in accordance with the Arizona-Nevada Shortage Sharing Agreement dated February 9, 2007, and 4.4 maf shall be apportioned for use in California.

2. During a Year when the Secretary has determined a Shortage Condition, the Secretary shall deliver Developed Shortage Supply available in a Contractor's DSS Account at the request of the Contractor, subject to the provisions of Section 4.C.

Section 3. Implementation of Intentionally Created Surplus

[Content of 2001 ISG Section 3., Implementation of Guidelines, is now found at Section 7., as modified herein.]

A. Categories of ICS

1. Extraordinary Conservation ICS

A Contractor may create Extraordinary Conservation ICS through the following activities:

a. Fallowing of land that currently is, historically was, and otherwise would have been irrigated in the next Year.

b. Canal lining programs.

c. Desalination programs in which the desalinated water is used in lieu of Mainstream water.

d. Extraordinary conservation programs that existed on January 1, 2006.

e. Extraordinary Conservation ICS demonstration programs pursuant to a letter agreement entered into between the United States Bureau of Reclamation and the Contractor prior to the effective date of these Guidelines.

f. Tributary Conservation ICS created under Section 3.A.2. and not delivered in the Year created.

g. Imported ICS created under Section 3.A.4. and not delivered in the Year created.

h. Other extraordinary conservation measures, including but not limited to, development and acquisition of a non-Colorado River System water supply used in lieu of Colorado River Mainstream water within the same state, in consultation with the Basin States.

2. Tributary Conservation ICS

A Contractor may create Tributary Conservation ICS by purchasing documented water rights on Colorado River System tributaries within the Contractor's state if there is documentation that the water rights have been used for a significant period of Years and that the water rights were perfected prior to June 25, 1929 (the effective date of the Boulder Canyon Project Act). The actual amount of any Tributary Conservation ICS introduced to the Mainstream shall be subject to verification by the Secretary as provided in Section 3.D. Any Tributary Conservation ICS not delivered pursuant to Section 3.C. or deducted pursuant to Section 3.B.2. in the Year it was created will, at the beginning of the following Year, be converted to Extraordinary Conservation ICS and will thereafter be subject to all provisions applicable to Extraordinary Conservation ICS. Tributary Conservation ICS may be delivered for Domestic Use only.

3. System Efficiency ICS

A Contractor may make contributions of capital[3] to the Secretary for use in projects designed to realize system efficiencies that save water that would otherwise be lost from the Colorado River Mainstream in the United States. An amount of water equal to a portion of the water conserved would be made available to contributing Contractor(s) by the Secretary as System Efficiency ICS. System efficiency projects are intended only to provide temporary water supplies. System Efficiency ICS will be delivered to the contributing Contractor(s) on a schedule of annual deliveries as provided in an exhibit to a Forbearance Agreement and Delivery Agreement. The Secretary may identify potential system efficiency projects, terms for capital participation in such projects, and types and amounts of benefits the Secretary could provide in consideration of non-federal capital contributions to system efficiency projects, including identification of a portion of the water saved by such projects.

4. Imported ICS

A Contractor may create Imported ICS by introducing non-Colorado River System water in that Contractor's state into the Colorado River Mainstream. Contractors proposing to create Imported ICS shall make arrangements with the Secretary, contractual or otherwise, to ensure no interference with the Secretary's management of Colorado River System reservoirs and regulatory structures. Any arrangement shall provide that the Contractor must obtain appropriate permits or other authorizations required by state and federal law. The actual amount of any Imported ICS introduced to the Mainstream shall be subject to verification by the Secretary as provided in Section 3.D. Any Imported ICS not delivered pursuant to Section 3.C. or deducted pursuant to Section 3.B.2. in the Year it was created will be converted, at the beginning of the following Year, to Extraordinary Conservation ICS and thereafter will be subject to all provisions applicable to Extraordinary Conservation ICS.

B. Creation of ICS

A Contractor may only create ICS in accordance with the following conditions:

1. A Contractor shall submit a plan for the creation of ICS to the Secretary demonstrating how all requirements of these Guidelines will be met in the Contractor's creation of ICS. Until such plan is reviewed and approved by the

[3] To the extent permitted by federal law, monies to pay construction, operation, maintenance, repair, and/or replacement costs.

Secretary, subject to such environmental compliance as may be required, such plan or any ICS purportedly created through it shall not be a basis for creation of ICS. An ICS plan will consist of at a minimum the following information:

a. Project description, including what extraordinary measures will be taken to conserve or import water;

b. Term of the activity;

c. Estimate of the amount of water that will be conserved or imported;

d. Proposed methodology for verification of the amount of water conserved or imported; and

e. Documentation regarding any state or federal permits or other regulatory approvals that have already been obtained by the Contractor or that need to be obtained prior to creation of ICS.

A Contractor may modify its approved plan for creation of ICS during any Year, subject to approval by the Secretary. A Contractor with an approved multi-Year plan for System Efficiency ICS is not required to seek further approval by the Secretary in subsequent Years unless the Contractor seeks to modify the plan.

2. There shall be a one-time deduction of five percent (5%) from the amount of ICS in the Year of its creation. This system assessment shall result in additional system water in storage in Lake Mead. This one-time system assessment shall not apply to:

   a. System Efficiency ICS created pursuant to Section 3.B. because a large portion of the water conserved by this type of project will increase the quantity of system water in storage over time.

   b. Extraordinary Conservation ICS created by conversion of Tributary Conservation ICS that was not delivered in the Year created, pursuant to Section 3.B. because 5% of the ICS is deducted at the time the Tributary Conservation ICS is created.

   c. Extraordinary Conservation ICS created by conversion of Imported ICS that was not delivered in the Year created, pursuant to Section 3.B. because 5% of the ICS is deducted at the time the Imported ICS is created.

   d. ICS created under demonstration programs in 2006 and 2007 which has already been assessed the 5% system assessment.

3. Except as provided in Sections 3.A.2. and 3.A.4., Extraordinary Conservation ICS can only be created if such water would have otherwise been beneficially used.

4. The maximum total amount of Extraordinary Conservation ICS that can be created during any Year is limited to the following:

   a. 400,000 af for California Contractors;

   b. 125,000 af for Nevada Contractors; and

   c. 100,000 af for Arizona Contractors.

5. The maximum quantity of Extraordinary Conservation ICS that may be accumulated in all ICS Accounts, at any time, is limited to the following:

   a. 1.5 maf for California Contractors;

   b. 300,000 af for Nevada Contractors; and

   c. 300,000 af for Arizona Contractors.

6. Except as provided in Sections 3.A.2. and 3.A.4., no category of surplus water can be used to create Extraordinary Conservation ICS.

7. The quantity of Extraordinary Conservation ICS remaining in an ICS Account at the end of each Year shall be diminished by annual evaporation losses of 3%. Losses shall be applied annually to the end-of-the-Year balance of Extraordinary Conservation ICS beginning in the Year after the ICS is created and continuing until no Extraordinary Conservation ICS remains in Lake Mead. No evaporation losses shall be assessed during a Year in which the Secretary has determined a Shortage Condition.

8. Extraordinary Conservation ICS from a project within a state may only be credited to the ICS Account of a Contractor within that state that has funded or implemented the project creating ICS, or to the ICS Account of a Contractor within the same state as the funding entity and project and with written agreement of the funding entity.

9. A Contractor must notify Reclamation by [insert Month Day] of the amount of ICS it wishes to create for the subsequent Year pursuant to an existing, approved plan. A Contractor may request mid-Year modification(s) to reduce the amount of ICS created during that Year, subject to the requirements of this Section 3.B. A Contractor cannot increase the amount of ICS it had previously scheduled to create during the Year.

C. Delivery of ICS

The Secretary shall deliver ICS in accordance with the following conditions:

1. The delivery shall be consistent with the terms of a Delivery Agreement with a Contractor regarding ICS.

2. The Secretary has determined an ICS Surplus Condition.

3. The existence of Forbearance Agreements necessary to bring the delivery of the ICS into compliance with Articles II(B)(2) and II(B)(6) of the Consolidated Decree.

4. A limitation on the total amount of Extraordinary Conservation ICS that may be delivered in any Year is as follows:

   a. 400,000 af for California Contractors;

   b. 300,000 af for Nevada Contractors; and

   c. 300,000 af for Arizona Contractors.

5. If the May 24-month study for that Year indicates that a Shortage Condition would be determined in the succeeding Year if the requested amounts for the current Year under Section 3.C. were delivered, the Secretary may deliver less than the amounts of ICS requested to be delivered.

6. If the Secretary releases Flood Control Surplus water, Extraordinary Conservation ICS accumulated in ICS Accounts shall be reduced by the amount of the Flood Control Surplus on an acre-foot for acre-foot basis until no Extraordinary Conservation ICS remains. The reductions to the ICS Accounts shall be shared on a pro-rata basis among all Contractors that have accumulated Extraordinary Conservation ICS.

7. If a Contractor has an overrun payback obligation, as described in the October 10, 2003 Inadvertent Overrun and Payback Policy or Exhibit C to the October 10, 2003 Colorado River Water Delivery Agreement, the Contractor must pay the overrun payback obligation in full before requesting or receiving delivery of ICS. The Contractor’s ICS account shall be reduced by the amount of the overrun payback obligation in order to pay the overrun payback obligation.

8. If more ICS is delivered to a Contractor than is actually available for delivery to the Contractor in that Year, then the excess ICS delivered shall be treated as an inadvertent overrun until it is fully repaid.

9. A Contractor may request mid-Year modification(s) to increase or reduce the amount of ICS to be delivered during that Year because of changed conditions, emergency, or hardship, subject to the requirements of this Section 3.C.

10. The Contractor shall agree in the Delivery Agreement that the records of the Contractor relating to the creation of ICS shall be open to inspection by the Secretary and by any Contractor or Basin State.

D. Accounting for ICS

The Secretary shall develop procedures to account for and verify, on an annual basis, ICS creation and delivery. At a minimum such procedures shall include the following:

1. A Contractor shall submit for the Secretary's review and verification, appropriate information, as determined by the Secretary, contained in a Certification Report, to demonstrate the amount of ICS created and that the method of creation was consistent with the Contractor's approved ICS plan, a Forbearance Agreement, and a Delivery Agreement. Such information shall be submitted by [insert Month Date] of the Year following the creation of the ICS.

2. The Secretary, acting through the Lower Colorado Regional Director, shall verify the information submitted pursuant to this section, and provide a final written decision to the Contractor regarding the amount of ICS created. The results of such final written decisions shall be made available to the public through publication pursuant to Section 3.D.3. and other appropriate means. A contractor and any party to an applicable Forbearance Agreement may appeal the Regional Director's verification decision to the Secretary and through judicial processes.

3. Each Year the Decree Accounting Report will be supplemented to include ICS Account balance information for each Contractor and shall address ICS creation, deliveries, amounts no longer available for delivery due to releases for flood control purposes, deductions pursuant to Section 3.B.2., deductions due to annual evaporation losses pursuant to Section 3.B.7., any amounts of ICS converted to Extraordinary Conservation ICS, and ICS remaining available for delivery.

Section 4. Implementation of Developed Shortage Supply

[Content of 2001 ISG Section 4., Effective Period & Termination, is now found at Section 8., as modified herein.]

A. Categories of DSS

1. Tributary Conservation DSS

A Contractor may create Tributary Conservation DSS by purchasing documented water rights on Colorado River System tributaries within the Contractor's state if there is documentation that the water rights have been used for a significant period of Years and that the water rights were perfected prior to June 25, 1929 (the effective date of the Boulder Canyon Project Act). The actual amount of any Tributary Conservation DSS introduced to the Mainstream shall be subject to verification by the Secretary as provided in Section 4.D. Tributary Conservation DSS may be delivered for Domestic Use only.

2. Imported DSS

A Contractor may create Imported DSS by introducing non-Colorado River System water in that Contractor's state into the Colorado River Mainstream, making sufficient arrangements with the Secretary, contractual or otherwise, to ensure no interference with the Secretary's management of Colorado River System reservoirs and regulatory structures. Any arrangement shall provide that the Contractor must obtain appropriate permits or other authorizations required by state and federal law. The actual amount of any Imported DSS introduced to the Mainstream shall be subject to verification by the Secretary as provided in Section 4.D.

B. Creation of DSS

A Contractor may only create DSS in accordance with the following conditions:

1. A Contractor shall submit a plan for the creation of DSS to the Secretary demonstrating how all requirements of these Guidelines will be met in the Contractor's creation of DSS. Until such plan is reviewed and approved by the Secretary, subject to such environmental compliance as may be required, such plan, or any DSS purportedly created through it, shall not be a basis for creation of DSS. A DSS plan will consist of at a minimum the following information:

   a. Project description, including what extraordinary measures will be taken to conserve or import water;

   b. Term of the activity;

   c. Estimate of the amount of water that will be conserved or imported;

d. Proposed methodology for verification of the amount of water conserved or imported; and

e. Documentation regarding any state or federal permits or other regulatory approvals that have already been obtained by the Contractor or that need to be obtained prior to creation of DSS.

A Contractor may modify its approved plan for creation of DSS during any Year, subject to approval by the Secretary.

2. There shall be a one-time deduction of five percent (5%) from the amount of DSS in the Year of its creation. This system assessment shall result in additional system water in storage in Lake Mead.

3. DSS may only be created during a Year when the Secretary has determined a Shortage Condition.

4. DSS may only be created by a project that is approved by the Secretary for creation prior to the Secretary determining a Shortage Condition.

5. A Contractor must notify Reclamation by [insert Month Day] of the amount of DSS it wishes to create for the subsequent Year pursuant to an existing, approved plan. A Contractor may request mid-Year modification(s) to reduce the amount of DSS created during that Year, subject to the requirements of this Section 4.B. A Contractor cannot increase the amount of DSS it had previously scheduled to create during the Year.

C. Delivery of DSS

The Secretary shall deliver DSS in accordance with the following conditions:

1. The delivery shall be consistent with the terms of a Delivery Agreement with a Contractor regarding DSS.

2. The Secretary has determined a Shortage Condition.

3. Delivery of DSS shall not cause the total deliveries within the Lower Division states to reach or exceed 7.5 maf in any Year.

4. Delivery of DSS shall be in accordance with Article II(B)(3) of the Consolidated Decree.

5. If a Contractor has an overrun payback obligation, as described in the October 10, 2003 Inadvertent Overrun and Payback Policy or Exhibit C to the October 10, 2003 Colorado River Water Delivery Agreement, the Contractor must pay the overrun payback obligation in full before requesting or receiving delivery of DSS. The

Contractor's DSS Account shall be reduced by the amount of the overrun payback obligation in order to pay the overrun payback obligation.

6. If more DSS is delivered to a Contractor than is actually available for delivery to the Contractor in that Year, then the excess DSS delivered shall be treated as an inadvertent overrun until it is fully repaid.

7. A Contractor may request mid-Year modification(s) to increase or reduce the amount of DSS to be delivered during that Year because of changed conditions, emergency, or hardship, subject to the requirements of this Section 4.C.

8. The Contractor shall agree in the Delivery Agreement that the records of the Contractor relating to the creation of DSS shall be open to inspection by the Secretary or by any Contractor or Basin State.

9. DSS may only be delivered in the Year of its creation. Any DSS not delivered pursuant to this Section 4.C. in the Year it is created may not be converted to Extraordinary Conservation ICS.

D. Accounting for DSS

The Secretary shall develop procedures to account for and verify, on an annual basis, DSS creation and delivery. At a minimum such procedures shall include the following:

1. A Contractor shall submit for the Secretary's review and verification appropriate information, as determined by the Secretary, contained in a Certification Report, to demonstrate the amount of DSS created and that the method of creation was consistent with the Contractor's approved DSS plan and a Delivery Agreement. Such information shall be submitted by [insert Month Date] of the Year following the creation of the DSS.

2. The Secretary, acting through the Lower Colorado Regional Director, shall verify the information submitted pursuant to this section, and provide a final written decision to the Contractor regarding the amount of DSS created. The results of such final written decisions shall be made available to the public through publication pursuant to Section 4.D.3. and other appropriate means. The Contractor may appeal the Regional Director's verification decision to the Secretary and through judicial processes.

3. Each Year the Decree Accounting Report will be supplemented to include DSS information for each Contractor and shall address DSS creation, deliveries, and deductions pursuant to Section 4.B.2 and 4.B.3.

Section 5. California's Colorado River Water Use Plan Implementation Progress

A. Introduction

[Adopted January 16, 2001; Deleted [insert Month Day, Year]]

B. California's Quantification Settlement Agreement

[Adopted January 16, 2001; Deleted [insert Month Day, Year]]

C. California's Colorado River Water Use Reductions

The California Agricultural (Palo Verde Irrigation District, Yuma Project Reservation Division, Imperial Irrigation District, and Coachella Valley Water District) usage plus 14,500 af of Present Perfected Right (PPR) use would need to be at or below the following amounts at the end of the Year indicated in Years other than Quantified or Flood Control Surplus (for Decree accounting purposes all reductions must be within 25,000 af of the amounts stated):

Benchmark Date (Calendar Year)	Benchmark Quantity (California Agricultural usage & 14,500 AF of PPR Use in MAF)
2003	3.75 [4]
2006	3.64 [3]
2009	3.60 [5]
2012	3.47

In the event that California has not reduced its use in accordance with the limits set forth above in any year in which the Benchmark Quantity applies, the surplus determination under Section 2.B.2. of these Guidelines will be suspended and will instead be based upon the 70R Strategy, for up to the remainder of the term of these Guidelines. If however, California meets the missed Benchmark Quantity before the next Benchmark Date or the 2012 Benchmark Quantity after 2012, the surplus determination under Section 2.B.2. shall be reinstated as the basis for the surplus determination under the AOP for the next following Year(s).

As part of the AOP process during the Interim Period of these Guidelines, California shall report to the Secretary on its progress in implementing its California Colorado River Water Use Plan.

[4] The Benchmark Quantities in 2003 and 2006 were met.

[5] The 2009 Benchmark Quantity is modified from 3.53 maf due to construction delays that have been experienced for the All-American Canal Lining Project.

Section 6. Coordinated Operation of Lakes Powell and Mead During the Interim Period

[Content of 2001 ISG Section 6., Authority, is now found at Section 9., as modified herein.]

During the Interim Period, the Secretary shall coordinate the operations of Lake Powell and Lake Mead according to the strategy set forth in this Section 6.

The objective of the operation of Lakes Powell and Mead as described herein is to avoid curtailment of uses in the Upper Basin, minimize shortages in the Lower Basin and not adversely affect the yield for development available in the Upper Basin.

The August 24-month study projections for the January 1 system storage and reservoir water surface elevations, for the following Water Year, shall be used to determine the applicability of the coordinated operation of Lakes Powell and Mead. Equalization or balancing of storage in Lakes Powell and Mead shall be achieved by the end of each Water Year.

Powell Elevation (feet)	Powell Operation	Powell Live Storage (maf)
3700		24.32
	Equalize, avoid spills or 8.23 maf	
3636 - 3666 (see table below)		15.54 - 19.29 (2008 - 2026)
	8.23 maf; if Mead < 1075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	
3575		9.52
	7.48 maf 8.23 maf if Mead < 1025 feet	
3525		5.93
	Balance contents with a min/max release of 7.0 and 9.5 maf	
3370		0

Lake Powell Equalization Elevation Table

In each of the following Water Years, the Lake Powell Equalization Elevation will be as follows:

Water Year	Elevation (feet)
2008	3636
2009	3639
2010	3642
2011	3643
2012	3645
2013	3646
2014	3648
2015	3649
2016	3651
2017	3652
2018	3654
2019	3655
2020	3657
2021	3659
2022	3660
2023	3662
2024	3663
2025	3664
2026	3666

1. Equalization: In Water Years when Lake Powell content is projected on January 1 to be at or above the elevation stated in the Lake Powell Equalization Elevation Table, an amount of water will be released from Lake Powell to Lake Mead at a rate greater than 8.23 maf per Water Year to the extent necessary to avoid spills, or equalize storage in the two reservoirs, or otherwise to release 8.23 maf from Lake Powell.

2. Upper Elevation Balancing: In Water Years when Lake Powell content is projected on January 1 to be below the elevation stated in the Lake Powell Equalization Elevation Table and at or above 3575 feet, the Secretary shall release 8.23 maf from Lake Powell if the projected elevation of Lake Mead is at or above 1075 feet. If the projected elevation of Lake Mead is below 1075 feet, the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release no more than 9.0 maf and no less than 7.0 maf from Lake Powell.

3. Mid-Elevation Releases: In Water Years when Lake Powell content is projected on January 1 to be below 3575 feet and at or above 3525 feet, the Secretary shall release

7.48 maf from Lake Powell if the projected elevation of Lake Mead is at or above 1025 feet. If the projected elevation of Lake Mead is below 1025 feet, the Secretary shall release 8.23 maf from Lake Powell.

4. Lower Elevation Balancing: In Water Years when Lake Powell content is projected on January 1 to be below 3525 feet, the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release no more than 9.5 maf and no less than 7.0 maf from Lake Powell.

5. When determining lake elevations and contents under this Section 6, no adjustment shall be made for ICS.

Coordinated Operation of Lakes Powell and Mead as described herein will be presumed to be consistent with the Section 602(a) storage requirement contained in the Colorado River Basin Project Act.

Releases from Lake Powell for coordinated operations will be consistent with the parameters of the Record of Decision for the Glen Canyon Dam Final Environmental Impact Statement and the Glen Canyon Dam Operating Criteria (62 *Federal Register* 9447, Mar. 3, 1997).

Section 7. Implementation of Guidelines

[Content of 2001 ISG Section 7, Modeling and Data Authority, is now found at Section 7.A., as modified herein.]

A. AOP Process.

[text may be inserted]

B. Consultation

The Secretary shall consult on the implementation of these Guidelines in circumstances including but not limited to the following:

1. The Secretary shall first consult with all the Basin States before making any substantive modification to these Guidelines.

2. Upon a request for modification of these Guidelines, or upon a request to resolve any claim or controversy arising under these Guidelines or under the operations of Lakes Powell and Mead pursuant to these Guidelines or any other applicable provision of federal law, regulation, criteria, policy, rule, or guideline, or the Mexican Water Treaty of 1944, the Secretary shall invite the Governors of all the Basin States, or their designated representatives, to consult with the Secretary in an attempt to resolve such claim or controversy by mutual agreement.

3. In the event projections included in any monthly 24-Month Study indicates Lake Mead elevations may approach an elevation that would trigger shortages in deliveries of water from Lake Mead in the United States, the Secretary shall consult with the Basin States on whether and how the United States may reduce the quantity of water allotted to Mexico.[6]

4. Whenever Lake Mead is below elevation 1025 feet, the Secretary shall consult with the Basin States annually to consider whether Colorado River hydrologic conditions, together with the anticipated delivery of water to the Lower Division states and Mexico, is likely to cause the elevation of Lake Mead to fall below 1000 feet. Upon such a consideration, the Secretary shall consult with the Basin States to discuss further measures that may be undertaken. The Secretary shall implement any additional measures consistent with applicable federal law.

[6] These Guidelines are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

5. During the Interim Period the Secretary shall consult with the Basin States regarding the administration of ICS.

6. During the Interim Period the Secretary shall consult with the Basin States regarding the creation of ICS through other extraordinary conservation measures pursuant to Section 3.A.1.h.

7. During the Interim Period the Secretary shall consult with the Basin States regarding the creation of System Efficiency ICS pursuant to Section 3.A.3.

8. The Secretary shall consult with the Basin States to evaluate actions at critical elevations that may avoid shortage determinations as reservoir elevations approach critical thresholds.

C. Mid-Year Review

[text may be inserted]

D. Operations During Interim Period

[text may be inserted]

Beginning no later than December 31, 2020, the Secretary shall initiate a formal review for purposes of evaluating the effectiveness of these Guidelines. The Secretary shall consult with the Basin States in initiating this review.

Section 8. Interim Period and Termination

[Adopted January 16, 2001; Deleted and Modified [insert Month Day, Year]]

A. Interim Period

These Guidelines will be effective upon the date of execution of the ROD for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations of Lake Powell and Lake Mead and will, unless subsequently modified, remain in effect through December 31, 2025 (through preparation of the 2026 AOP).

B. Effective Period - Special Provisions

1. The provisions for the delivery and accounting of ICS in Section 3 shall remain in effect through December 31, 2036, unless subsequently modified, for any ICS remaining in an ICS Account on December 31, 2026.
2. The provisions for the creation and delivery of Tributary Conservation ICS and Imported ICS in Section 3 shall continue in full force and effect until fifty years from the date of the execution of the ROD.
3. The provisions for the creation and delivery of DSS in Section 4 shall continue in full force and effect until fifty years from the date of the execution of the ROD.

C. Termination of Guidelines

Except as provided in Section 8.B., these Guidelines shall terminate on December 31, 2025 (through preparation of the 2026 AOP). At the conclusion of the effective period of these Guidelines, the operating criteria for Lake Powell and Lake Mead are assumed to revert to the operating criteria used to model baseline conditions in the Final Environmental Impact Statement for the Interim Surplus Guidelines dated December 2000 (i.e., modeling assumptions are based upon a 70R Strategy for the period commencing January 1, 2026 (for preparation of the 2027 AOP)).

[text may be inserted]

Section 9. Authority and Disclaimer

These Guidelines are issued pursuant to the authority vested in the Secretary by federal law, including the Boulder Canyon Project Act of 1928 (28 Stat. 1057), the Colorado River Storage Project Act (70 Stat. 105), and the Consolidated Decree issued by the U.S. Supreme Court in *Arizona v. California*, 547 U.S. 150 (2006) and shall be used to implement Articles II and III of the Criteria for the Coordinated Long Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Pub. L. No. 90-537), as amended.

[text may be inserted]

Appendix T

NRC Executive Summary

This appendix contains the Executive Summary for the National Research Council 2007 report on *Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability*. The information provided in the National Research Council 2007 Report was used by Reclamation to inform the EIS process on the potential impacts on the Colorado River of climate change and hydrologic variability. Copies of the full report are available from the National Academies Press through their website (http://www.nap.edu).

T.1 NRC Executive Summary

Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability
http://books.nap.edu/catalog/11857.html

Summary

Encompassing an area of more than 240,000 square miles, the Colorado River basin covers portions of seven western U.S. states and part of extreme northwestern Mexico. Passing through the heart of what author Wallace Stegner called "the dry core" of the arid western United States, the Colorado's mean annual flow of roughly 15 million acre-feet is not large in comparison to major rivers like the Columbia or the Mississippi. As the largest source of surface water in a large, arid region, however, the Colorado is of great importance to cities, farmers, tribes, anglers, industries, and rafters. In addition to water diversions for municipal, agricultural, and other uses, Colorado River flows generate hydroelectricity, support recreational opportunities and ecological habitats, and sustain cultural and historical values.

Given the Colorado River's importance, variations in its flow record have long been of keen interest to many parties. Direct streamflow measurements date back to the late 1890s when gaging stations were established at a few sites along the river. As the river's flow was measured over the next century, and as a network of stream gaging stations grew, a more complete understanding of Colorado River flows and variability emerged. For example, it is known today that the Colorado River Compact of 1922—the water allocation compact that divides Colorado River flows between the upper and lower Colorado River basin states—was signed during a period of relatively high annual flows. It is also accepted that the long-term mean annual flow of the river is less than the 16.4 million acre-feet assumed when the Compact was signed—a hydrologic fact of no small importance with regard to water rights agreements and subsequent allocations.

Since the 1970s direct measurements of Colorado River flows have been complemented by studies of past hydroclimate conditions that draw from a body of indirect, or proxy, evidence based on tree-

ring data. Because patterns of tree-ring growth of trees at lower elevations can reflect moisture availability, tree-ring data can be used to assemble records, or "reconstructions," of past river flows. Using data from coniferous tree species with long life spans in the Colorado River region, flows dating back several centuries have been reconstructed. The first tree-ring-based flow reconstruction for the Colorado River at Lees Ferry, Arizona—the point at which the Colorado River basin is divided legally into its upper and lower basins—was assembled by Charles Stockton and Gordon Jacoby, Jr., in 1976. Additional reconstructions of Colorado River flows that date back to the 15th century, including several undertaken in the past few years, have enhanced scientific understanding of the region's long-term hydrologic and climate patterns.

Tree-ring-based reconstructions became increasingly prominent topics of discussion in western water circles in the early 2000s. Because this period was exceptionally dry across much of the West, the tree-ring-based reconstructions prompted many questions and concerns about the possible extent and severity of future droughts. The water years 2002 and 2004 (as measured from October 1 through the following September 30), for example, were among the 10 driest years of record in the upper basin states of Colorado, New Mexico, Utah, and Wyoming. Significantly, flows into the basin's reservoirs dropped sharply during this period; for example, 2002 water year flows into Lake Powell above Glen Canyon Dam were roughly 25 percent of mean values. These drought conditions stimulated increased interest in tree-ring-based flow reconstructions and long-term Colorado River flows and water availability.

Out of interest in these issues and their implications, in 2005 the National Research Council's Water Science and Technology Board initiated a study to review hydrologic and climatic sciences of the Colorado River region. The Committee on the Scientific Bases of Colorado River Basin Water Management was appointed to assess the extant body of scientific studies regarding both Colorado River hydrology and hydroclimatic trends that might affect river flows. The committee also was asked to consider related topics, including hydrologic models, data, and methods; organizations for evaluating hydroclimatic data; and systems operations and water management practices (the full statement of task to this committee is listed in Chapter 1).

This committee's statement of task called for a report that produced "an improved hydrologic baseline" for Colorado River water management. In discussing this phrase, the committee noted that it might be interpreted in different ways. An improved hydrologic baseline could, for example, entail a new estimate of long-term mean annual Colorado River flows; establishment of new river gaging stations, computer models, or numerical methods; or a recommendation to reorganize existing (or create new) programs and institutions for evaluating hydrologic and climatic data. After discussing the language in its task statement, the committee concluded that the most appropriate way to help improve a hydrologic baseline for the Colorado River would be to evaluate existing scientific information (including temperature and streamflow records, tree-ring-based reconstructions, and climate model projections) and how it relates to Colorado River water supplies, demands, water management, and drought preparedness.

The following sections of this Summary address the topics of hydroclimatic data and sciences, realities of Colorado River water management, and improving drought preparedness via cooperation, science, and planning. The report's findings and recommendations are presented in bold.

HYDROCLIMATIC DATA AND SCIENCES

Temperature Trends and Model Projections

Temperature records across the Colorado River basin and the western United States document a significant warming over the past century. These temperature records, along with climate model projections that forecast further increases, collectively suggest that temperatures across the region will continue to rise for the foreseeable future. Higher regional temperatures are shifting the timing of peak spring snowmelt to earlier in the year and are contributing to increases in water demands, especially during summer. Higher temperatures will result in higher evapotranspiration rates and contribute to increased evaporative losses from snowpack, surface reservoirs, irrigated land, and vegetated surfaces. Projections of future precipitation are more uncertain than are temperature predictions, leading to uncertainty as to possible changes in future streamflow. Recent studies of the hydrologic implications of warming across the region, based on many global climate models, suggest that on average (across models) runoff and streamflow will decrease. There is, however, uncertainty in these predictions, and some models even suggest increases.

The 20th century saw a trend of increasing mean temperatures across the Colorado River basin that has continued into the early 21st century. There is no evidence that this warming trend will dissipate in the coming decades; many different climate model projections point to a warmer future for the Colorado River region.

Modeling results show less consensus regarding future trends in precipitation. Several hydroclimatic studies project that significant decreases in runoff and streamflow will accompany increasing temperatures. Other studies, however, suggest increasing future flows, highlighting the uncertainty attached to future runoff and streamflow projections. Based on analysis of many recent climate model simulations, the preponderance of scientific evidence suggests that warmer future temperatures will reduce future Colorado River streamflow and water supplies. Reduced streamflow would also contribute to increasing severity, frequency, and duration of future droughts.

Estimating Colorado River Flows: Gaging Stations and Tree-Ring Based Reconstructions

The first gaging stations on the Colorado River were established in the late 19th century. The best-known of the river's many gaging stations is at Lees Ferry, Arizona, established there in 1921. For many years the gaged record of Colorado River flows represented the best science-based knowledge about the river's long-term behavior. Imbedded within this gaged record was an implicit assumption that there was a single, mean value of the river's annual flow, and that interannual variations occurred around this long-term, fixed average. Under this assumption, the basin may have experienced wet and dry periods, but river flows and weather conditions were nonetheless expected to return to an average state, largely defined by climate and hydrology of the early and middle 20th century.

Questions regarding this long-held paradigm of Colorado River mean discharge arose and have been debated in the latter part of the 20th century. Much of this evolving debate reflected concerns over global climate change that came to prominence beginning in the 1970s. Views of the river's long-term variability continued to evolve with more studies of climate change and hydrology that were conducted beginning in the 1980s. Recent tree-ring-based studies demonstrate that Colorado River flows occasionally shift into decade-long periods in which average flows are lower, or higher, than the 15 million acre-feet/year mean based on the current gaged record. The reconstructions also reinforce the point that the gaged record of Colorado River streamflow covers but a small subset of the range of natural hydroclimatic variability present over several centuries and that future Colorado River hydrology may not mimic the hydrologic behavior reflected within the Lees Ferry gaged record.

For many years, scientific understanding of Colorado River flows was based primarily on gaged streamflow records that covered several decades. Recent studies based on tree-ring data, covering hundreds of years, have transformed the paradigm governing understanding of the river's long-term behavior and mean flows. These studies affirm year-to-year variations in the gaged records. They also demonstrate that the river's mean annual flow—over multidecadal and centennial time scales, as shown in multiple and independent reconstructions of Colorado River flows—is itself subject to fluctuations. Given both natural and human-induced climate changes, fluctuations in Colorado River mean flows over long-range time scales are likely to continue into the future. The paleoclimate record reveals several past periods in which Colorado River flows were considerably lower than flows reflected in the Lees Ferry gaged record, and that were assumed in the 1922 Colorado River Compact allocations.

Tree-Ring-Based Reconstructions, Drought, and Future Water Availability

Tree-ring-based streamflow reconstructions allow the gaged record to be placed in the context of longer-term hydroclimatic variability. Although such reconstructions are only estimates of past river flows, they collectively point to a past in which severe, extended drought was recurrent. They also reveal that 1905-1920 was an exceptionally wet period.

Multicentury, tree-ring-based reconstructions of Colorado River flow indicate that extended drought episodes are a recurrent and integral feature of the basin's climate. Moreover, the range of natural variability present in the streamflow reconstructions reveals greater hydrologic variability than that reflected in the gaged record, particularly with regard to drought. These reconstructions, along with temperature trends and projections for the region, suggest that future droughts will recur and that they may exceed the severity of droughts of historical experience, such as the drought of the late 1990s and early 2000s.

Maintaining the Colorado River Streamflow Gaging Network

The Lees Ferry gage record is an important part of the scientific basis for understanding Colorado River discharge and variability and thus for Colorado River water management. Previous federal-level political and financial support for stream gaging stations has been inconsistent. Over the years, some stations have been discontinued. The loss of stations with long periods (greater than 30 years) of record represents a problem of special concern. The value and importance of reliable and continuous hydrologic records will only grow in the future. It would be imprudent and short-sighted to allow the integrity of the Colorado River gaging station network to be compromised or degraded.

Measured values of streamflow of the Colorado River and its tributaries provide essential information for sound water management decisions. Loss of continuity in this gaged record would greatly diminish the overall value of the existing flow data set, and once such data are lost they cannot be regained. The executive and legislative branches of the U.S. federal government should cooperate to ensure that resources are available for the USGS to maintain the Colorado River basin gaging system and, where possible, expand it.

REALITIES OF COLORADO RIVER WATER MANAGEMENT

In considering its full statement of task and in speaking with Colorado River scientific, engineering, and management experts during the course of this study, this committee identified several trends and realities that affect applications of scientific information in water management. Some of them may prove politically contentious, but they nonetheless merit careful consideration by decision makers at all levels in Colorado River water planning.

Increasing Water Demands, Limited Water Supplies

The late 20th and early 21st centuries witnessed high rates of population growth across the western United States. Population in Arizona, for instance, jumped from about 3.7 million in 1990 to over 5.1 million in 2000—a roughly 40 percent increase (this rate would double Arizona's population in less than 20 years). In Colorado, population grew from slightly fewer than 3.3 million in 1990 to about 4.3 million in 2000—a 30 percent increase. These figures do not necessarily equate directly to increases in water demand; conservation measures, pricing policies, and consumer habits and preferences all influence per capita water uses. In fact, some innovative urban water use and conservation programs have led to reductions in per capita use. Nevertheless, expanding populations have prompted significant increases in urban water demands. Water consumption in Clark County, Nevada (which includes Las Vegas), for example, approximately doubled in the 1985-2000 period. Population growth rates and future projections are on a sharply increasing trajectory in the western United States and they point to sizable and growing water demands for the foreseeable future. In addition, other demands on water supplies, such as those emanating from tribal settlements or from reallocations to support instream flows, will likely grow in the years ahead.

From a water resources perspective, the traditional means of coping with (and effectively encouraging) growth in the western United States was to develop new water supplies by creating large storage reservoirs. After a period of vigorous dam construction in the 1950s and 1960s, prospects for constructing additional large dams in the Colorado River basin have diminished. Today, rather than creating new reservoirs, municipalities are focusing on new, often nonstructural, strategies for augmenting water supplies. A significant trend in this quest has been the sale, lease, and transfer of agricultural water rights to municipalities, particularly in southern California and Colorado. (In Arizona, settlements of tribal water right, with subsequent transfers to municipalities, have also been important.)

Agricultural water rights have been crucial to meeting burgeoning urban water demands in many places. There are other ways for urban areas to obtain additional water supplies, such as through greater use of municipal effluent water (the only growing water supply available in the arid West). Nevertheless, agricultural water appears to constitute the most important, and perhaps final, large reservoir of water available for urban use in the arid U.S. West. In aggregate, the amount of water devoted to agricultural uses is quite large; about 80 percent of western U.S. water supplies are devoted to crop production. Modest shifts of agricultural water to municipal and industrial uses can do much to meet increasing urban water demands. The direct effects associated with the loss of agricultural water, however, such as reduced food production capability, can be significant. In addition, agricultural-urban transfers often entail other "third-party" effects that include costs for rural communities, ecosystems, and other groups indirectly dependent on water supplies affected by the transfers. In recent years many creative water transfer arrangements, involving legally defined water banks and underground water storage programs designed to help mitigate third-party effects, have been developed. The availability of agricultural water is finite, however, and such programs thus are limited in their ability to satisfy increasing, long-term demands. The combination of limited Colorado River water supplies, rapidly increasing populations and water demands, warmer regional temperatures, and the specter of recurrent drought point to a future in which the potential for conflict among existing and prospective new users will prove endemic.

Steadily rising population and urban water demands in the Colorado River region will inevitably result in increasingly costly, controversial, and unavoidable trade-off choices to be made by water managers, politicians, and their constituents. These increasing demands are also impeding the region's ability to cope with droughts and water shortages.

Technologies and Strategies for Augmenting Water Supplies

A wide array of technological and conservation measures can be used to help stretch existing water supplies. These measures include underground storage of water, water reuse, desalination, weather modification, conservation, and changes in water pricing structures and rates. These measures may not necessarily be inexpensive or easy to implement, but many of them show promise and will continue to be pursued and developed as water supplies tighten in future years. Areas experiencing population growth will continue to demand additional water supplies, however, and gains realized through technology, conservation, and other measures will be readily absorbed by increasing population and water demands.

Technological and conservation options for augmenting or extending water supplies—although useful and necessary—in the long run will not constitute a panacea for coping with the reality that water supplies in the Colorado River basin are limited and that demand is inexorably rising.

IMPROVING DROUGHT PREPAREDNESS: COOPERATION, SCIENCE, AND PLANNING

Interstate Cooperation

The drought of the late 1990s and early 2000s prompted the Colorado River states to move toward a new level of interstate cooperation in devising water shortage management criteria. A preliminary proposal presented in a February 2006 letter from the seven basin states to the U.S. Secretary of the Interior (see Appendix A) responded to the Secretary's request that the states develop shortage guidelines and management strategies under low reservoir conditions. This letter represents a noteworthy effort to avoid potential disruptions of operational criteria that govern flow allocations among the basin states.

The interstate cooperation and initiative exhibited by the Colorado River basin states in their February 2006 letter to the Secretary of the Interior is a welcome development that will

prove increasingly valuable—and likely essential—in coping with future droughts and growing water demands.

Scientist-Decision Maker Collaboration

The scientific knowledge base of Colorado River hydrology and climate rivals, and may exceed, comparable knowledge bases for any of the world's river systems. Some of this scientific knowledge has been fundamental to legal and operational decisions, such as the Bureau of Reclamation's Operating Criteria, reservoir operations rule curves, and other aspects of Colorado River basin water resources planning and policy. Some of this scientific information, on the other hand, may not be as well integrated in Colorado River basin water policy as it should be.

Drought conditions in the early 2000s stimulated stronger two-way communication between the scientific community and the water management community. This increased collaboration took the form of workshops, conferences, and other discussions among climate and water experts (especially paleoclimate and tree-ring specialists), hydrologists, civil engineers, and water resources planners and decision makers. Communication between scientists and water managers is important because, for example, it is not always clear what types of scientific information the water management community would find most useful. Scientists can help explain scientific concepts and findings to the water management and user community, while water managers can help scientists frame scientific questions and lines of inquiry that they would find most useful for operational and longer term strategic decisions. These interchanges require sustained, two-way collaboration in order to enhance mutual learning between these groups. It will be important for western water managers to sustain this interest in Colorado River climate, drought, and water planning issues when wetter conditions return, as severe drought conditions will undoubtedly occur again. It will also be important for scientists to sustain their interests in water policy issues related to water supply, demand, and drought management.

A commitment to two-way communication between scientists and water managers is important and necessary in improving overall preparedness and planning for drought and other water shortages. Active communication among people in these commu-

nities should become a permanent fixture within the basin, irrespective of water conditions at any given time. Such dialogue should help scientists frame their investigations toward questions and topics of importance to water managers, and should help water managers keep abreast of recent scientific developments and findings.

Comprehensive, Action-Oriented Study of Pressing Colorado River Water Issues

The Colorado River Compact and much of the Law of the River—the federal and state statutes, interstate compacts, court decisions, and other operating criteria and administrative decisions that define the river's overall governance—were framed during an era in which water for irrigation (and municipal uses in Southern California) was of paramount concern. Today, population growth and increasing water demands have moved urban water issues to the fore of the western water landscape. Increasing urban population and water demands have prompted municipal water managers to think creatively about more efficient water management and ways to increase water supplies and/or limit water use. States and municipalities have sponsored many conservation, landscaping, education, and other related programs. There have been few initiatives, however, to systematically document or synthesize these efforts, which may be hindering progress toward more efficient and better coordinated urban water management across the region. Moreover, knowledge of important topics and issues, such as water demand forecasting and the environmental implications of large-scale agriculture-urban water transfers, lags behind advances in hydrologic and climate sciences.

A more systematic and coordinated approach to urban water conservation and drought preparedness could be promoted through a collaborative investigation across the Colorado River basin. The basin states and municipalities generally establish water practices and policies tailored to their unique circumstances. A comprehensive, accessible report of basin-wide urban water practices, comparing the many lessons learned from diverse experiences across the basin in coping with water shortages and limited supplies, could serve as a more systematic and action-oriented basis for water planning. The collaboration involved in preparing such a report could also promote better communication among federal agencies, the basin states, and municipalities on urban water management strategies and alternatives. It could also encourage a sustained commitment toward a more proactive approach to managing urban water during periods of drought and in the face of growing population.

A comprehensive, action-oriented study of Colorado River region urban water practices and changing patterns of demand should be conducted, as such a study could provide a more systematic basis for water resources planning across the region. At a minimum, the study should address and analyze the following issues:

- **historical adjustments to droughts and water shortages,**
- **demographic projections,**
- **local and regional water demand forecasting,**
- **experiences in drought and contingency planning,**
- **impacts of increasing urban demands on riparian ecology,**
- **long-term impacts associated with agriculture-urban transfers, and**
- **contemporary urban water polices and practices (e.g., conservation, landscaping, water use efficiency technologies).**

The study could be conducted by the Colorado River basin states, a U.S. federal agency or agencies, a group of universities from across the region, or some combination thereof. The basin states and the U.S. Congress should collaborate on a strategy for commissioning and funding this study. These groups should be prepared to take action based on this study's findings in order to improve the region's preparedness for future inevitable droughts and water shortages.

Colorado River Basin Water Management

Evaluating and Adjusting to Hydroclimatic Variability

Committee on the Scientific Bases of Colorado River Basin Water Management

Water Science and Technology Board

Division on Earth and Life Studies

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* The activities of this committee were overseen and supported by the National Research Council's Water Science and Technology Board (see Appendix C for listing). Biographical information on committee members and staff is contained in Appendix D.

Preface

The Colorado River has long been uniquely important in the exploration, development, and culture of the western United States. The Colorado is a desert river, stretching from high in the Rockies, through great canyons and arid regions in Utah and Arizona, and finally ending in the Gulf of California in Mexico. For millions of years it has shaped landforms and in the Grand Canyon has exposed geologic formations that are half as old as the Earth itself. The great American scientist John Wesley Powell explored this region widely. He had extensive knowledge of many Native American tribes and his 1869 boating expedition down the Colorado River through the Grand Canyon is legendary. Powell's 1878 publication *Lands of the Arid Region of the United States, with a More Detailed Account of the Lands of Utah* offered many new ideas regarding the roles of the U.S. federal government in developing western water supplies. Although Powell may have foreseen some aspects of western development, one thing he probably did not foresee was the future extent of population growth in the Colorado River region. Nor was Powell likely to have imagined that changes in regional climate might someday affect hydrologic conditions.

Our committee was asked to review the hydrologic and climatic bases of Colorado River water management. In considering this existing body of scientific information, we were struck by the warming across the region in the past century and by the fact that nearly all global climate models forecast increasing temperatures for the Colorado River region. We also noted the exceptionally hot and dry conditions across much of the nation in the summer of 2006, and that the 2006 average annual temperature for the contiguous United States was the warmest on record and nearly identical to the record set in 1998. These conditions are consistent with warming trends in the region.

As we proceeded it became clear that a broad understanding of Colorado River water management issues is not possible unless both water supply and demand issues are adequately considered. Terms such as "population growth" and "water demand" did not appear in our statement of task. As we spoke with water experts from across the region at our meetings, however, they identified important linkages among hydrology and climate and issues such as population growth and water demands, urban water management and conservation, riparian ecology, and water transfers. Clearly, interest in hydroclimatic issues in the region is being driven in large part by increasing water demands and a limited ability to augment water supplies through traditional means. Furthermore, our statement of task called for us to consider the broad topics of systems operations and water management practices. We thus felt it incumbent upon us to comment on topics of water demand, technologies and practices for augmenting water supplies, and programs for coping with drought.

Our report presents population growth data for much of the western United States that is served by Colorado River water. The cities in the region are collectively the fastest growing in the nation. Of further concern is that this growth seems to be occurring with little regard to long-term availability of future water supplies. Ideally, these issues will be openly discussed and squarely addressed before the water supply-and-demand balance across the region becomes more critical. This is important because, for example, the drought of the early 2000s turned out to be even worse than many assumptions regarding a worst-case-scenario drought. This ongoing drought has contained a sequence of exceptionally dry years. Inflows into the basin's storage reservoirs have been well below normal and it may take 15 years of average future hydrologic conditions to refill the basin's largest water storage reservoirs, Lakes Mead and Powell. These hydroclimatic trends are especially troubling in light of rapidly increasing water demands.

I thank our committee members for the hard work and intellect they devoted to producing this consensus report. Each of them brought unique expertise to our deliberations and report preparation and they all devoted many hours of personal time to our study. Their views were fully considered in our study process and I thank them for their contributions, good will, and spirit of collaboration. I also thank the many water scientists, engineers, administrators, and other experts from across the region that spoke with our committee. They provided a comprehensive and fascinating update of key water and science issues across the region and presented important topics and questions for our committee's consideration, all of which were essential to our deliberations and report (Appendix B lists these speakers).

I also thank the National Research Council (NRC) staff members for their dedication and diligent work in our study process. Jeff Jacobs, senior staff officer with the Water Science and Technology Board (WSTB), ensured that our committee stayed on task and that the varying opinions and written contributions from our committee members were blended to create a single, coherent report. Jeff and the committee were ably assisted by WSTB research associate Dorothy Weir, who handled administrative details of the meetings and ably assisted in all phases of report preparation.

We are grateful to the sponsors who provided support for this study. These sponsors included federal, state, and municipal water organizations across the West, which reflects the broad interest in and importance of in these issues. These sponsors were the California Department of Water Resources, the Metropolitan Water District of Southern California, the Southern Nevada Water Authority, and the U.S. Bureau of Reclamation. We also thank the National Academies for providing a substantial portion of funding and for exercising leadership in initiating this study.

This report was reviewed in draft form by individuals chosen for their breadth of perspectives and technical expertise in accordance with the procedures approved by the National Academies' Report Review Committee. The purpose of this independent review was to provide candid and critical comments to assist the institution in ensuring that its published report is scientifically credible and that it meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The reviewer comments and draft manuscript remain confidential to protect the deliberative process. We thank the following reviewers for their helpful suggestions, all of which were considered and many of which were wholly or partly incorporated in the final report: John A. Dracup, University of California; Jerome B. Gilbert, Orinda, California; W.R. Gomes, University of California; Martin P. Hoerling, National Oceanic and

Atmospheric Administration; Malcolm K. Hughes, University of Arizona; Katharine L. Jacobs, University of Arizona; John W. Keys, III, Moab, Utah; Upmanu Lall, Columbia University; John E. Thorson, California Public Utilities Commission; and James L. Wescoat, Jr., University of Illinois.

Although these reviewers provided constructive comments and suggestions, they were not asked to endorse the report's conclusions and recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Daniel P. Loucks, Cornell University, who was appointed by the NRC's Report Review Committee, and by A. Dan Tarlock, Chicago Kent College of Law, who was appointed by the NRC's Division on Earth and Life Studies. Drs. Loucks and Tarlock were responsible for ensuring that an independent examination of this report was conducted in accordance with NRC institutional procedures and that all review comments received full consideration. Responsibility for this report's final contents rests entirely with the authoring committee and the NRC.

The seven Colorado River basin states and cooperating agencies, particularly the Bureau of Reclamation, face great challenges in addressing the complex issues of Colorado River water supply management. The pressures of meeting the needs of the burgeoning population in the face of future severe droughts and uncertain impacts of global change are indeed great. Political pressures will abound but there are signs of increasing cooperation on a variety of water use issues. We hope this report represents a contribution to the knowledge base of Colorado River hydroclimate and water management and that it helps promote common understanding and cooperation on these matters.

Ernest T. Smerdon
Chair

Contents

Appendix U

Climate Technical Work Group Report

This appendix contains a copy of a forthcoming report entitled *Review of Science and Methods for Incorporating Climate Change Information into Bureau of Reclamation's Colorado River Basin Planning Studie*s. The report provides a summary of an assessment of the state of knowledge with regard to climate change and modeling for the Colorado River Basin and provides recommendations on future research and development needs. This report will be a forthcoming Reclamation publication with no change in content; however the formatting will be changed from that used in this appendix. This report was prepared by the Climate Technical Work Group that was empanelled by Reclamation to provide information on climate science and future climate conditions and their potential impact on the Colorado River. The Climate Technical Work Group included climate experts from the University of Colorado (National Oceanic and Atmospheric Administration – Western Water Assessment), the University of Arizona, the University of Nevada – Las Vegas, the University Corporation for Atmospheric Research, Reclamation, and Hydrosphere Consultants, Inc.

Bureau of Reclamation

Climate Technical Work Group

Review of Science and Methods for Incorporating Climate Change Information
into Reclamation's Colorado River Basin Planning Studies

Final Report

August 21, 2007

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Table of Contents

List of Figures

List of Tables

List of Attachments

U.1 Executive Summary

U.1.1 Background

The potential impacts of climate change and hydrologic variability on the Colorado River have been subjects for discussion for many years. The continuing drought in the Colorado River Basin coupled with recent advances in scientific knowledge regarding the potential impacts of climate change has heightened this interest.

The recent drought has emphasized that the principal influence on water availability is the amount of runoff in the basin. The conventional assumption used in water resources planning is that the past record of runoff can be used to represent future conditions; that the future will look like the recent past. Reclamation, like most water management agencies, has, until recently, relied on this conventional assumption in its planning activities.

Reclamation has recognized the limitations of the conventional assumptions for some time, but the continuing drought conditions accelerated efforts in the agency to investigate alternative assumptions which may be used in its planning and operations. Furthermore, considerable evidence from paleo records concluded that the observed record of the last 100 years did not capture the full range of variability of historical streamflows in the Colorado River.

Reclamation's Lower Colorado Region initiated a multi-faceted research and development program in 2004 to enable the use of other methods for projecting possible future inflow sequences for Colorado River planning studies. The research and development effort has been designed to provide information for the near-term (e.g., some facets have already been completed), as well as the longer-term that involves collaboration with other research organizations (e.g., National Oceanic & Atmospheric Administration and United States Geological Survey). The effort is focused on two key areas:

- collaboration with other federal agencies and universities to conduct research to gain knowledge and understanding of the potential impacts of climate change and climate variability on the Colorado River, and

- improvement of Reclamation's decision support framework, including modeling and data handling capabilities, in order to utilize the new information when it becomes available.

To assist in the direction and prioritization of these efforts, particularly over the next few years, a group of experts in meteorology, climate and hydrology, referred to as the Climate Technical Work Group (Work Group), was empanelled to provide information to Reclamation about the state of knowledge regarding climate science and future climate conditions and their impact on water resources, particularly on the Colorado River Basin.

In addition, the Work Group ran parallel with and informed Reclamation's development of the final environmental impact statement (EIS) for the proposed adoption of interim operational guidelines for Lake Powell and Lake Mead on the feasibility of considering long-term projections of climatic conditions in its assessment of alternative proposed guidelines. Contributions from the Work Group as well as the research and development program were invaluable in advising the analysis and content in the final EIS to address future hydrologic variability and the potential for increased hydrologic variability due to climate change.

Reclamation convened a meeting of the Work Group on November 8, 2006. In addition to the outside expert invitees, a number of Reclamation staff and contractors also attended the meeting. The members of the Work Group and attendees at this meeting are listed in Attachment 1. The November 8 meeting provided the opportunity for a face-to-face discussion between the climate experts and Reclamation staff. Following the meeting, a smaller group of Reclamation staff, contractors and outside experts developed this report. The members of this drafting group are listed in Attachment 1. The drafting group developed an initial outline which was circulated to the entire Work Group in February 2007. Based on feedback on the outline, a draft of this report was developed and circulated to the Work Group for review in April 2007. Comments were received from the Work Group and other interested parties including climate scientists, water resource engineers, and Reclamation personnel. The Work Group revised the document and transmitted it to Reclamation in its final form in August 2007. Reclamation pre-published the final report as an appendix to the final EIS for the proposed adoption of Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead in October 2007.

U.1.2 Findings

U.1.2.1 State of Climate Change Science

There is strong scientific consensus that the earth has been warming, that this warming is driven substantially by human emissions of greenhouse gases, and that warming will continue. Climate models project that temperatures will increase globally by 1 to 2ºC in the next 20-60 years. The projections are fairly consistent for the next 20 years, with a 1ºC increase, but exhibit larger uncertainty in the 40-year projections. Scientists agree on some of the important broad-scale features of the expected hydrologic changes, the most likely of which will be an increase in global average precipitation and evaporation as a direct consequence of warmer temperatures.

U.1.2.2 Potential Impacts to the Colorado River Basin

The impact of climate change on the region of the Colorado River Basin (CRB) is less certain; however, it is expected that regional temperatures will also increase. Regional precipitation response is less certain with comparable evidence suggesting wetter or drier conditions. There is some consistency to indications of a general drying for mid-latitude regions such as the CRB, but this indication must be tempered by the limited precision of existing atmospheric models in resolving the topography of the southwestern U.S.

The potential impacts of climate change on the CRB's water resources have been a subject of research for several decades. Although an aggregate message from these studies may be that a decrease in runoff can be expected, runoff response across these same studies *ranges from increase to decrease*. These studies show that system storage is very sensitive to changes in mean inflows as well as to sequences of dry and wet years.

The degree to which current methods can provide reliable information about future streamflow variability remains a question.

U.1.2.3 Options for Relating Climate Change Projections to Reservoir Operations

There are several options available for translating climate projections into operations response information. The three core steps for long term operations analysis under assumed climate change include: (i) selecting a simulated climate scenario that overlaps with observed historical conditions and extends into a future planning horizon, has been bias-corrected, and has been downscaled to a basin-relevant resolution; (ii) relating the downscaled climate conditions over the basin to natural runoff response; and (iii) relating simulated natural runoff response to water supply and operations response. After these core steps are defined, it is necessary to consider other options about how variability in water resources conditions will be addressed.

In addition to the uncertainties inherent in projections of greenhouse gas concentrations, and in simulation of future climate conditions using General Circulation Models (GCMs), there are various uncertainties associated with relating climate projections to runoff and operations. These include the assumptions on converting simulated climate time series into a meteorological input sequence for runoff analysis, assumptions on how to convert meteorological input to runoff, assumptions on how to represent system operations within the operations model under a changing climate, and assumptions on future land use and land cover.

U.1.2.4 Paleoclimatic Information

Paleoclimatic information for the Colorado River basin is extensive, with the most notable, and reliable, streamflow reconstructions being for Lees Ferry (dividing point between Upper and Lower basin). The streamflow reconstructions there go back as far as AD 762 and have been used to create hydrologic scenarios for planning studies. The main limitation in the use of paleoclimatic information is when reconstructed flow values are beyond the "predictor space" on which the model is based. These values may be less reliable than other reconstructed values. There is an emerging area of research on how paleoclimatic information can be used with climate change projections. The main idea is to combine the variability in the paleohydrologic records with the more certain future warming for assessing possible future scenarios.

U.1.2.5 Interannual and Interdecadal Variability

There is an increasing awareness that in addition to gradual changes (long-term trends) in climate conditions, there is also a large degree of interannual and interdecadal variability in climate, which may dominate the climate experienced in a basin in the short term (10-20 years in the future). The well known El Niño-Southern Oscillation (ENSO) has linkages in the Lower Basin where El Niño events bring generally wetter conditions and La Niña events bring drier conditions. A limitation on research relating interannual and interdecadal variability is the relatively short time periods available for the analysis. The use of paleoclimatic data may enhance the understanding of these multidecadal phenomena. The impacts from interannual and interdecadal climate variability on streamflow may be significant for planning studies with short planning horizons (e.g., 20 years). This could be just as important as evaluating the impacts of climate change that may not really be noticed in the basin for 20-50 years.

U.1.3 Recommendations

U.1.3.1 Planning Studies

Shorter Look-Ahead Studies: For studies and management decisions involving shorter look-ahead horizons (e.g., less than 20 years), an appropriate level of analysis might involve a qualitative discussion of climate change and interannual-to-decadal variability within the study's look-ahead horizon. If the role of shorter-term climate is critical to the study, the proposed qualitative discussion might be accompanied by a quantitative sensitivity analysis based on instrumental record and paleoclimate evidence.

Longer Look-Ahead Studies: For studies and decisions concerned with greater than 20-year look-aheads and being evaluated on the near-term, it is suggested that a quantitative sensitivity analysis be conducted on operations response to projected climate change using approaches previously mentioned in ES 2.3. By comparing system performance using projected climate change hydrology to historical hydrology, useful knowledge about system sensitivity should be ascertained.

U.1.3.2 Research and Development

Improved Availability and Temporal Resolution of Regional Climate Projection Datasets: Currently, there is limited access to bias-corrected and downscaled climate projection datasets over the Colorado River basin. An archive of bias-corrected and spatially downscaled GCM outputs should be made available to researchers and the public. In addition, as dynamically downscaled datasets become available, these datasets should be added to the archive.

Improved Ability to Model Runoff Under Climate Change: Currently there are only a few runoff models available to generate CRB natural flow given climate inputs, and Reclamation does not have easy access to these models. Reclamation needs to build internal staff expertise with available runoff model applications in the basin, and build coalitions with external groups that use such applications. Ideally, such runoff applications would also report other hydrologic processes' response to climate change (e.g., soil moisture, evapotranspiration, groundwater interactions with surface water).

Investigate Paradigm for Colorado River basin Precipitation Response: While there is an evolving paradigm for how the American Southwest and other existing dry subtropical areas of the globe should respond to climate change, it is not clear how nearby relatively wet mountainous areas such as the Rockies should respond. In addition, the ability of GCMs to simulate future precipitation conditions at this spatial scale is questionable. Reclamation should encourage and support work to improve scientific understanding of precipitation response to climate change.

Diagnose and Improve Existing Climate Models Before Adding Additional Features: Given known GCM limitations in simulating regional precipitation, climate research groups should focus a portion of their efforts on diagnosing and correcting biases in the current collection of climate models.

Investigate Changes in Modeled Climate Variability at Multiple Time Scales: It is well appreciated that the Colorado River is sensitive to changes in mean flow. However, variability as represented by drought spells, wet refill periods, and extended decadal and longer periods of above and below-average flow are also critical for determining system yield. Therefore, investigation of such variability in modeled sequences of precipitation, runoff and other climatic variables is critical.

Improve Understanding of Surface water, Groundwater and Land cover Interaction: Because rivers and groundwater are intimately connected, understanding the entire recharge process and its response to climate change is critical. Hence, research is required on groundwater recharge and movement at scales relevant to regional runoff analysis, and this in turn requires understanding the aggregate process of mountain block recharge and the role of riparian and root zone vegetation. The latter leads to additional research questions on how basin land cover and natural evapotranspirative demand will respond to global climate change.

Improve Prediction of Interdecadal Oscillations: The predictability of interdecadal climate oscillation phases and their associated hydrologic impacts on the Colorado River basin are not well understood. Shorter-term planning may be more influenced by these oscillations than by projected changes in climate means. Reclamation should actively support, either materially or otherwise, efforts in the science and applications community to advance knowledge in this area.

Investigate use of Paleo Record to Inform Modeled Streamflow Variability: Reclamation has funded some research on how to use information from the paleoclimate record in modeling studies. While the past will not repeat, the paleo record contains a wealth of information on natural variability that should not be ignored. For example, there may be valuable ways of combining paleo data with modeled and or historical data to modify the variability in these sequences in useful ways.

Interact with Federal Climate Change Science Program and Other Climate Change Research Initiatives: Although Reclamation can pursue and fund some of the Research and Development work described above, many of these problems will require the assistance of the larger scientific and engineering community. The Department of the Interior is one of thirteen agency members of the approximately $2 billion per year federal Climate Change Science Program, the umbrella under which all federal climate change activity is pursued. In order to raise the profile of these issues and obtain resources to help solve them, Reclamation should engage the CCSP. In addition, Reclamation should collaborate with NOAA, the National Center for Atmospheric Research, and the University research community.

U.2 Introduction

U.2.1 Process and Context

As part of its responsibility to manage water resources within the Colorado River basin, The U.S. Department of Interior, Bureau of Reclamation (Reclamation) is continuously evaluating the effect of operating procedures and policies in the basin. The primary effects of changing operating rules are changes in reservoir releases, river flows, reservoir contents, water quality and water deliveries to end users. These primary effects influence economic, social and environmental conditions. Reclamation makes its evaluation of the primary effects of operating policies with modeling studies that simulate the effect of operating rules on system conditions and water availability. Additional models are used to estimate secondary effects.

Conventional water resources planning has been based on two assumptions:

- The observed history of hydrology for a particular system adequately captures the past mean and variability of water supply for that system
- The past mean and variability of water supply is representative of future conditions.

Reclamation has recognized the weakness of the conventional assumptions for some time, but the acute drought conditions that began in 2002 accelerated efforts in the agency to investigate alternative assumptions on which planning and operations could be based. By 2004, the problem with the conventional assumptions had been clearly demonstrated when the reservoirs on the Colorado River reached states that could not have been simulated by conventional approaches in 2002.

The recent drought also brought attention to the need to develop operating rules to allocate the water of the lower Colorado River in times of shortage. Reclamation, the Basin States and the Secretary of the Interior realized that it was necessary to adopt specific operational guidelines to address the operation of Lake Powell and Lake Mead during drought. Accordingly, the Secretary of the Department of the Interior acting through the Bureau of Reclamation, Upper and Lower Colorado Regions (hereinafter, Reclamation), proposed adoption of specific Colorado River Lower Basin (Lower Basin) interim shortage guidelines and coordinated reservoir management strategies to address operations of Lake Powell and Lake Mead, particularly under drought and low reservoir conditions. The guidelines would change the way the reservoir system on the river is operated and define circumstances where deliveries to certain water users would be curtailed. Such operational changes may affect reservoir storage levels and releases at Lake Powell and Lake Mead, which in turn may subsequently affect river flows, available water supplies, and other resources.

The Secretary has designated Reclamation as the lead federal agency for the development and implementation of the proposed interim guidelines, and for the purpose of compliance with the National Environmental Policy Act of 1969 (NEPA). Reclamation and five cooperating federal agencies have prepared a Draft EIS (Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated

Operations for Lake Powell and Lake Mead, U.S. Department of the Interior, Bureau of Reclamation, Upper and Lower Colorado Regions; Reclamation 2007) to provide an opportunity to develop the information needed to analyze and consider trade-offs inherent in the proposed action.

Five alternatives have been considered and analyzed in the Draft EIS. The potential hydrologic effects of the alternatives were evaluated through the use of water resources modeling studies. The water resources modeling served as the basis for other analyses of the potential effects of the alternatives on other environmental resources. In addition to making these analyses, Reclamation conducted sensitivity analyses using alternative assumptions regarding the hydrology of the Colorado River basin. Three alternative hydrologic scenarios were used in these sensitivity analyses, two based on reconstructions of pre-historic flows (paleohydrology) and one based on synthesizing new scenarios based on the statistics of the observed record (stochastic hydrology).

Reclamation recognized that the three sensitivity analyses did not directly respond to growing concerns that global climate is changing and with that change would come corresponding changes in the hydrology of the Colorado River basin. Impacts arising from the proposed actions are sensitive to the magnitude and timing of the natural streamflows in the Colorado River, which in turn would be influenced by any changes in climatic conditions.

Reclamation wished to evaluate the potential impact of climate change on water availability and environmental conditions in the Colorado Rive basin, but recognized that there is considerable scientific uncertainty about the precise nature of climate change and its effects in the basin. Reclamation also did not know what tools might be available to evaluate the impact of climate change. The Lower Colorado River Region of Reclamation decided to empanel a group of experts in meteorology, climate and hydrology, referred to as the Climate Technical Work Group (Work Group), to consult with the agency and assist it in addressing these questions. The Upper Colorado River Region and the Technical Services Center of Reclamation also participated in the Work Group process.

Reclamation asked the Climate Technical Work Group to provide information to Reclamation about the state of knowledge regarding climate science and future climate conditions and their impact on water resources. In addition, information regarding the feasibility of considering long-term projections of climatic conditions in its assessment of alternative proposed guidelines and strategies were considered.

U.2.2 Description of Document

This document summarizes the state of climate science and how future climate conditions may impact the water resources of the Colorado River basin. Section W.2.0 describes the Climate Technical Work Group, the charges provided to the Work Group, and the process used in preparing the final report. Section W.3.0 provides background information on how climate assumptions are currently represented in long-term planning. Section W.4.0 summarizes the state of science on observed and projected climate conditions. Section W.5.0 summarizes the various studies that have evaluated the potential impacts of climate change on the water resources of the Colorado River basin. Section W.6.0 describes methods that may be used for relating climate information to long-term water resources planning. Section

W.7.0 summarizes available paleoclimatic information, some of which might serve as proxy information for future climate possibilities. Section W.8.0 summarizes the state of science on shorter- to longer-term climate oscillations and variability that also impact water resources. Lastly, Section W.9.0 provides a summary of key themes from each section, identifies critical issues that warrant further investigation, and offers recommendations for how climate change and variability information could be further incorporated into Lower Colorado (LC) Reclamation's longer term planning efforts.

U.3 Climate Technical Work Group

U.3.1 Formation and Charge

Beginning in September, 2006, Reclamation identified potential members of the Climate Technical Work Group and began extending invitations for participation in the Work Group process to those candidates. Twelve climate scientists and hydrologists were invited to participate on the Work Group. These invitees are listed in Attachment 1.

Reclamation asked the Work Group to provide information in the following areas:

- ♦ The state of knowledge that exists regarding long-term projections of climatic conditions, including the state of knowledge regarding climatic processes, and the state of knowledge regarding numerical simulation of long-term future conditions (Section W.4.0).
- ♦ What methods would be appropriate, timely and cost-effective to quantify future conditions, including quantifying the uncertainty arising from the state of knowledge of climate processes and numerical representations of climate processes?(Sections W.4.0 and W.5.0)
- ♦ The extent to which existing reconstructions of paleo streamflows could be used, alone or in conjunction with long-term climate projections, in the evaluation of alternative guidelines and strategies. (Section W.7.0)

U.3.2 Process

Reclamation convened a meeting of the Work Group on November 8, 2006. In addition to the outside expert invitees, a number of Reclamation staff and contractors also attended the meeting. The attendees at this meeting are listed in Attachment 1.

The November 8 meeting provided the opportunity for a face-to-face discussion between the climate experts and Reclamation staff. It was conducted informally, with considerable give and take. The meeting began with a presentation by Reclamation staff about the purpose of the Work Group and its charge. Reclamation suggested that a report from the Work Group would be a useful work product. Reclamation provided a comprehensive orientation to the Colorado River basin, including the hydrology of the basin, the Law of the River, water use in the basin, the water resources facilities in the basin, and operations. Discussions regarding operations addressed the recent drought and the current process of developing shortage guidelines. Subsequent discussions focused on the science of climate change and the likely impacts of climate change on the hydrology of the Colorado River basin. Considerable attention was given to the uncertainties inherent in projections of temperature and precipitation in the Basin.

Following the meeting, Reclamation convened a group of Reclamation staff, contractors and outside experts to develop an initial draft of a report from the Work Group. The members of this drafting group are listed in Attachment 1. The drafting group initially developed a suggested outline for this report, which was circulated to the entire Work Group in February 2007. The drafting group subsequently prepared a draft of this report, which was circulated to the Work Group in April 2007 for review. Comments were received from the Work Group and other interested parties including climate scientists, water resource engineers, and Reclamation personnel. A revised version of the document was finalized in August 2007.

U.4 Recent Treatment of Hydrology and Climate by LC Reclamation in Long-Term Planning Analyses

U.4.1 Recent LC Reclamation Requirements

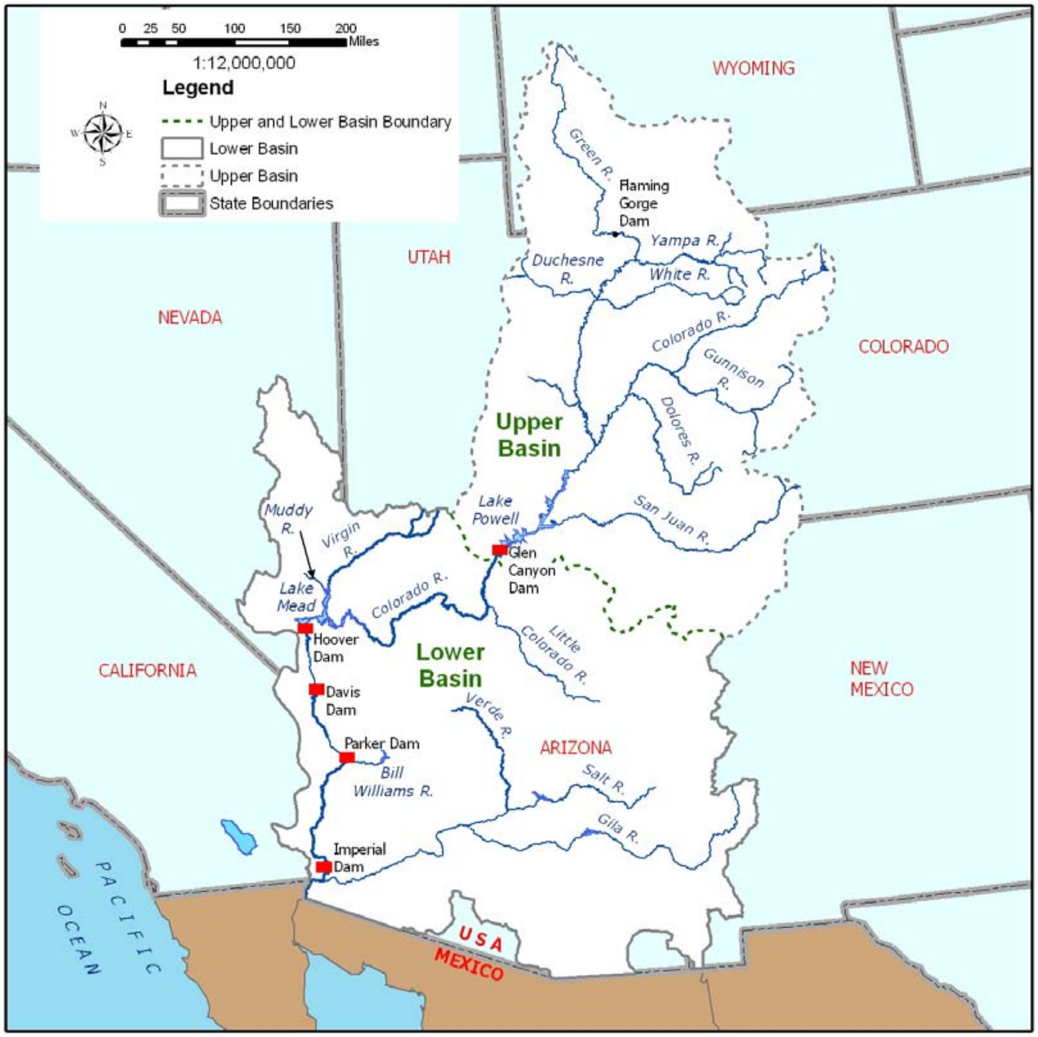
The Colorado River basin is located in the southwestern United States, as shown on Figure U-1, and occupies an area of approximately 250,000 square miles. The Colorado River is approximately 1,400 miles in length and originates along the Continental Divide in Rocky Mountain National Park in Colorado. The basin has been divided into Upper Basin and the Lower Basin, as shown in Figure U-1. Reclamation is the agency that has been designated to act on the Secretary’s behalf with respect to the operation of Glen Canyon Dam and Hoover Dam. More information about the Colorado River and its water resources can be found in Section 1.7 of the Draft EIS (Reclamation, 2007).

As part of its responsibility to manage water resources within the Colorado River basin, Reclamation is continuously evaluating the effect of operating procedures and policies in the basin. The primary effects of changing operating rules are changes in reservoir releases, river flows, reservoir contents and water deliveries to end users. These primary effects influence economic, social and environmental conditions. Reclamation makes its evaluation of the primary effects of operating policies using a water resources system model of the Colorado River that simulates the effect of operating rules on system conditions and water availability. Additional models are used to estimate secondary effects.

U.4.2 Colorado River Simulation System (CRSS)

Future Colorado River system conditions are simulated using the Colorado River Simulation System (CRSS). CRSS is a simulation model consisting of a database and a modeling code. The database describes the physical configuration of the natural and man-made features of the Colorado River system, the operating rules for the man-made features, the natural gains and losses of water that enter and leave the system, and the water used by or requested for use for human activities. The modeling code simulates the physical processes and institutional drivers that determine the system conditions, according to the data contained in the database. The model is run to determine system conditions for a given scenario, as described by the input data. For some resource analyses, results from CRSS are used as input to additional modeling studies that are required to characterize impacts to other resources.

Figure U-1
The Colorado River basin



CRSS simulates 12 reservoirs, 115 water delivery points and 29 inflow points. It simulates water entering the system, storage in system reservoirs, releases from storage, river flows, natural and man-caused losses of water, and the water demands of and deliveries to water users in the basin states and Mexico. The input data for the model include monthly natural inflows, various physical process parameters (such as the evaporation rates for each reservoir), initial reservoir conditions, and the diversion and depletion schedules for entities in the basin states and Mexico. The operating rules are also input for each scenario analyzed. CRSS is fully described in Appendix A of the Draft EIS (Reclamation, 2007).

The principal independent input to the model are data representing the patterns of inflows at the 29 inflow points. These inflows define the water inventory that will be managed in the system for beneficial use and environmental protection. Other inputs, such as water demands and operating rules, are controlled principally by human decisions. Despite differences between operating rules among scenarios, the future conditions of the Colorado River system (especially water levels at Lake Mead and Lake Powell) are most sensitive to future inflows.

U.4.3 Climate-related CRSS Inputs

The hydrology of a watershed is driven by its climate. Liquid water is introduced to a watershed by precipitation of water vapor from the atmosphere and is continuously removed from the watershed in the form of water vapor through the processes of evaporation and evapotranspiration. These processes are said to “deplete” the available water in a watershed. Any remaining liquid water may leave the watershed as stream or groundwater discharge. Some water will be stored temporarily in a watershed as groundwater, as ice or snow, or in man-made impoundments. Evapotranspiration, as used here, is the sum of evaporation of water from soil and transpiration of water from plants as they grow. Natural landscapes and agriculture deplete water through evapotranspiration. Water is evaporated from the surface of natural and man-made water bodies and through the operation of industrial processes. Depletion of available water supplies is the unavoidable cost of putting water to uses that benefit human beings.

As climate changes so will the hydrology of a watershed. Changes in precipitation, radiation and temperature will affect the water balance in a watershed and hence will affect the net runoff leaving that watershed. Changes in precipitation change the water supply input to a watershed. At regional scales, the dominant effect on the rate of evaporation is the availability of radiant energy at the evaporating surface. Air temperature is often used as a surrogate for energy input, and also influences convective heat transport. Changes in radiation and temperature will change the magnitude and pattern of evaporative water losses that deplete outflows from a watershed. In snowmelt-driven basins, changes in radiation and temperature will affect the fraction of precipitation that falls as snow and the rate and timing of snowmelt and will thereby change the pattern of outflows. Changes in radiation, temperature and precipitation will also change the magnitude and patterns of some human water uses. The effect of climate on streamflow is discussed in more detail in Section W.5.0.

Like any other watershed, the hydrology and water resources of the Colorado River basin are driven by climate and therefore are sensitive to climate change. Inputs to CRSS reflect past climate, including past climate variability, but do not reflect projected changes in climate. The input variables for CRSS that are sensitive to climate conditions are inflows and losses, water use by humans, and reservoir evaporation. These are described in the following paragraphs.

U.4.3.1 Inflows

CRSS represents the natural gains and losses to the river system at 29 “inflow points” throughout the basin. Fourteen of these inflows are “rim inflows”, which represent physical flow in a river reach at the outermost perimeter of the watershed. The remaining fifteen inflow points are incremental gains and losses, which represent the amount of water that is introduced to or removed from a particular river reach by “natural” processes. Incremental gains and losses include inflows from smaller tributaries and depletions along the reach. All inflows are expressed as monthly volumes.

These values represent "natural flows" that in turn represent the conditions that would have existed if all man-caused water uses and operational effects (e.g. reservoir storage and release) had not occurred. The natural flows include the effect of natural processes including depletions arising from evapotranspiration and the effect of storage and recharge to and from groundwater.

U.4.3.2 Water Use

Water use can be categorized as natural or social. Natural water use includes, for example, depletion of river flows by riparian vegetation or upland vegetation in a watershed. Social water use includes the demands of agriculture, industry and municipalities. CRSS incorporates natural water uses into the natural flow values representing rim inflows and incremental gains and losses. Social water uses, are driven by management choices and are represented explicitly in the model as variables.

Changes in climate will affect natural water use, but the response of water use to climate change is complex and varies on different time scales. The immediate response to changes in radiation and temperature is change in depletions arising from evaporation and evapotranspiration. Changes in precipitation will not affect depletions directly, but rather change the water supply. The longer term impacts of changes in radiation and temperature, and in the depth and intensity of precipitation will be changes in vegetation and even soil structure, subsequently affecting natural gains or losses in the watershed and riparian systems.

Changes in radiation, temperature and precipitation will change the patterns of diversion and depletion of water applied to social uses. This is primarily driven by changes in the intensity of evapotranspiration from agriculture and outdoor domestic use, but is also influenced by changes in the growing season brought on by changes in temperature. Of indoor domestic and industrial uses, depletions from uses such as cooling and reservoir storage (in the form of evaporation from the reservoir surface) are likely to be affected by changing climate. Because changes in climate will change the pattern of diversion (required to satisfy the irrigation requirements of crops or landscaping plants), the pattern and volume of direct flow diversions, releases from reservoirs and return flows will also change. These responses are driven by economic and institutional factors and are difficult to predict.

The impact of these effects on water use in the Upper Basin will be changes in the pattern and annual volume of inflows to Lake Powell. Section W.5.0 discusses some of the assessments that have been made about the effects of climate change on streamflows in the Colorado River basin. However, quantifying the changes in inflows to Lake Powell is complicated by the economic and institutional responses to the changes in water supply and irrigation requirements.

Because deliveries to Lower Basin water uses are defined by institutional constraints (e.g. contracts and decrees), changes in water use in much of the Lower Basin will not directly change the total amount of water released from system reservoirs. Changes in the seasonal pattern of water deliveries in the Lower Basin could change the timing of operational trigger events in Lake Mead and thus induce subtle but long-lasting effects in upstream reservoir operations. Changes in water use along the Lower Basin tributaries to the Colorado River below Lake Mead will have a more substantial effect on system operation, since changes in the amount and timing of return flows from these uses will change the amount and timing of releases from Lake Mead that are required to meet the water delivery requirements to Mexico.

U.4.3.3 Reservoir Evaporation

CRSS represents the net evaporation (evaporation adjusted for precipitation falling directly on the reservoir) from the water surface of reservoirs. Thus, changes in precipitation, radiation or temperature will affect the net evaporation simulated by CRSS.

U.4.4 Recent LC Reclamation Hydrologic Scenarios

Reclamation has used four different approaches to represent streamflow hydrology in modeling studies of the Colorado River system. These four approaches are summarized below. More detail on each approach can be found in Appendix N of the Draft EIS (Reclamation, 2007).

U.4.4.1 Direct Natural Flow Record (DNF)

Reclamation has developed a database of historical natural flows, gains and losses at the 29 inflow points required by CRSS. This database covers a period from October 1905 through December 2004 (water year 1906 through water year 2004). Analyses using this database are run on a calendar year basis and cover the period January, 1906 through December, 2004.

Reclamation has recognized that due to the natural variability of streamflows, the exact pattern of flows captured in the historical natural flow dataset is unique and will not occur again. In an effort to incorporate variability in system conditions that would reflect the natural variability of streamflow, Reclamation adopted a block bootstrap approach for resampling the historical record, known as the Indexed Sequential Method (ISM) (Reclamation, 1985; Ouarda et. al., 1997). ISM cycles through each year in the natural flow record and extracts a sequence of flows beginning at that year and extending through the desired scenario length. If a flow sequence overlaps the end of the natural flow data set (calendar year 2004) the method wraps around to the start of the natural flow record (calendar year 1906) and continues the sequence from that point. Because there are 99 years in the natural flow record the ISM method can create 99 distinct flow sequences. The ISM method applied to the 1906 to 2004 natural flow record is referred to as the Direct Natural Flow Record (DNF) approach.

The strengths of this method are that it is easy to implement, it is understandable, and it has been widely accepted by stakeholders on the Colorado River. However, each DNF scenario consists only of annual and monthly flow magnitudes and sequences that have occurred in the observed record, with the exception of new sequences being generated as a result of the wrap.

Reclamation has relied for some time on the DNF approach for planning in the Colorado River basin. Because it recognized the limitations in the DNF approach, Reclamation has for several years been conducting or sponsoring research aimed at developing methods that do not suffer from the same limitations as the DNF approach. In evaluating alternative shortage policies Reclamation has conducted sensitivity analyses using three alternative hydrologic scenarios, which are described briefly in the following paragraphs.

U.4.4.2 Non-Parametric Paleo Conditioned (NPC)

This technique also applies a bootstrap re-sampling to the historical natural flow record, but in this case the re-sampling is done on a year-by-year basis and the selection is conditioned on hydrologic state sequences (i.e., wet or dry) that are modeled based on a paleo reconstruction of streamflows at Lees Ferry. In the NPC method the magnitudes of individual flows are taken from the historical natural flow record, but the sequences of flows reflect sequence properties characteristic of the paleo reconstruction. The result is that wet and dry spells represented by the NPC method are different than those represented by the DNF or the direct paleo (DP) (described below) method. In particular, the NPC method will represent longer dry spells than are present in the historical natural flow record because longer dry spells are present in paleo reconstructions of streamflow in the Colorado River basin. Because the magnitudes of individual flows are taken from the historical natural flow record, the NPC method will not generate flow magnitudes beyond those in the observed record. The NPC method was used to generate 125 traces, each of 53 years in length.

This method is described in detail in Appendix N of the Draft EIS (Reclamation, 2007) and in Prairie (2006).

U.4.4.3 Parametric Stochastic Natural Flow Record (PS)

This technique uses parametric stochastic methods to fit the observed natural flows (1906-2003) to an appropriate set of stochastic models for streamflow generation and disaggregation. A parameter fitting procedure is applied to fit the observed natural flow to a contemporaneous autoregressive order 1 (CAR(1)) model. The PS method was used to generate 100 traces, each of 53 years in length. The PS method can generate both flow magnitudes and sequences not seen in the observed record, though the generated scenarios will be statistically similar to the observed record. The PS method can generate flow magnitudes much larger or much smaller than those in the observed record, which may be difficult to justify on a physical basis.

This method is described in more detail in Appendix N of the Draft EIS (Reclamation, 2007) and in Salas (1985) and Lee et al. (2006).

U.4.4.4 Direct Paleo (DP)

This technique uses a reconstruction of streamflow at Lees Ferry by Woodhouse, et al. (2006) which has been disaggregated to the 29 inflow points using a nonparametric disaggregation method (Prairie et al., 2006). The reconstructed trace used in this method is the same trace used in the NPC method, but in the DP approach both the magnitudes and sequences of flows are taken directly from the paleo reconstruction, whereas in the NPC method only the characteristics of the state sequence are taken from the paleo reconstruction, and the values result from resampling the observed streamflow conditioned on the previous resampled streamflow and the current and previous sequence properties. The DP approach will represent the longer droughts indicated by paleo reconstructions, but will also represent individual annual flow magnitudes that are not present in the historical natural flow record. Unlike the other methods, the long-term mean flow produced by the DP method will be different (in this case lower) than that seen in the observed record.

This method is described in more detail in Appendix N of the Draft EIS (Reclamation, 2007).

U.4.5 Climate Assumptions Implied by Hydrologic Scenarios

As noted earlier, the conventional water resources planning has been based on two assumptions: that the observed history of hydrology for a particular river system adequately captures the past mean and variability of water supply for that system, and that the observed history is representative of future conditions. Implicit in these conventional assumptions is the premise that climate, which drives hydrology, is static. Only in recent years have a significant fraction of water resources managers begun to depart from this premise and find ways of incorporating information about the potential hydrologic impacts of climate change in water resources planning.

All four hydrologic scenarios currently in use by Reclamation are based on the implicit assumption that the future mean and variability of streamflow can be adequately characterized by the statistics of past observations. The DNF and PS approaches assume that the last roughly 100 years characterize future conditions while the NPC and DP approaches extend that period to approximately 500 years. These scenarios do not reflect any probability that the future mean and variability of streamflows will differ from past values due to changes in future climate conditions. However, as discussed in Section W.7, the paleohydrology reflected in the NPC and DP approaches could be adapted to reflect alternative assumptions regarding future climate that are consistent with the findings of recent climate research and modeling.

U.5 State of Science: Historic and Future Climate

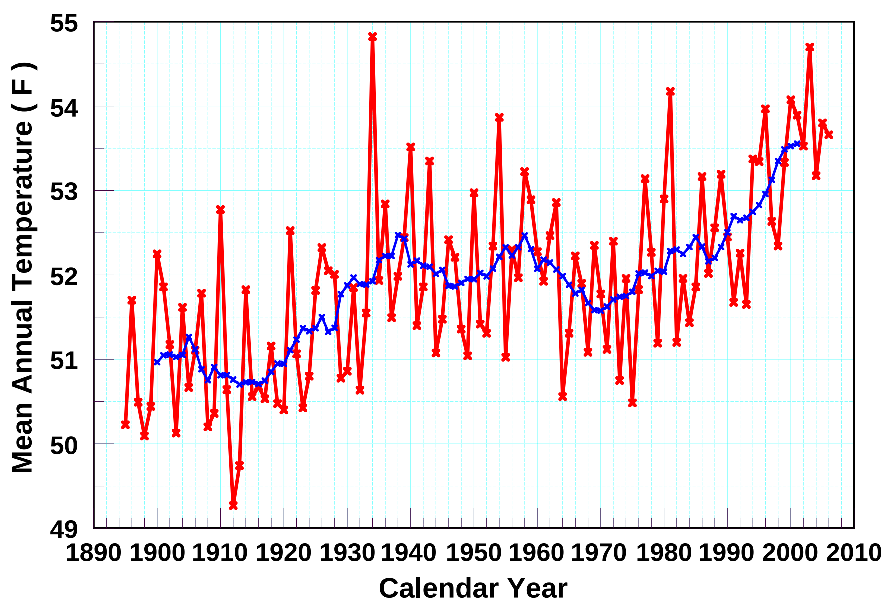
U.5.1 Historical Climate of the Colorado River Basin

One of the motivations for considering climate change implications for Colorado River basin water management is that changes in hydroclimatological conditions have already been expressed in the historical records. Through a variety of statistical methods, modeling efforts, and analytical processes, researchers have begun to identify and quantify trends within environmental time series and, in some cases, begun to forecast future climate trends. Recent climate trend research has focused on time series of streamflow, temperature, precipitation, and snow water equivalent (SWE) time series.

U.5.1.1 Temperature Trends

Trends in temperature for the Colorado River basin were summarized in the recent National Research Council (NRC, 2007) study. Figure U-2 displays the annual average air temperature for the entire Colorado River basin from 1895-2006. Overall there has been an approximately 1.6OC increase in the 11-year running mean. The increases primarily occurred during the periods 1920 to 1940 and 1970 to the present. These trends are also consistent with those seen in regional and global temperature records. However, the trends in the Colorado River basin are the largest in the continental U.S. when expressed as standard deviations. The significance of increase temperatures on the regions snowpack and streamflow are discussed in following sections.

Figure U-2
Annual and 11-year Running Average Temperature for the Colorado River Basin

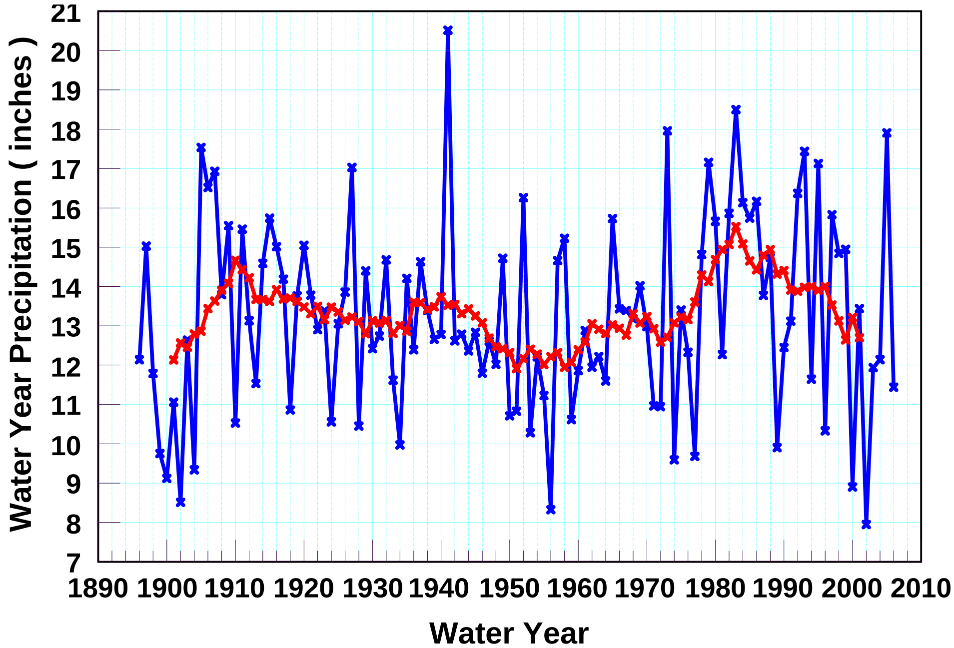


(Source: Western Regional Climate Center and NRC, 2007)

U.5.1.2 Precipitation (Rainfall and Snow) Trends

Trends in precipitation for the Colorado River basin were also summarized in the recent NRC (2007) study. Figure U-3 displays the annual precipitation for the Upper Colorado River basin from water years 1896 to 2006. There is a high degree of variability over the entire record. However, the past 30 years of record seem to have different variability as compared to the early part of the record. For instance, the lowest and highest annual precipitation amounts occurred in the past 30 years. In addition, there is evidence of more regimes of wet and dry episodes, lasting 4-6 years, since the middle 1970's compared with the previous 30-40 years. Even though there is more variability in the recent record, there does not appear to be an overall trend in the annual precipitation over the entire record.

Figure U-3
Annual and 11-year Running Average Precipitation for the Upper Colorado River Basin from Water Year 1896 to 2006



(Source: Western Regional Climate Center and NRC, 2007)

It is also important to evaluate the form of precipitation (i.e., rain or snow). In the mountainous western U.S., approximately 50 – 70% of precipitation is observed as snow (e.g. Clark et. al. 2001). As a result, melting snowpack is an important and significant source of water for much of the west, particularly in the Upper and Lower Colorado River basins (e.g., Hamlet et al., 2005). Recent published research has studied the climate trend of snow data through the investigation of April 1st snow water equivalent (SWE) values, as April 1st is in many locations an accurate estimate of the peak of spring snowpack and total runoff (e.g., McCabe and Dettinger, 2002). Most studies in this review used observed National Resource Conservation Service (NRCS) SNOwpack TELemetry (SNOTEL) or snowcourse data. Table U-1 summarizes the time periods and parameters used in studies focused on snow and streamflow for the western United States.

Table U-1
Summary of Studies Evaluating Trends in Snow and Streamflow for the Colorado River Basin

Study Name	Time Period	Snow	Streamflow
Groisman et. al., 2001	1939-1999		
Hamlet et. al., 2005	1916-2003	Decreasing	earlier peaks
Kalra, et. al., 2007	1941-2004	Decreasing	
Lins and Slack, 1999	1944-1993		
Mote et. al., 2005	1950-1997	Decreasing	
Pagano and Garen, 2005	1901-2002		
Regonda et al., 2005	1950-1999	Decreasing	earlier peaks
Stewart et al., 2005	1948-2002	Decreasing	earlier peaks
Knowles et al., 2006	1949-2004	Decreasing	

Arrows indicate either increasing or decreasing trend. Blank cells indicate that there was no trend or the authors did not investigate that parameter.

All the studies (Mote, 2003; Hamlet et al., 2005; Regonda et al., 2005; Knowles et al., 2006; Mote, 2006; Kalra, 2007) noted a decline in April 1 SWE with a particular emphasis on high elevation stations. Mote (2003) attributes the decline in SWE observations in the Pacific Northwest and western U.S. (including the Colorado River basin) to increased temperature and a greater portion of precipitation falling as rainfall, particularly at elevations below 1800 meters. Mote et al., (2005) expanded upon the study presented in Mote, (2003) by using the Variable Infiltration Capacity (VIC) Model. In the Lower Colorado River basin, the VIC Model showed an increasing trend in SWE, sometimes in excess of 30% from 1950 to 1997. The Upper Colorado River had primarily a decreasing trend.

Regonda et. al. (2005) collected data from snowcourse sites over the period 1950 to 1999 in an attempt to quantify the timing of snowmelt with trends in hydroclimatic variables. April 1 SWE values from snowcourse sites spanning the western U.S. were correlated with streamflow stations in the Western United States. Regonda et. al., (2005) found decreases in SWE correlated to increases in temperature and precipitation. This suggests that the temperature changes (negative) are having a more pronounced change on SWE than increases in precipitation. The decreases in SWE were found to be most pronounced within low elevation basins. As a result of warming trends and lower volumes of snow pack, peak runoff rates from snowmelt have begun to trend earlier in the year.

Knowles et al., (2006) closely evaluated the trend toward earlier runoff by comparing the SWE to winter-total precipitation for the western United States. They found that there is a trend toward smaller SWE compared to winter-total precipitation. This means more precipitation is occurring in the form of rain instead of snow.

Kalra et. al., (2007) evaluated April 1 SWE data from 121 SNOTEL stations from 1941 to 2004 in the western United States. After stations exhibiting significant autocorrelation were excluded, SWE observations at the remaining SNOTEL sites showed decreases from 1941 to 2004.

U.5.1.3 Streamflow Trends

Streamflow patterns in the western U.S. are significantly affected by snowmelt conditions, motivating interest in comparing streamflow and SWE trends. Streamflow is of primary concern in water management, as reduced streamflow can negatively impact reservoir operations. Decreasing streamflow can have an adverse effect on hydroelectric power generation, irrigation demands, recreational activities, and the environment (e.g., Regonda et. al., 2005). The timing of peak streamflow is also of concern, as changes to the timing of peak streamflow may affect flood control, impact the environment, and impose hardship on those dependent on the timing of flow due to seasonal snowmelt, such as farmers. Investigation of streamflow records typically uses observations from the United States Geological Survey (USGS), specifically from gages within the Hydro-Climatic Data Network (HCDN), which are USGS streamgages minimally affected by anthropogenic regulation and with a sufficient period of record.

Kalra et al., (2007) examined long-term trends and abrupt step changes within the USGS HCDN data over various basins and time scales (i.e., water year, seasonal, and decadal). No significant trends in streamflow volumes were found for the Colorado River basin over the entire length of record. These results are also confirmed from prior studies (e.g., Lins and Slack, 1999; Groisman et al., 2001; McCabe and Wolock, 2002; Pagano and Garen, 2005; Stewart et al., 2005). The tendency for no trend in total annual streamflow is reasonable considering that there is no trend in total annual precipitation. However, the tendencies in changes in seasonal streamflow volumes may be more apparent due to the expected changes in temperature (warmer) and the form of precipitation in warmer future climate scenarios.

U.5.2 Future Climate

The future water supply for the Colorado River basin will depend on many climatic factors. Climate change may alter the quantity and timing of local and regional precipitation. Higher temperatures would mean more precipitation falling as rain than snow, reducing snowpack water storage, likely greater evaporative losses, and shift in the timing of runoff to be earlier in the season. While it is difficult to make certain predictions of changes in the overall quantity of precipitation for the region, scientific theory suggests that higher carbon dioxide (CO_2) concentrations warm the lower atmosphere, raising its water holding capacity, which, among other things, intensifies the global hydrological cycle (Meehl, et al. 2005; Trenberth et al. 2003). In some regions, this could lead to more intense but possibly less frequent periods of precipitation. In other words, we may see longer periods of drought, alternating with spells of heavy snowfall and rainfall events, and subsequent changes in the timing and magnitude of runoff. Such changes could create a number of difficulties for water managers throughout the Colorado River basin. For example, greater runoff variability could make it more difficult to maintain optimal reservoir levels, which could reduce the reliability of water storage, although this is less a problem in the Lower Colorado than elsewhere due to the size of overyear storage.

U.5.2.1 Global Climate Change

The scientific evidence for human-caused global climate change has become quite compelling in recent years. The Intergovernmental Panel on Climatic Change (IPCC) recently released the first of four parts of its Fourth Assessment Report (AR4 IPCC 2007), describing the science and physical evidence surrounding climate change. This also includes the anticipated changes in water resources summarized by the Working Group II in "The Summary for Policymakers." The consensus among involved scientists and policy makers is that "… global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750… and the understanding of anthropogenic warming and cooling influences on climate leads to *very high confidence* that the globally averaged net effect of human activities since 1750 has been one of warming.. ." Certainly, other forcings act on the climate system beyond human influences, most notably solar, volcanic, oceanic, and cryogenic (ice) forcings, but when these processes are included alongside human forcing, an anthropogenic "fingerprint" emerges.

CO_2 is a major green house gas, contributing somewhere between 10 and 25 percent of the natural warming effect, second only to water vapor. As the earth emits long wave radiation toward space, atmospheric constituents like water vapor, CO_2, ozone, and methane absorb this energy flow and radiate energy back to earth. Climate models suggest that without these greenhouse gases the average earth temperature would be about 19ºC cooler, and in the absence of other changes and feedbacks in the climate system, a doubling of CO_2 would warm the lower atmosphere by about 1.2ºC (Kiehl and Trenberth 1997).

Figure U-4 is a plot of annual mean departures from the 1961-90 average for global temperatures (with a mean of 14.0°C) and carbon dioxide concentrations from ice cores and Mauna Loa (1958 on), with a mean of 333.7 ppmv (updated from Karl and Trenberth 2003). The plots show that the rise in CO_2 coincides with a rise in global average surface temperatures.

Increasing CO_2 is not the only human activity affecting our climate system and in fact, CO_2 is only responsible for about two-thirds of the greenhouse effect, the rest being attributable to methane, nitrous oxide, chlorofluorocarbons, and ozone. Changes in land use, aerosol emissions from fossil fuel burning, the storage and use of water for agriculture, etc. are all environmental changes that affect climate (Pielke et al., 2007). Climatologists have tried to quantify the relative role of various human factors on the climate system in terms of each component's "radiative forcing", which are summarized in Figure U-5 and taken from the AR4. Most notably, the radiative forcing of CO_2 is the largest single component, with natural solar irradiance (solar variability) substantially smaller. Also, there are human activities that counteract the positive forcing of CO_2. For examples, aerosols from the burning of fossil fuels tend to reflect heat back into space, reducing the net heat at the surface. When all the components are considered, there is a net positive radiative forcing on the order of 1.5 watts per square meter (W/m^2).

Figure U-4
Global average temperature and CO_2 trends (Karl and Trenberth 2003)

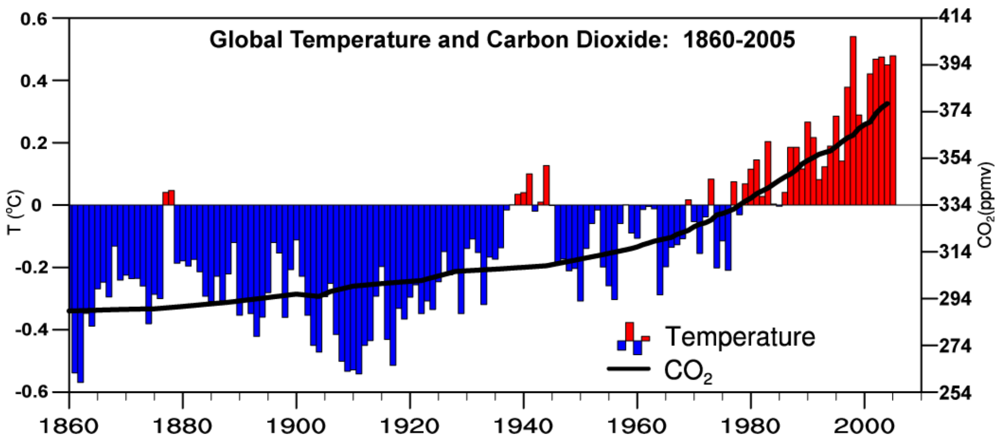
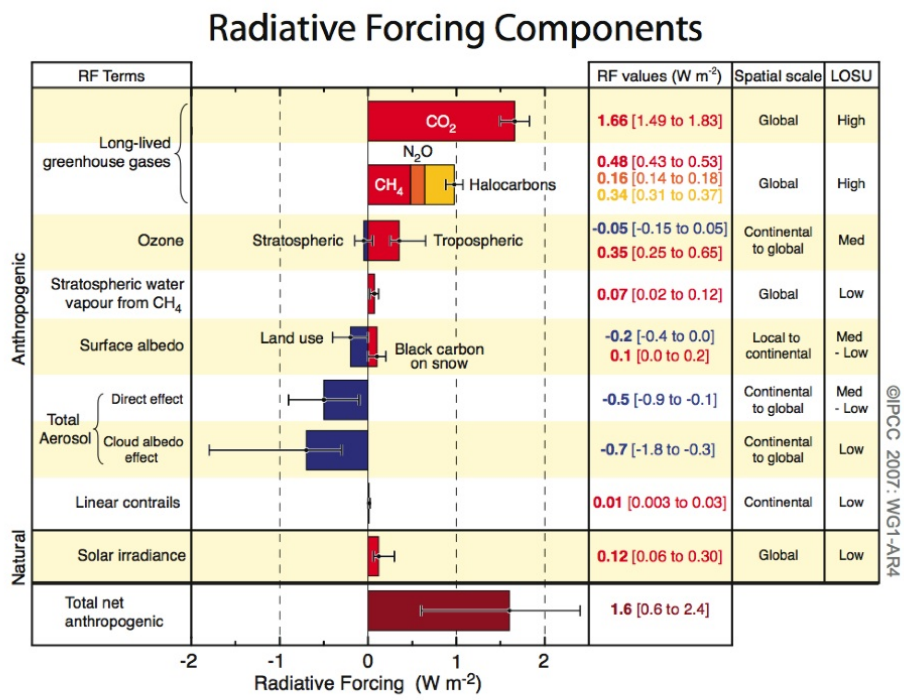


Figure U-5
Relative Radiative Forcing Attributable to Human Activities,
Where "Positive" Means that the Earth is Gaining Energy Faster Than It is Losing It
(RF-Radiative Forcing; LOSU- Level of Scientific Understanding)

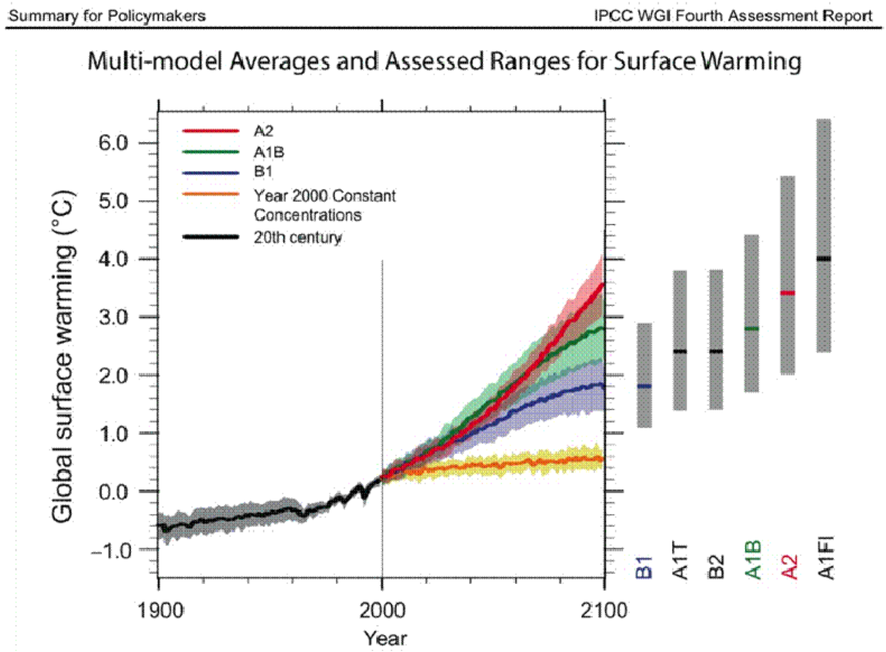


Problematically, CO_2 has a relatively long residence time in the atmosphere and while its sources are local, it is generally globally distributed. Recognizing that it is a strong forcing component, the IPCC has convened panels of experts that have developed “storylines of the future”, which are used to project concentrations of greenhouse gases. These transient concentrations are then used in Generalized Circulation Models (GCMs) to project the relative contribution of CO_2 (and other factors) to future warming. Most GCMs consist of an atmospheric module that is coupled to the other key components of the climate system, including representation of oceans, sea ice, and the land surface. The major GCMs include tens of vertical layers in the atmosphere and the oceans, dynamic sea-ice sub-models and effects of changes in vegetation and other land surface characteristics (Washington, 1996; Gates et al., 1999). The atmospheric part of a climate model is a mathematical representation of the behavior of the atmosphere based upon the fundamental, non-linear equations of classical physics. A three-dimensional horizontal and vertical grid structure is used to track the movement of air parcels and the exchange of energy and moisture between parcels.

The CO_2 storylines include both “green” centered trajectories that moderate fossil fuel use and fossil fuel intensive trajectories, leading to either low or high green house gas concentrations, respectively. These different emission pathways then imply different mean global and regional climate warming rates. The details of these scenarios are beyond the scope of this report, but Figure U-6 summarizes the projected global average surface warming based on a consensus derived from several GCMs across a range of future projections (e.g. referred to ‘A2’, ‘A1B’, and ‘B1’ scenarios; for details about the different scenarios, see http://www.ipcc.ch/pub/sres-e.pdf). Note this figure includes a projected global average temperature if we were to keep CO_2 at 2000 concentration levels, suggesting that we are already *committed* to further warming beyond anything that has taken place already.

The consequences of the projected future warming are likely to be changes in atmospheric and oceanic circulation, and in the hydrologic cycle, leading to altered patterns of precipitation and runoff. Scientists agree on some of the important broad-scale features of the expected hydrologic changes, the most likely of which will be an increase in global average precipitation and evaporation as a direct consequence of warmer temperatures. That, however, does not mean that there will be more precipitation everywhere or that runoff and recharge would increase in proportion to precipitation.

Figure U-6
From the IPCC Working Group I, Fourth Assessment Report, Summary for Policy Makers (IPCC 2007)

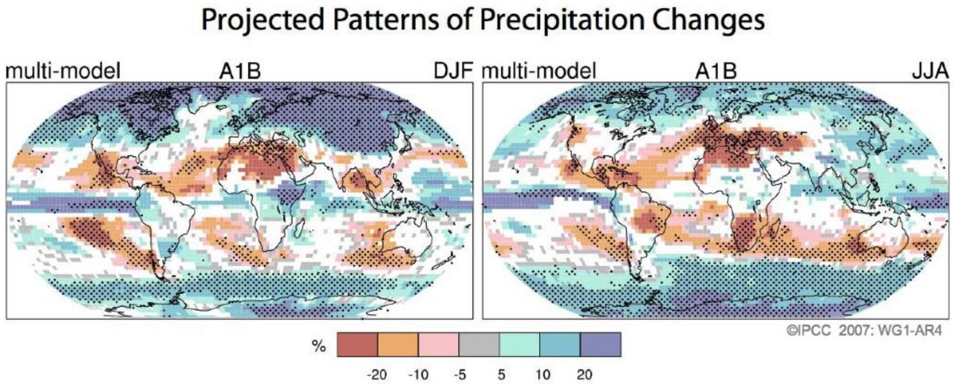


Historic observed global average temperatures, and projected global average temperatures based on various projections of global CO_2 concentrations.

U.5.2.2 Regional Climate Change

At the regional scale, such as the Colorado River basin, there is high confidence in projections of future temperature change, with less confidence in projections of future precipitation change (Dai, 2006). Changes in circulation patterns will be critically important in determining changes in precipitation and water availability, and climate models can provide only a crude picture of how those patterns may change. The currently available evidence suggests that arctic and equatorial regions may become wetter, and that subtropical regions may experience drying. Projections of precipitation changes for mid-latitude regions such as the Colorado River basin are less consistent, but generally indicate a drier climate (e.g., Milly et al., 2005; Seager, 2007). Seager (2007) argues for an imminent transition to a drier climate in southwestern North America. He points out the consistency of climate models in producing a human-induced aridification caused by large scale changes in the atmospheric branch of the hydrological cycle, stating that "the subtropics are already dry because the mean flow of the atmosphere moves moisture out of these regions whereas the deep tropics and the higher latitudes are wet because the atmosphere converges moisture into those regions. As air warms it can hold more moisture and this existing pattern of the divergence and convergence of water vapor by the atmospheric flow intensifies. This makes dry areas drier and wet areas wetter." Figure U-7 shows projected patterns of precipitation change. Note the general pattern of drier conditions in the mid-latitudes and desert regions, and wetting in the tropics and high latitudes (IPCC 2007).

Figure U-7
Statistical Summary of Projected Patterns of Precipitation Change from Multiple
General Circulation Models for December, January and February (left) and June, July, and August (right)



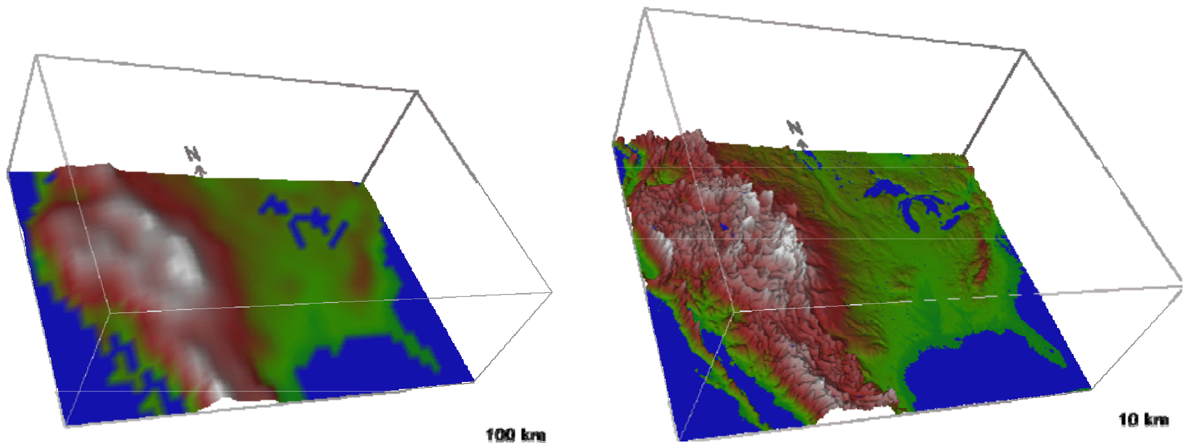
The stippled areas show region where there is greater agreement among models.

However, climate simulations of southwestern North America are problematic because the region is both downstream from the Pacific and also in an area where topography can make a difference, issues that are not well captured in the bulk of GCMs (if correct in any at all). The climate of the Southwestern US depends greatly on the dynamics in the tropical and extra-tropical Pacific Ocean circulations that are not accurately simulated in current GCMs. The subtle dynamics of the jet stream and storm tracks particularly in the winter and the influence of the North American Monsoon in the summer are also important and not well represented. Despite tremendous technological advances in computing capability, it is still very time consuming and costly to use these models to simulate future climates. One of the most important compromises for achieving model results in a reasonable amount of time is to decrease the model's horizontal resolution. This limitation means that it is prohibitively costly to run a GCM at a spatial resolution that would accurately depict the effects of mountains and other complex surface features on regional climates.

The problem with such a coarse horizontal resolution is that important processes occurring at finer scales are not well resolved (Figure U-8). Topography, for example, is very important in determining the location of precipitation. As moist air rises over mountains or hills, the moisture condenses, producing clouds and, if conditions are right, precipitation. Although there has been marked improvement over the last three decades in the simulation of precipitation, it is still not well represented in GCMs, especially in areas of complex topographies, since the coarse horizontal resolution **o**f GCMs tends to smooth out important landscape features that affect atmospheric processes. At the resolution of most GCMs the models represent the mountains of the western United States as a set of gentle ridges and do not resolve finer scale features that influence regional climate. Clearly, that level of spatial resolution is too coarse to reproduce the effects of topography on the region's precipitation and runoff patterns (Grotch and MacCracken, 1991; Giorgi and Mearns, 1991; Pan et al. 2004).

Figure U-8
Horizontal Spatial Resolution Depicted by Typical
Global Climate Models, and Where We Hope to Be in the Next 5 to 10 Years

GCMs in 2006 **GCMs in 5 to 10 years**



The current inadequacies of GCMs and the recognition that each has its own strengths and weaknesses has led researchers to conclude that no single model can be considered ‘best’ and it is important to utilize results from a range of coupled models for regional impact and adaptation studies (Allen et al., 2000). Tebaldi et al., (2006) presented a probabilistic approach that combines the regional output of 21 unique GCMs to produce probabilistic projections of regional, future climate change. Their statistical model combines information from each GCM, including each model’s ability to re-create the regional climate over the period 1960 through 1990 (a measure of a model’s bias), and the agreement among models in future projections. Models that diverge greatly from other models are given less weight in deriving the final statistical distributions of change. Figures U-9 a and b show probabilistic projections of future seasonal temperature and precipitation change in the Upper Colorado River basin for the 2000-2020 and 2040-2060 period for the low CO_2 emission, B1 scenario; the “middle-of-the-road” A1B emissions scenarios; and the high A1 emissions scenario for the Upper Colorado River basin.

Not surprising, the projection differences among the three scenarios from 2000 to 2020 are not substantial since the CO_2 trajectories are very similar in the early period, with regional mean warming just below 1ºC. It isn’t until later in the 21st century, that the projections diverge under the various CO_2 scenarios. The Tebaldi et al., (2006) results suggest a GCM model consensus of temperature increases a bit below 1ºC over the next 20 years, with some seasonal variation. Interestingly, the results show moderate increases in winter precipitation across all scenarios, with little or no change in spring and fall precipitation and slight decreases in summer precipitation, with some scenario dependency (bottom, Figure U-9 b). By the 2040 to 2060 period, the mean regional warming projections exceed 1ºC and the magnitude of the regional temperature increases are much more tied to the specific projection scenario. Remarkably, the temperature projections for the moderate (A1B) and higher emissions scenario (A2) are quite similar, while the precipitation projections show slightly wetter winters under the moderate B1 scenarios and slight *drying* over these decades for the higher A1B and A2 higher CO_2 projection scenarios. All three scenarios show summer drying and little or no change in the spring and fall "shoulder" seasons.

Figure U-9 (a)
Scenario-specific Absolute Change in Temperature (top) and Percent Change in Precipitation (bottom) in the Upper Colorado for the Period 2000-2020
DJF, MAM, JJA, SON for the B1, A1B and A2 Scenarios

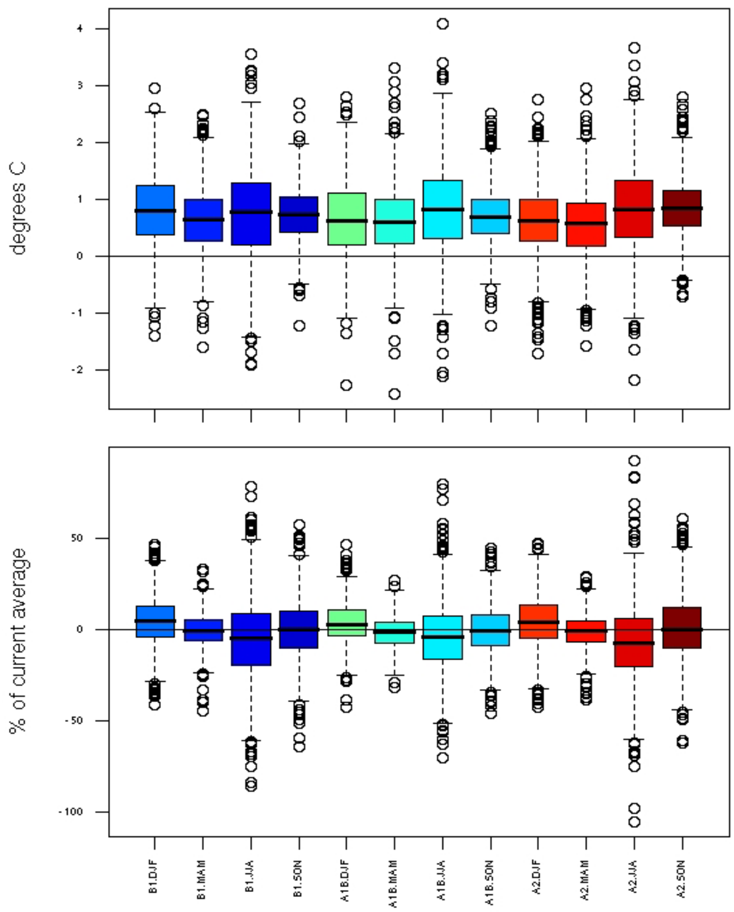
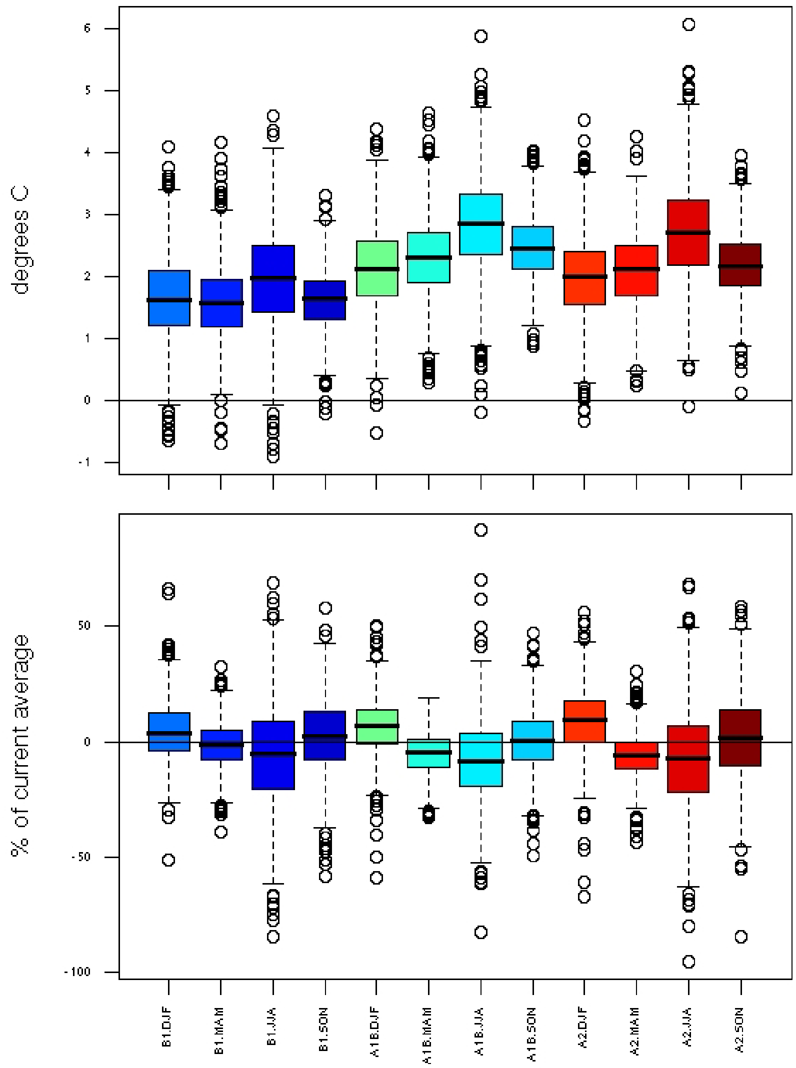


Figure U-9(b)
Scenario-specific Absolute Change in Temperature (top) and
Percent Change in Precipitation (bottom) in the Upper Colorado for the Period 2040-2060
DJF, MAM, JJA, SON for the B1, A1B and A2 Scenarios



GCMs also produce runoff estimates that can be useful in identifying whether regions are going to have more or less water resources. Milly et al., (2005) evaluated the global patterns of water availability under climate change scenarios. Depending on the region of the globe, annual runoff could increase or decrease. The relative changes for the southwest U.S. were decreases in annual runoff. These estimates are for large areas and downscaling is necessary to identify regional impacts. This is discussed further in Section U.4.2.3.

U.5.2.3 Regionalizing Future Climate Projections (Downscaling)

As was summarized in previous sections, GCMs are able to simulate large-scale climate features realistically, but exhibit biases at a regional scale. The regional biases are problematic for analysis of climate implications for hydrology and water resources (Maurer, 2007). Recognizing the regional limitations of GCMs has led to the application of “downscaling” as a means of trying to understand how local scale processes, of greater interest to water resource planners, might respond to larger-scale weather and climate changes (Wilby et al., 2004). Regardless of the technical approach, the primary goal is to process the raw GCM output so that it reflects the large-scale features and temporal trends from the GCM simulation, but also the historical patterns of climate variables at the regional and local scale (Wood et al., 2004).

Downscaling techniques generally fall into classes involving either simulated (dynamical), statistical, or bias-correction/disaggregation methods. Downscaling can produce more sub-regional detail and eliminate system biases between observed local climate and climate generated by GCMs. Downscaling does not necessarily provide more reliable information or increase our confidence in a particular GCM scenario for climate change. Several downscaling approaches are summarized:

Dynamic Methods. This class involves the use of regional climate models run at a relatively high resolution over a limited area with boundary conditions (and sometimes interior domain information as well) prescribed from the lower resolution GCM. This is often referred to as “dynamical” downscaling since the regional climate model explicitly accounts for the dynamic aspects of the climate system that operate on finer spatial scales than the GCM can represent. It is possible for these “nested models” to resolve some limitations of general circulation models for a specific region. They are still limited in their capabilities to give reliable projections for future precipitation change. The intensive computational demands of dynamical models severely limit their usefulness for producing long-range climate change scenarios. Proponents argue, however, that mesoscale models uniquely represent important feedback mechanisms (such as the effects of land surface albedo on boundary layer climate dynamics) that may moderate or enhance climate change.

Statistical and Bias Correction Methods. This class of downscaling methods involves deriving statistical relationships between observed small-scale (often station level) variables and larger (GCM) scale variables, using analogue methods (circulation typing), regression analysis, or neural network methods (Mearns, 1999; Yates et al., 2003, Clark and Hay, 2004). Future values of the large scale variables obtained from GCM projections of future climate are then used to drive the statistical relationships and estimate the smaller-scale details of future climate.

Stochastic weather generators have been used to develop climate datasets for impact analysis. These can address some of the issues just raised with their ability to simulate plausible climate scenarios, and have themselves been used as downscaling techniques in global change studies (Wilks, 1992). Typically, a stochastic weather generator is developed based on the historically observed data at a location, and can then be used to simulate climate scenarios consistent with the global change scenarios. However, Katz

(1996) points out that modifying the parameters of a stochastic model can lead to unanticipated effects. For example, modifying the probability of daily precipitation occurrence using a stochastic weather generator (Richardson 1981) also changes the mean and standard deviation of the daily temperature as well.

The statistical downscaling approach of Maurer (2007) and Wood et al., (2002; 2004) is relevant because it was used in recent studies of the Colorado River basin (Christensen and Lettenmaier, 2006); Christensen et al., 2004). The method involves two steps: (a) identifying and accounting for bias between GCM-simulated climate variables and corresponding observations during a "common historical overlap period", and (b) disaggregating the bias-corrected GCM output to region and local scales so that the information is more spatially consistent with the basin and local scales considered in impacts analyses. The procedure improves upon an earlier downscaling techniques (called the "perturbation" method) that involved identifying and applying adjustment factors based only on climatological monthly mean differences in observed precipitation (P) and temperature (T) and between GCM output and observations (e.g., Lettenmaier et al., 1999; Miller et al., 2003). The limitations of such an approach are that it doesn't consider GCM interannual variability, does not address the GCM's potential bias in temporal variability, and can result in implausible precipitation sequences after rescaling. Recently, techniques address these limitations through the use of distribution-mapping between GCM gridded output and historical gridded observations (Maurer, 2007; Wood et al., 2002).

Implementation of the latter bias-correction technique requires definition of "observed historical" using a reference gridded climate dataset (e.g., usage of National Climate Data Center Cooperative Observer Data aggregated to 2° latitude-longitude spatial resolution). The "common historical overlap period" is then defined, where both "observed historical" data and GCM historical simulation data are considered. Within this historical period, month-specific cumulative distribution functions (CDFs) are calculated, describing the range and distribution of P and T conditions at each grid point in the region of consideration. (Note: GCM historical simulation data may have to be interpolated and mapped to grid point locations consistent with the observed dataset's grid or vice versa) Bias-correction within the "common historical overlap period" then ensues: on a grid-point by grid-point basis, the quantiles for GCM-simulated P and T CDFs are then mapped to the same quantiles for the observationally based CDF at a grid-point by grid-point basis. For example, suppose the 70th percentile GCM P value for December is adjusted to equal the 70th percentile observed P value for December. This basis for adjusting GCM output is then carried forward beyond the "common historical overlap period" to adjust GCM-projected conditions. For example, let's say a projected December P value happens to equal the median unadjusted GCM-historical December P value. Just as the GCM-historical median value was adjusted to equal the observed median value, the projected value would be adjusted in the same fashion. For GCM T values, the full-period linear trend in the simulation is removed prior to bias-correction, and then replaced afterwards (Wood et al. 2004; Maurer 2007).

Following bias-correction, the GCM gridded dataset is spatially disaggregated, or "downscaled", to a finer resolution. While other dynamical or statistical methods could be used at this stage, a relatively simpler interpolation technique has been used in recent applications (Wood et al., 2002; Wood et al., 2004; Maurer et al., 2007; Christensen and Lettenmaier, 2006).

Relative Limitations Among Method. Each technique has strengths and weaknesses. For example, simulated downscaling would seem to offer the best capability in preserving physical relations between local- and larger-scale climate features, even under a changing climate. That said, the simulation approach is computationally intensive and constrains consideration of multiple climate change scenarios and future periods to be considerably less than what might be considered using statistical or bias-correction/disaggregation methods. Likewise, the latter two methods are computationally efficient, but relatively more limited in how they approximate the relation between local- and larger-scale climate features. Statistical methods assume a stationary relationship that may not hold under a changing climate. Disaggregation rests on the assumption that the variance of conditions simulated in a GCM should be constrained by the variance of observed climate conditions, even though such an assumption might not hold true as climate changes.

Substituting Sensitivity Analysis for Downscaling-Analog Methods. Conducting downscaled analyses based on the projections from multiple climate models can be a very laborious and time-consuming task. The daunting prospect of developing detailed climate data sets for impact analysis has led to simpler "scenario" approaches in contrast to the "projection" based approach which rely on GCM results and the downscaling steps just described.

The scenario approach includes simple "back-of-the-envelope" methods that can explore the possible implications of climate change for water resources. Since it is unlikely that we will be able to "predict" the climate of the future, we can be informed by the climate of the past and at least be guided or bound by the projected future changes. For example, what are the consequences throughout the basin of a reoccurring 1930's 'dust-bowl' era drought, with current population and water use, and what if a 1ºC warming were superimposed on top of these conditions? This approach introduces a "worst case" climate scenarios on a regional or local scale based on historical events, such as a region's most severe drought in the past century or climate traces developed from tree ring studies. This approach has the advantage of realism, because events that occurred in the past could occur again. A drawback of this approach is that the hypothetical scenarios may not be internally consistent and it is difficult to estimate their likelihood. Despite those drawbacks, systematic analysis of such scenarios can be useful for delineating the relative importance of changes in temperature and precipitation and can provide an inexpensive way to explore vulnerabilities of water supply systems, water quality, and in-stream resources.

Several analyses have used hypothetical changes in temperature and precipitation amounts by simply scaling a historic record by some predefined amount, essentially amounting to a sensitivity analysis to a climate perturbation. Such a climate scenario would simply take historical climate sequences and add an absolute temperature change and/or a percent change in precipitation to this historical record, with the magnitudes of changes bounded by the regional changes suggested by GCMs. If climate models suggest a 1ºC warming over the next 30 years, then a 30 year, 1ºC trend can simply be added to the historic temperature data. This kind of sensitivity analysis is useful for understanding the response of the hydrologic system to a warmer climate.

U.6 A Review of Assessments of Climate Change Impacts in the Colorado River Basin

Section W.5.1 in this chapter provides an overview of the six major studies since 1979 on how climate change might affect the runoff of the Colorado River. Section W.5.2 discusses more general recent studies on potential hydrological changes in the American Southwest under a warmer climate including the new IPCC regional findings. The final section summarizes and discusses all of the studies including limitations and the range of future projections.

U.6.1 Literature Review of Colorado River Climate Change Studies

Since 1979 there have been six major studies on how climate change might affect runoff in the Colorado River (See Table U-2). These studies approach the problem using two, or in some cases three steps. The first step is to obtain future temperature and precipitation by using either arbitrary scenarios or GCM outputs. Early studies used the former approach while more recent studies have used the latter technique. The second step is to use the temperature and precipitation and possibly other climatic variables in either statistical/empirical relationships or hydrology models to generate streamflow. Finally, some of the studies use an ‘operational’ model to convert projected streamflows into reservoir levels, compact deliveries, energy production, and other information. These steps are depicted in Figure U-14 for one of the studies. In addition to the major studies on the basin, there have been several other smaller studies and these are discussed at the end of this section.

U.6.1.1 Geohydrological Implications of Climate Change on Water Resource Development (Stockton and Boggess, 1979)

Charles Stockton[1], of the University of Arizona Laboratory of Tree-Ring Research, and William Boggess wrote a report prepared for the U.S. Army Corps of Engineers Engineering Research Center in 1979. The authors investigated how four different climate change scenarios would impact the water supplies of the United States.

[1] Stockton was also coauthor of the 1976 Stockton and Jacoby Colorado River tree-ring reconstruction discussed in 7.1

Table U-2
Summary of Model Results for Colorado River Basin

Study	Flow Generation Technique	Selected Results on Typical Changes in Flow (doesn't reflect range of change across studied scenarios)	Notes
Stockton and Boggess, 1979	Langbein's 1949 US Historical Runoff-Temperature-Precipitation Relationships	+2C and -10% Precip = ~ -33% reduction in Lees Ferry Flow	Results are similar for the warmer/drier and warmer/wetter scenarios. Cooler and wetter and cooler and drier are very likely not applicable.
Revelle and Waggoner, 1983	Regression of runoff on Upper Basin Historical Temperature and Precipitation	+2C and -10% Precip= -40% reduction in Lee Ferry Flow	+2C only = -29% runoff, -10% Precip only = -11% runoff. Regression can be used to calculate a variety of projections.
Nash and Gleick, 1991 and 1993	NWSRFS Hydrology model runoff derived from 5 temperature & precipitation Scenarios and 3 GCMs using doubled CO_2 equilibrium runs.	+2C and -10% Precip = ~ -20% reduction in Lee Ferry Flow	Many runoff results from different scenarios and sub-basins ranging from decreases of 33% to increases of 19%. Used USBR CRSS Model for operations impacts
Christensen et al., 2004	UW VIC Hydrology model runoff derived from temperature & precipitation from NCAR GCM using Business as Usual Emissions.	+2C and -3% Precip at 2100 = -17% reduction in total basin runoff by 2100	Used single GCM with low temperature sensitivity to CO_2 increases. Created and used operations model, CRRM.
Hoerling and Eischeid, 2006	Regression of runoff on PDSI developed from 18 AR4 GCMs and 42 runs using Business as Usual Emissions.	+2.8C and ~0% Precip = -45% reduction in Lee Ferry Flow by 2035-2060	Range of results is considerable. Reduction in runoff seen even when using 20th century historical wet period with 21st century projected temperatures.
Christensen and Lettenmaier, 2006	UW VIC Hydrology Model runoff using temperature & precipitation from 11 AR4 GCMs with 2 Emissions scenarios.	+4.4C and -2% Precip at 2070-2099 = -11% reduction in total basin runoff by 2070-2099	Range of results is considerable including some with increased runoff, especially in earlier 21st century periods. Increased winter precipitation apparently buffers reduction in runoff. Also used CRRM operations model.

The scenarios were the four combinations of +/- 2ºC along with +/- 10% change in precipitation, and were generically called *warmer and drier, cooler and wetter, cooler and drier, and warmer and wetter*. At the time of this report there was some discussion about the possibility of a new ice age, (global temperature records indicated a cooling from 1940 to 1970) yet the National Academy of Sciences issued a prescient report about the potential for global warming, Carbon Dioxide and Climate: A Scientific Assessment, (Charney, 1979) that same year. Hence, the study considered all possible future climates.

In all parts of the country except the Upper Colorado basin, they determined that scenarios 1, (*warmer and drier*), and scenario 2 (*cooler and wetter*) set the lower and upper bounds on runoff changes since changes in temperature and precipitation in the *cooler and drier* and *warmer and wetter* scenarios usually offset each other. In the Upper Colorado River the warmer and wetter scenario also showed substantial decreased runoff.

Stockton and Boggess utilized relationships developed by Walter Langbein (Langbein, 1949) of the USGS in the 1940s showing how precipitation and temperature jointly affect runoff across the United States. Langbein's nomograph (Figure U-10) shows that for the *same precipitation* runoff decreases as temperature increases, and for the *same temperature* runoff increases as precipitation increases, with runoff increasing faster when precipitation is high.

For the Upper Colorado River, Stockton and Boggess calculated that runoff would decrease by about one-third to approximately 10 maf under the *warmer and drier*, and, surprisingly, under the *warmer and wetter* scenarios. Under *cooler and wetter*, annual flow doubled to 30 maf, while under the *cooler and drier* scenario runoff was effectively unchanged.

Figure U-10
Nomograph of Relationship Between Mean Annual Precipitation (inches), Mean Annual Temperature (ºF) and Mean Annual Runoff (inches) in the United States (from Langbein, 1949)

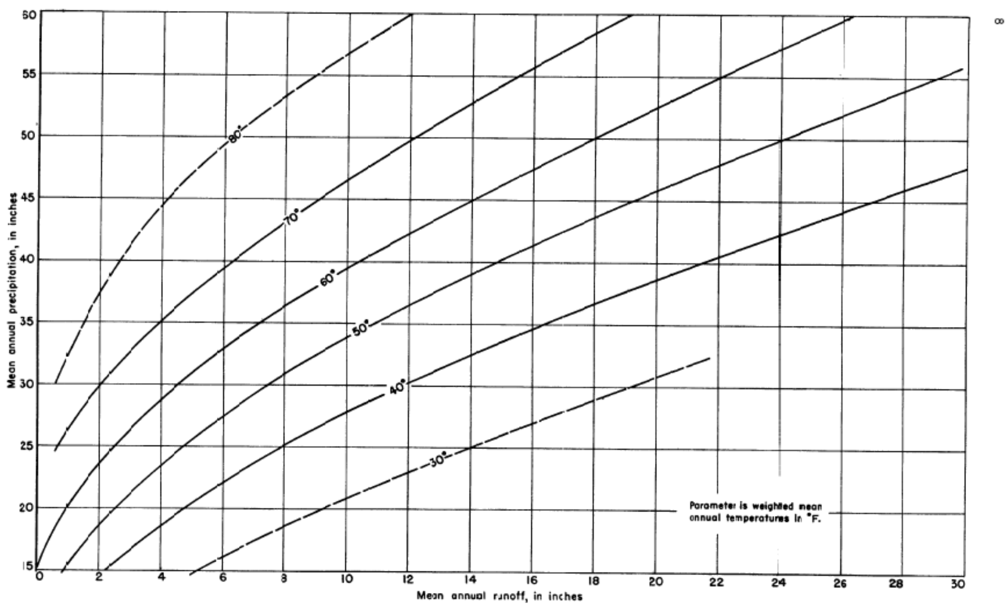


Figure 2.--Relationship of annual runoff to precipitation and temperature.

Data appropriate to Colorado River is in lower left-hand corner.

U.6.1.2 Effects of a Carbon Dioxide-induced Climatic Change on Water Supplies in the Western United States (Revelle and Waggoner, 1983)

In 1983 Roger Revelle, of the Scripps Institution of Oceanography, and Paul Waggoner, of the Connecticut Agricultural Experiment Station, wrote a chapter in *Changing Climate, Report of the Carbon Dioxide Assessment Committee*, published by the National Academy of Sciences. The authors investigated how future warming and drying in the Colorado River might affect runoff. The first part of the article restated in tabular format the empirical relationships established by Langbein in 1949 (Table U-3) among temperature, precipitation and runoff for arid areas.

Table U-3
Revelle and Waggoner's Restatement of Langbein's Relationship
Between Temperature, Precipitation and Runoff

Precip in inches (") →									
Temp (ºC)	Temp (ºF)	8"	%P as runoff	12"	%P as runoff	16"	%P as runoff	20"	%P as runoff
-2	28.4.	2.1	27%	3.6	31%	6.1	39%	9.1	46%
0	32	1.3	20%	2.9	25%	4.9	31%	7.5	38%
2	35.6	1.1	14%	2.2	19%	3.7	24%	6.1	31%
4	39.2	0.7	8%	1.6	13%	3.1	20%	4.9	25%
6	42.8	0.4	4%	1.0	8%	2.4	15%	3.9	20%
8	46.4	0.0	0%	0.7	6%	1.7	11%	3.2	16%
10	50			0.3	3%	1.1	7%	2.5	13%
12	53.6			0.0	0%	0.7	5%	1.9	9%
14	57.2					0.4	3%	1.3	6%
16	60.8					0.0	0%	0.8	4%

Shaded area represents the runoff portion roughly applicable to the Upper Colorado River Basin – Revelle and Wagonner's 1931-1976 data indicated the Upper Basin average temperature was 40F/4C with about 330mm/12" of precipitation.

The second part reviewed the 1979 findings of Stockton and Boggess, discussed above. The third and most frequently cited part of the article generated a multiple linear regression between Upper Basin temperature and precipitation, and unimpaired flow at Lee Ferry. Using the period 1931 to 1976 they established the following relationship:

Lee Ferry Annual Flows (in maf) = 42.1 + 1.07*(Annual Precipitation in inches)
-1.08*(Annual Average Temperature in Fahrenheit)[2]

The equation explains 73% of the variance in flows (r2=.73) and shows that a 2ºC/3.6ºF increase (1931-1976 Upper basin average was 4.18ºC/7.5ºF) would lead to a decline in runoff of by 4800 mcm (3.9 maf) or 29% and a 10% decrease in precipitation (1931-1976 basin average was 333 mm/13.1") would reduce flow by 1730 mcm (1.4 maf) or 11%. With both a 2ºC increase and 10% precipitation decrease, flow would decline by 40%. They note that the regression shows that a 28% increase in precipitation is necessary to balance a 2ºC increase.

[2] The original version was in metric units: Lee Ferry Annual Flows (in cubic meters) = 9274 + 52(Annual Precipitation in mm) -2400(Annual Average Temp in Celsius)

Figure U-11
Scatterplot Showing the 1931-1976 Precipitation and Flow Data
Used by Revelle and Waggoner (1983)

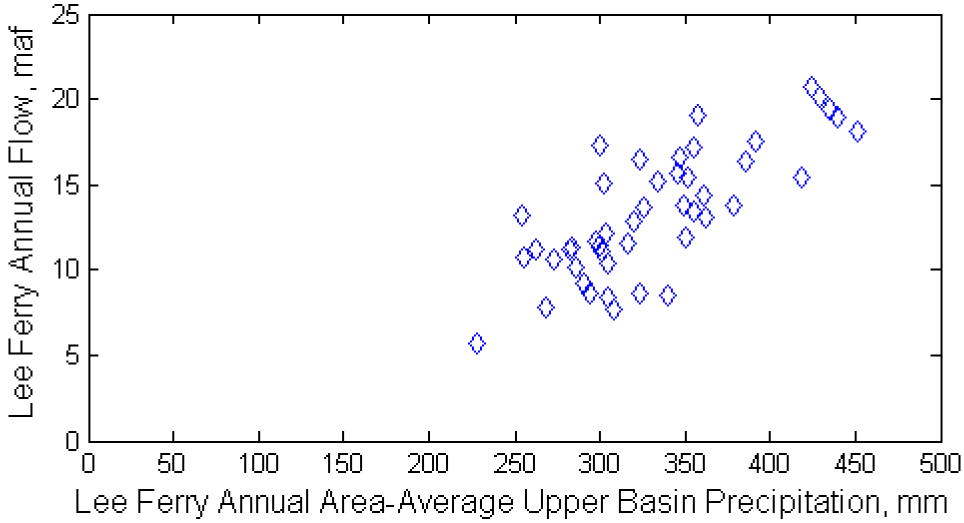
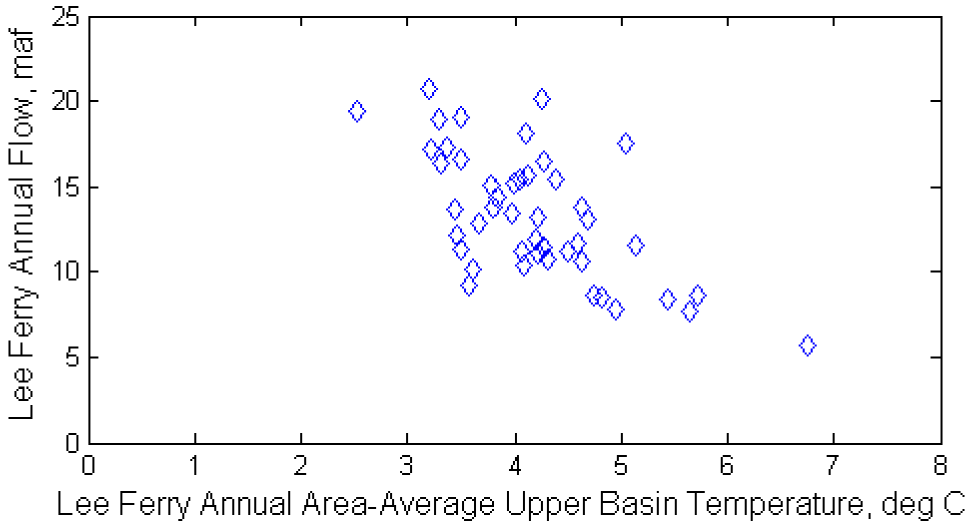
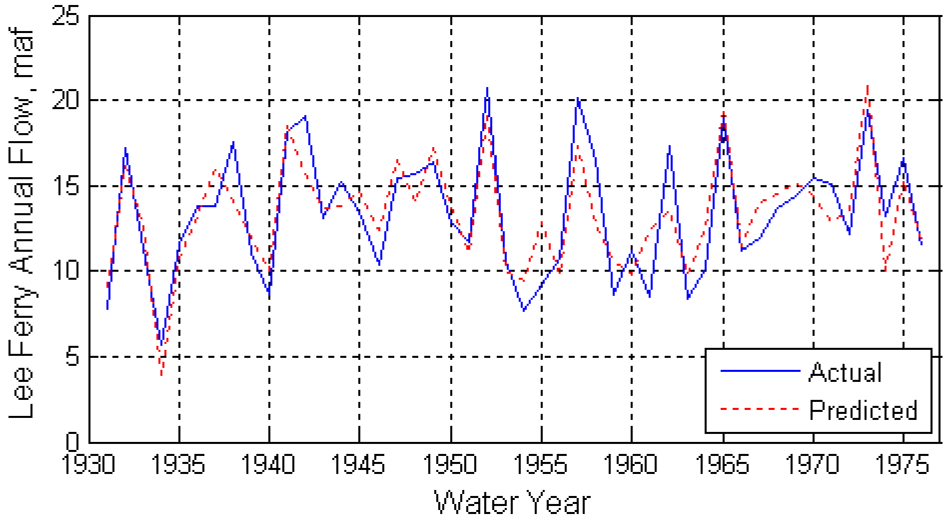


Figure U-12
Scatterplot Showing the 1931-1976 Temperature and Flow Data
Used by Revelle and Waggoner (1983)



Revelle and Waggoner also constructed a regression (not provided) using data from 1901 to 1930 but this only explained 57% of the variance. The authors felt the relatively low explained variance was due to a limited number of data stations, a lack of snoU-related precipitation data, and stations unrepresentative of true temperatures.

Figure U-13
Actual and Predicted Flows Using Revelle and Waggoner
(1983) Regression Equation



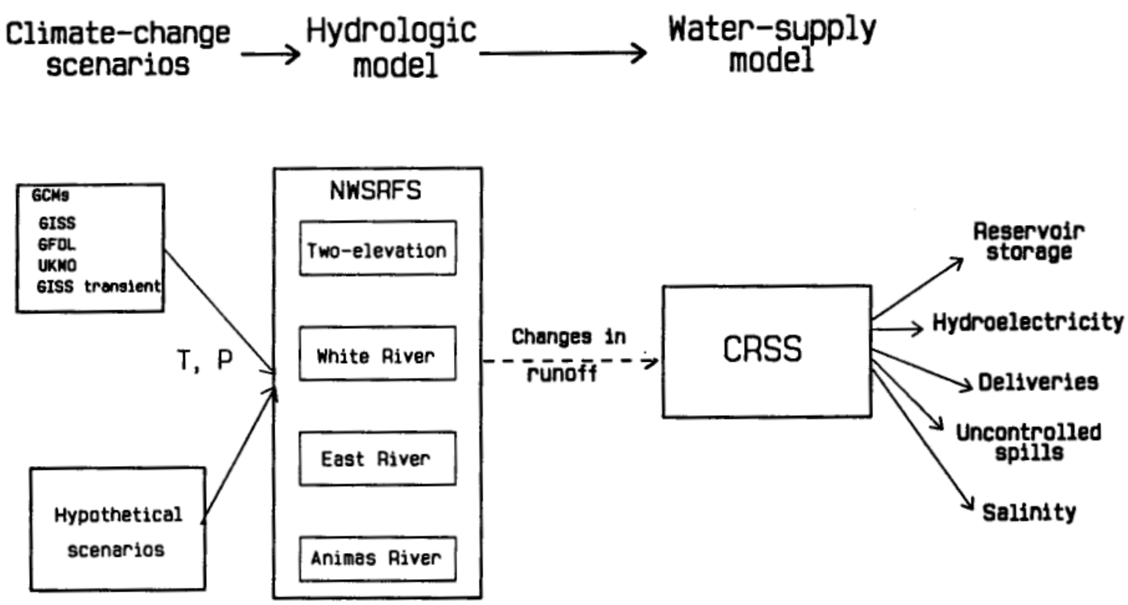
U.6.1.3 Sensitivity of Streamflow in the Colorado River basin to Climatic Changes (Nash and Gleick, 1991) and The Colorado River basin and Climatic Change (Nash and Gleick, 1993)

Linda Nash and Peter Gleick of the Pacific Institute for Studies in Development, Environment and Security wrote two similar articles on future Colorado River flows under varying assumptions of a changing climate, one published in the Journal of Hydrology (Nash and Gleick, 1991) and one as a report to the Environmental Protection Agency as part of a grant (Nash and Gleick, 1993). The 1993 article is an expanded version of the 1991 study and includes the addition of results of modeling simulated future flows with Reclamation's CRSS River operation model (See Figure U-14).

In the Nash and Gleick (1991) study, the authors considered a total of 15 different scenarios for temperature and precipitation conditions, 10 from assumed futures and five based on GCM simulations. These scenarios were then used as meteorological inputs into the National Weather Service River Forecasting System (NWSRFS) hydrologic model in three relatively unimpaired sub-basins of the Colorado River basin above Lake Powell. NWSRFS is the operational model used by the NOAA National Weather Service Colorado River basin River Forecast Center (CBRFC) and all other River Forecast Centers. It is composed of the Sacramento soil moisture model and the Snow17 snowmelt model, among other components.

The NWSRFS applications had been previously calibrated by CBRFC staff and had r2 values between historical and forecasted flows of approximately 0.9 on a monthly basis. Mean streamflow predictions were biased by about +/-1% relative to historical flows. (The authors noted that the NWS used entire historical data set in calibration thereby making it impossible to use some of this data in independent model verification studies.) This study simulated future streamflow in three of the sub-basins in the NWSFRS model with limited human influences, the White River near Meeker, the Animas River near Durango, and the East River near Gunnison. In addition, inflows were simulated for Lake Powell by using a coarser two-elevation aggregated model.

Figure U-14
Drawing from Nash and Gleick, 1993, Showing the Different Models Used in the Study



Sources of different temperature and precipitation inputs used to drive the hydrologic model are on the left. The Christensen studies have a similar hierarchy, but utilize different models at all three points.

The hypothetical scenarios involved all combinations of 2ºC and 4ºC temperature increases, and changes in precipitation of -20%, -10%, 0%, +10% and +20%. The GCM-based efforts used GCM temperature and precipitation outputs from the nearest grid point or grid points in two cases. GCM ouput data were taken from two Goddard Institute for Space Studies model grid points (+4.8ºC /+ 20% precipitation and +4.9ºC/+10% precipitation), a NOAA Geophysical Fluid Dynamics Laboratory model (+4.7ºC / 0% precipitation), and two UK Meteorological Office model (UKMO) grid points (+6.8ºC/+30% precipitation, and 6.9ºC/+10% precipitation)[3]. The GCM outputs were

[3] The versions of the GISS, GFDL, and the UKMO GCMs used in the recent 2007 IPCC AR4 studies are vastly different from those used in Nash and Gleick (1991, 1993).

derived from a doubled-CO_2 experiment where CO_2 concentrations were instantly doubled and then the GCMs were allowed to achieve temperature equilibrium.

Fifty-two (52) different scenarios were evaluated (not every modeled flow point used every scenario.) Thirty-seven (71%) scenarios resulted in flow decreases and fifteen (29%) resulted in flow increases. Runoff varied from a 33% decrease to a 19% increase. A 20% increase in precipitation caused runoff to increase in every case. A 2ºC increase was roughly offset by a 10% increase in precipitation. A 2ºC increase with no change in precipitation caused runoff declines of -4% to -12%. A 4ºC increase with no change in precipitation caused runoff declines from -9% to -21%. A 4ºC increase must be matched with precipitation increases of +15% to +20% for runoff to stay constant. The aggregated two-elevation model for Lake Powell inflow was more sensitive to increases in temperature than the other models, either an artifact of the model or a physical manifestation of increased evaporation in the lower elevation zones of this modeled runoff point compared to the relatively high elevations at the other modeled points. The results follow expectations with higher temperatures and lower precipitation generating less runoff. Temperature increases also cause the peak flow to shift earlier in the year.

In the 1993 study Nash and Gleick added (1) a "transient" climate study showing results for the decade 2030 to 2039, (2) a direct GCM runoff analysis (runoff calculated by the GCM as part of its hydrology code, not the runoff from the NWSRFS), and (3) an operations model, CRSS, to investigate how changes in inflows would affect reservoir operations and system reliability. Transient climate studies use fully specified month by month GHG emissions scenarios that generally increase over time as inputs and keep continuous daily, monthly or annual output data from the GCM for later analysis, rather than just the final equilibrium response. All current studies such as the Christensen et al. (2004), Christensen and Lettenmaier (2006) and Hoerling and Eischeid (2006) are based on models which have archived transient climate output.

This was the first Colorado River study to find that chronic small reductions in streamflow are ultimately manifested as large declines in system storage and hydropower due to total demands that are at or near the mean streamflow. Many other studies such as the Severe and Sustained Drought study (Harding et al., 1995), Christensen et al., (2004), and Christensen and Lettenmaier (2006) have confirmed these findings.

In the 1993 study, runoff reductions of 20% caused mean annual reductions in storage of 60 to 70% and reductions in power generation of 60%. A 15% drop in runoff caused Lee Ferry minimum flows to drop by 86%. A 10% runoff reduction caused Lake Powell releases to fall below the 8.23maf target in several years and storage to decline by 30% relative to historical levels. The specific results from this study are very dependent on assumptions made about how to allocate shortages, reservoir starting conditions, Upper Basin compact deliveries during extended drought, and other factors.

U.6.1.4 The Effects of Climate Change on the Hydrology and Water Resources of the Colorado River basin (Christensen, et al., 2004)

This 2004 study, published in a special edition of the journal Climatic Change, was part of a larger study funded by the Department of Energy known as the Accelerated Climate Prediction Initiative (ACPI). Niklas Christensen, Andrew Wood, Nathalie Voisin, Dennis Lettenmaier and Richard Palmer, all of the Department of Civil and Environmental Engineering at the University of Washington, used the National Center for Atmospheric Research Parallel Climate Model (PCM) to simulate runoff and operations on the Colorado River during three future 21st century periods, 2010-2039, 2040-2069, and 2070-2098 (See Table U-4).

The version of PCM in the study featured coupled atmospheric, ocean, sea ice and land surface components and operated at T42 resolution or approximately 300km grid boxes. At the time, PCM simulations showed less cooling (‘temperature sensitivity’) than many other GCMs for the same greenhouse gas emissions. This version of PCM was part of the multi-model ensemble referenced in IPCC’s Third Assessment Report (2001) and contrasts with the version of PCM and other models that are referenced in IPCC’s Fourth Assessment Report results shown in Section W.4.0.

Table U-4
Changes in Temperature and Precipitation Provided by NCAR GCM, Runoff and Snow Water Equivalent Results from VIC Hydrology Model, and Storage, Hydropower and Spills from CRRM Operations Model
(from Christensen et al., 2004)

Period	Temperature (ºC)	Precipitation	Runoff	Snow Water Equivalent	Storage
Historical Control	0.5	354 mm/yr	45 mm/yr		32.3 MAF/yr
		-1%	-10%		-7%
2010-39	1.0	-3%	-14%	-2%	-36%
2040-39	1.7	-6%	-18%	-7%	-32%
2070-39	2.0	-3%	-17%	-8%	-40%

Monthly temperature and precipitation output from PCM was downscaled to 1/8 degree daily data (see Section W.4.2.3.2) for use by a daily hydrological simulation model, the Variable Infiltration Capacity (VIC) model. VIC simulates snow accumulation and melt, soil moisture, evapotranspiration, and runoff and baseflow. Runoff and baseflow are routed through a flow network so that streamflow can be calculated. VIC was calibrated using climate and natural flow data from 1950 to 1989. Calibration runs indicated a flow match at Imperial Dam within 1% of calculated natural flow at the site. At Cisco near the Colorado-Utah state line, VIC flow was 9% smaller than calculated natural flow, and at Green River, Utah, VIC was 3% larger than calculated natural flow. VIC output was used in a monthly operations model, Colorado River Reservoir Model (CRRM), based roughly on Reclamation’s CRSS model.

Three future PCM runs for the 21st century were used. (These "ensemble members" were created by initializing PCM with slightly different atmospheric conditions.) A 50-year control climate run starting in 1995 with no additional greenhouse gas emissions (i.e., with fixed 1995 GHG levels) was also completed. PCM 21st century results averaged over the three runs were compared to the control run, and to historical observed data or calculated natural flow in the historical period.

Due to lags in the climate system, the control run showed warming of about 0.5ºC which is in rough agreement with what many believe to be 'committed warming' should greenhouse gas emissions stop immediately. The three 21st century runs showed average increases of approximately 3ºC over the observed average temperature of 10ºC. In general the warming was concentrated in spring and summer.

Average annual precipitation in the control run was 1% less than historical, and in the three 21st century runs was 3%, 6%, and 3% lower in Periods 1, 2, and 3 respectively. The seasonal precipitation pattern in the control run was very similar to the historical observed, and the 21st century runs showed a similar pattern but with less precipitation in the spring.

April 1 snow water equivalent (SWE) in the control run was only 86% of the observed historical SWE, while SWE was 76%, 71%, and 70% in Periods 1-3, respectively. The reduction in SWE in the control run was attributed to higher spring temperatures, and the 21st century reductions were due to higher temperatures and/or reduced winter and spring precipitation. Southern Colorado suffered the highest reductions and those occurred in Periods 2 and 3.

Runoff was reduced by 10% in the control run, and by 14%, 18% and 17% in periods 1-3, respectively, in the 21st century runs. A spatial analysis of these reductions indicated that a considerable enhancement of evapotranspiration increases occurred in the high elevation areas where a large portion of runoff occurs. Peak runoff advanced from June in the historical data to May in the latter parts of the control and 21st century runs.

Christensen et al., (2004) also reported extensively on how these flows would affect operations as modeled in CRRM. The authors caution that these results strongly depend on initial conditions in the operations model and should not be interpreted as predictions but used instead to find system sensitivities to changes in future flows. Most of the modeling was predicated on constant year 2000 Upper Basin demands to simplify analysis, but a set of runs were done with Upper Basin demands increasing over time.

As previously reported by Nash and Gleick (1993), the authors found that because the Colorado River is nearly at full allocation, reservoir reliability and storage levels were extremely sensitive to inflow reductions -- average reservoir levels dropped significantly even with small reductions in runoff. For example, storage in the control run dropped by 7%, and periods 1-3 showed reductions of 36%, 32%, and 40%, respectively, relative to simulated historical conditions. Deliveries from Lake Powell were met 92% of the time in the historical data, and 72% in the control run and 59%, 73%, and 77% in periods 1-3, respectively. The control run showed reductions relative to the historic conditions because it used year 2000 demands. Variability in the 21st century runs explains some of the other differences. For example, a wet period at the end of Period 2 left system reservoirs at a relatively high level and hence reliability in Period 3 was slightly higher than Period 2 despite roughly similar SWE and runoff.

U.6.1.5 Past Peak Water in the Southwest (Hoerling and Eischeid, 2006)

Martin Hoerling and Jon Eischeid of the NOAA Earth System Research Laboratory in Boulder published their findings in December of 2006 in Southwest Hydrology, a magazine (not a peer-reviewed journal) that is part of the National Science Foundation funded effort at the University of Arizona known as Sustainability of Semi-arid Hydrology and Riparian Areas (SAHRA). Hoerling and Eischeid (2006) projected future Colorado River flows based on the Palmer Drought Severity Index (PDSI) calculated from modeled climate changes for the Upper Colorado River basin. PDSI is a frequently used drought metric and is calculated by combining temperature, precipitation, evapotranspiration and soil moisture. The index can vary from -4 (extreme drought) to +4 (extreme wetness).

Using historical data from 1895 to 1989, they first created a simple linear regression for the Upper Colorado basin:

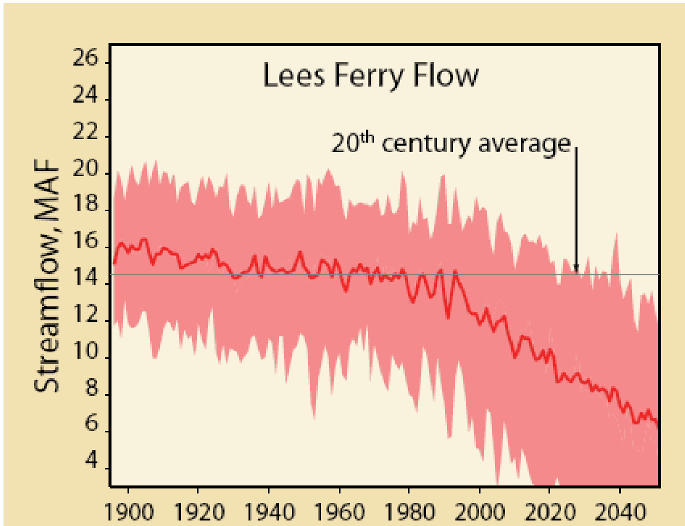
$$\text{Lee Ferry Annual Flows (in MAF)} = 14.5 + 1.69(\text{PDSI})$$

This regression explains 63% of the variance at Lees Ferry over the 105-year calibration period. The equation explained 85% of the variance in the flows over a verification period from 1990 to 2005.

Hoerling and Eischeid then proceeded to calculate the future PDSI using temperature and precipitation data from 42 different climate simulations using ‘business as usual’ greenhouse gas emissions (A1B) from 18 different coupled atmosphere-land-ocean models completed for the recent IPCC 4th Assessment. They then used the regression model above to translate these PDSI values into projected future annual streamflow (See Figure U-15).

The authors found that annual streamflows in the river over the next twenty-five years would average 10 maf, approximately the same as during the recent 1999-2004 drought. From 2035 to 2060 the flows would drop to an average of 7 maf. The individual years vary considerably from these averages with some years being close to the historical mean of 15 maf (see figure). For the next twenty years, individual years may still produce normal flows. In some future years the regression equation did generate some streamflows below zero (not shown). Although negative flows are obviously physically impossible, this is a known limitation when regression equations are used outside of their calibration inputs.

Figure U-15
Projected Lees Ferry Future Flows



Solid line is average of 42 runs, and shaded band shows 10% to 90% range of individual simulations
(from Hoerling and Eischeid, 2006)

The authors noted that the climate models show little net change in precipitation over the next century yet significant drought as represented by the modeled PDSI would be a very common occurrence with average PDSI the same as during the 2000-2003 drought (<-3). They suggested that 20th century droughts were driven by precipitation decreases with enhancement by temperatures but a "near perpetual state of drought will materialize in the coming decades as a consequence of increasing temperature." The models in the study project an average temperature increase of 1.4ºC during 2006-2030, and average warming of 2.8ºC during 2035-2060, compared to 1895-2005.

The authors cautioned that it is unclear if the streamflow PDSI relationship used in the study is strictly applicable to the substantial changes anticipated in future climate. It should also be noted that the PDSI index was developed for use in the Great Plains and does not account for the different phases of precipitation, snow or rain, and their very different characteristics.

U.6.1.6 A Multimodel Ensemble Approach to Assessment of Climate Change Impacts on the Hydrology and Water Resources of the Colorado River basin (Christensen and Lettenmaier, 2006)

Niklas Christensen and Dennis Lettenmaier, both with the Department of Civil and Environmental Engineering at the University of Washington published in an article on future Colorado River flows in *Hydrology and Earth System Sciences* in 2006. The study is based on GCM model results prepared for the 2007 IPCC Fourth Assessment (AR4) (see Table U-5 for rounded temperature, precipitation, runoff and snow water equivalent results; and, Figures U-15 to U-18 for additional information on this study).

The authors used 11 major climate models and two different future emissions scenarios, A2, a relatively high scenario with 2100 CO_2 levels of 850 ppm and B1, a relatively low level scenario with 2100 CO_2 levels of 550 ppm. (Current CO_2 levels are approximately 380 ppm and are increasing at about 1.5 – 2.0 ppm/year.) The authors selected these two scenarios because they likely bracket any future emissions trajectory and because the GCM output for these scenarios was available from a wide variety of models.

This study essentially reapplied the approach from the Christensen et al. 2004 Climatic Change paper but featured an expanded suite of climate models. As in the 2004 study, for discussion the output was broken into 3 periods: 2010-2039, 2040-2069, and 2070-2099.

Table U-5
Average Ensemble Temperature Increase, Percent Changes in Precipitation, Runoff, and April 1 Snow Water Equivalent All Relative to Historic 1950-99 Modeled Base Case for Both the B1 and A2 Emissions Scenarios
(from Christensen and Lettenmaier, 2006)

Period	Temperature (ºC)		Precipitation		Runoff		Snow Water Equivalent	
	B1	A2	B1	A2	B1	A2	B1	A2
2010-39	1.3	1.2	1%	-1%	0%	0%	-15%	-13%
2040-69	2.1	2.6	-1%	-2%	-7%	-6%	-25%	-21%
2070-99	2.7	4.4	-1%	-2%	-8%	-11%	-29%	-38%

For this study VIC was re-calibrated on historic 1950-99 data (an additional 10 years relative to the 2004 study). VIC generated a less than 1% underprediction of streamflow at Imperial Dam, and +3% and -9% errors at Green River and Cisco, respectively, based on reconstructed natural flow at these points.

Temperatures increases (ºC) for the B1 runs during periods 1-3, shown as "average (minimum, maximum)," were 1.28 (0.53, 1.83), 2.05 (1.13, 2.99), and 2.74 (1.13, 2.99), respectively, relative to historical observations (see Table U-5 for rounded temperature, precipitation, runoff and snow water equivalent results. Figures U-15 to U-18 present additional information on this study). For the A2 runs during the same periods, the temperature increases (ºC) by 1.23 (0.63, 1.82), 2.56 (1.61, 3.65), and 4.35 (2.77, 6.06). (Many studies show that temperatures in the next quarter century are tied to existing greenhouse gas concentrations and hence the slightly higher B1 temperature relative to A2 in period 1 is not unusual; generally, changes between emission scenarios show lagged behavior such as reported for Periods 2 and 3.) Temperature increases show more warming from mid-summer to early fall, which is consistent with a reduction in soil moisture during these periods.

Annual precipitation percent change from historical for the B1 runs during periods 1-3, shown as "average (minimum, maximum)," were +1% (-8, 11), -1% (-11, 9), -1% (-11, 19), respectively. For the A2 runs and same periods, percent precipitation changes were -1% (-9, 7), -2% (-21, 13) and -2% (-16, 13), respectively. Of critical importance is that October to March average precipitation increases by +5%, +1%, and +2% for B1 and by

+6%, +5% and +4% for the A2 scenario. In contrast, the 2004 study had winter precipitation decreases in the single digits. The increases occurred generally at the highest elevations in the Rockies.

April 1 snow water equivalent (SWE) change from historical for the B1 runs, shown as "average (minimum, maximum)," was -15% (-41, 0), -25% (-48, -1), -29% (-53, -18) during for periods 1-3, respectively. For the A2 runs, SWE change was -13% (-36, 1), -21% (-52, 6) and -38% (-66, -15) during the same periods, respectively. The authors believe that SWE decreases are due to increasing temperatures, given especially that winter precipitation increases. SWE reductions are greatest in the low to mid elevation areas. The combination of declining SWE and increasing winter precipitation is indicative of more precipitation occurring as rain.

Mean-annual runoff during Periods 1-3 changed from historical by 0% (-23, 17), -7% (-27, 12) and -8% (-30, 29) for the B1 runs, respectively, and by 0% (-16, 14), -6% (-39, 18), and -11% (-37, 11) for the A2 runs during the same periods. These reductions are larger than the precipitation declines and are believed to be driven by increasing temperatures and high evapotranspiration.

Christensen and Lettenmaier (2006) also reported results from their operations model, CRRM. CRRM was modified to reflect the Basin States' current proposal with regard to how Lower Basin shortages should be tied to Lake Mead Levels. Hence, the model calculates shortages when necessary to all major Lower Basin entities. They caution that CRRM results reflect many assumptions and non-linear interactions, such as reservoir initial starting conditions and the sequencing of individual annual inflows. In addition, as previously stated, all Colorado River operations models including CRRM fail to address certain critical issues including, for example, Upper Basin curtailments as may be required by the Colorado River Compact during extended drought. Upper Basin demands were fixed at year 2000 levels to simplify analysis yet over time these demands will surely grow. Thus these results should be used only in a comparative sense.

In general, CRRM reservoir levels are higher than reported in the 2004 study, although the authors claim that the results are within the same range of sensitivity. They state that a decrease of 10% in average streamflow is magnified into a 20% change of the same sign in reservoir storage. Similarly, a 20% inflow change results in a 40% storage impact. The authors state that because of the large ratio of storage to inflow in the basin, neither increases in storage nor changes in operating rules will likely change the storage impacts under declining inflows.

U.6.1.7 Other Colorado River Basin Studies of Note

In addition to the studies reported above, there have been several other studies, either focused on parts of the basin or that summarize past studies. These are discussed briefly below.

In 1990 John Schaake of NOAA's Office of Hydrologic Development investigated the notion of elasticity in flow due to changes in precipitation and temperature in a chapter entitled "From Climate to Flow" in *Climate Change and U.S. Water Resources* (Schaake

1990). Using the NWSRFS hydrologic model on the Animas River basin, Schaake discovered that a 10% increase in precipitation would increase flow by 20% while a 2°C temperature increase would reduce flow by 2%. A 2°C increase and a 10% increase in potential evapotranspiration would change flows by -9%.

Greg McCabe and Lauren Hay of the USGS wrote Hydrological Effects of Hypothetical Climate Change in The East River Basin, Colorado, USA in Hydrological Sciences in 1995 (McCabe and Hay, 1995). McCabe and Hay used 9 hypothetical climate scenarios – all combinations of +4°C, 0C, -4C and -20%, 0%, and +20% precipitation – to drive a USGS hydrologic model, PRMS. Modeled runoff varied from -30% (+4C, -20%) to +40% (-4C,+20%). The authors also investigated how natural variability might mask decreasing runoff and found that it might take 80 to 90 years to detect a runoff reduction at the 95% confidence level due to a gradual +4C and -20% precipitation change.

In 1999 in the Journal of the American Water Resources Association, Peter Gleick and Elizabeth Chalecki wrote The Impacts of Climatic Changes for Water Resources of the Colorado and Sacramento-San Joaquin Basins (Gleick and Chalecki, 1999). This article provides an overview of all studies on the Colorado River prior to the publication date.

U.6.2 Recent Studies Featuring GCM Projections for the American Southwest

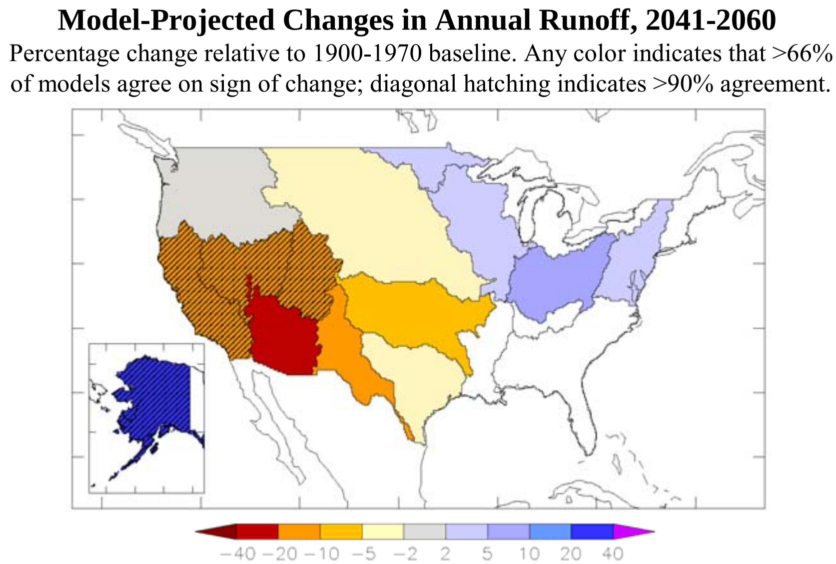
Since 2005 there have been three studies which have analyzed large scale 21st century GCM projections such as runoff, precipitation and evaporation for the American Southwest. These studies have not utilized smaller scale hydrologic or other models like the studies described in Section W.5.1. An important distinction between studies using GCM runoff versus hydrology model runoff is that whereas GCMs calculate runoff as part of their hydrological cycle at the GCM scale (e.g., for 10,000 km^2 grid cells), hydrological models like VIC and NWSRFS run at much higher resolution, contain far more detailed representations of land surface physics, and are calibrated and verified against streamflow records, which is not typically the case for runoff from GCM internal runoff schemes.

U.6.2.1 Global pattern of trends in streamflow and water availability in a changing climate (Milly et al., 2005)

In the journal Nature in 2005, USGS scientist Chris Milly and others surveyed runoff proxy information from 12 AR4 GCMs found to be relatively better skilled at reproducing 20th century streamflow trends over large regions. The study had both a ‘verification’ period which used historical data to select the 12 models from 21 potential candidates, and a projection period using SRES A1B which used future runoff from the selected models. The American Southwest was not one of the areas used to select the models and hence model fidelity to historical conditions in this region is not known. The runoff projections were for the entire globe. In a later not-published addendum to the study, Milly looked specifically at the continental United States and found that based on the same model results greater than 90% of the GCM simulations show future Colorado

River basin runoff reductions from approximately 10 to 30% (see Figure U-16) in the period 2041-2060[4].

Figure U-16
Projected Colorado River Runoff (from Milly et al., 2005)



(After Milly, P.C.D., K.A. Dunne, A.V. Vecchia, Global pattern of trends in streamflow and water availability in a changing climate, *Nature*, **438**, 347-350, 2005.)

The IPCC AR4 Working Group 1 chapter on climate models (Randall et al., 2007) as well as the AR4 Working Group 2 chapter on freshwater resources (Kundzewicz et al., 2007) both relied on this study. Randall et al. noted that this study was an important scientific advance because it showed that despite the limitations in the hydrologic cycle in the climate models, the models can capture observed changes in 20th century streamflow associated with atmospheric conditions. Further, they say that, "This enhances confidence in the use of these models for future projection."

U.6.2.2 Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America, (Seager et al., 2007)

A 2007 study in Science by Columbia University scientist Richard Seager and others, using many of the same GCMs and runoff proxy information as Milly et al., obtained similar conclusions to Milly et al. Unlike Milly et al.'s world-wide focus, Seager's study was specific to an area he termed the 'American Southwest' but was actually far larger than the general use of this term[5]. This area includes the entire Lower Basin, but excludes

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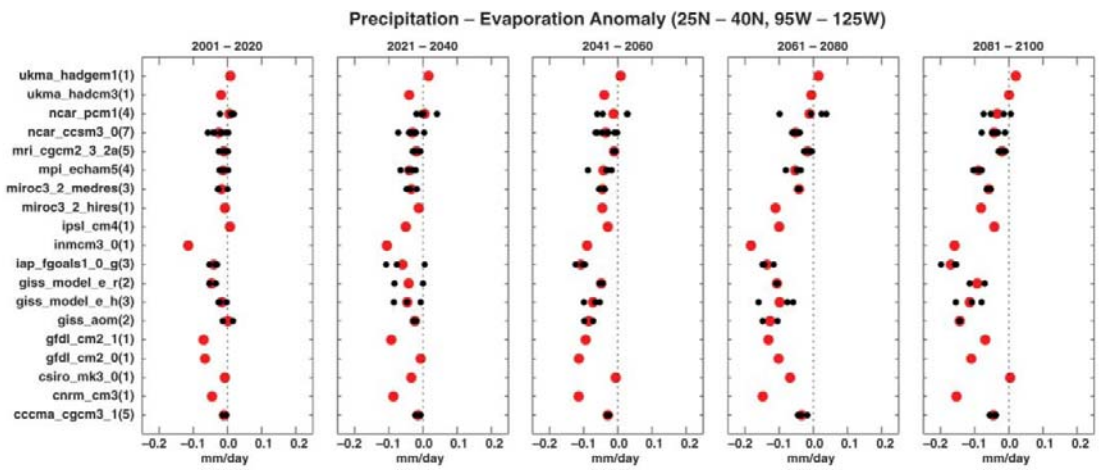
[4] Enhanced Graphics of the U.S. from the addendum are available at: http://www.gfdl.noaa.gov/~pcm/project/runoff_change.ppt and these graphics are shown below.

[5] The area was all land from 125U-95W and 24-40N or approximately Brownsville, TX to Lincoln, NE to Eureka, CA in the U.S. It also includes land in Mexico.

almost all of the Green River and hence is not equivalent to the Colorado River basin. Seager et al. used future GCM projections from 19 AR4 climate models using the A1B emissions scenario compared to 1950-2000 model climatologies. Eighteen of the nineteen models show a drying trend (see figure U-17). Seager et al., focus on the change in future precipitation less future evaporation, a proxy for runoff. In support of the modeled runoff declines, Seager et al., (2007) point to theory and studies about Hadley cell expansion and associated poleward storm track movement in a warming climate. They also discuss recent observational and paleoclimate evidence for support of hypothesized Hadley cell changes.

Figure U-17
The Change in Annual Mean Precipitation Minus Evaporation (~ Runoff) for the
American Southwest in Twenty-Year Periods to 2100 Calculated Relative to Model Climatologies 1950-2000



Models are shown at left. Red dots are the ensemble mean and black dots represent individual ensemble members. Only 1 in 19 models has a wet trend and only 3 individual projections out of 49 show a wet trend. (from Seager et al., 2007)

U.6.2.3 Intergovernmental Panel on Climate Change, 2007

The Fourth Assessment of the Intergovernmental Panel on Climate Change released its report in the spring of 2007 (IPCC, 2007). Chapter 11 from The Physical Science Basis Work Group contains regional climate projections, including North America (Christensen et al., 2007). Christensen et al[6]., note that for North America as a whole, the annual mean warming is likely to exceed the global mean warming in most areas. Snow season length and snow depth are very likely to decrease in most of North America, except in the northernmost part of Canada where maximum snow depth is likely to increase. At the coarse horizontal resolution of the climate models, high-altitude terrain is poorly resolved, which likely results in an underestimation of warming associated with snoU-albedo feedback at high elevations in western regions.

[6] This is not the same Christensen as in the Christensen and Lettenmaier studies.

Specific IPCC findings for the Southwestern USA are that warming will likely be greatest in summer, not winter as for other parts of the continent, and that annual mean precipitation is likely to decrease (see Figure U-7). The projection of smaller warming over the Pacific Ocean than over the continent, and amplification and northward displacement of the subtropical anticyclone, is likely to induce a decrease in annual precipitation in the south-western USA and northern Mexico. In the context of the report, 'likely' is used to mean a 66% to 90% chance of occurrence. Regional projections are only made for relatively large areas without definite boundaries such as the "Southwestern USA". The IPCC makes regional projections where there is "near unanimity among models with good supporting physical insights." They note that up-to-date coordinated Regional Climate model projections were not available for North America at the time the report was issued.

U.6.3 Synthesis and Discussion of Results

Almost thirty years have passed since the first attempt by Stockton and Boggess (1979) to quantify how climate change might affect the runoff in the Colorado River basin. Since that early attempt using Langbein's 1949 empirical temperature-precipitation-runoff relationships, scientists have used primarily two types of future climate temperature and precipitation projections– (1) pure hypothetical scenarios and (2) GCM output – to drive two types of flow generation techniques – (1) statistical regression and (2) hydrology process models – in order to project future flows on the river. To put these studies into proper context it is important to understand the limitations relating to GCMs, future applicability of statistical and empirical relationships based on historical data, hydrology model assumptions, and/or operational model assumptions.

These studies utilize three different generations of GCMs, dating from the early 1990s, late 1990s and mid 2000s. GCM-derived climate inputs for the most recent studies (Hoerling and Eischeid, 2006, Christensen and Lettenmaier, 2006) are believed to significantly more robust than older results (Nash and Gleick, 1991, 1993) because of increased understanding and increased model resolution. In general, temperature projections are considered much more reliable than precipitation, even in the latest models. As noted by the IPCC, even with many advances over the years, global climate models still do not adequately resolve precipitation in mountainous areas. It is noteworthy, however, that the most recent GCM results for precipitation in the Colorado River basin show somewhat consistent results across models with very little change in average projected annual precipitation relative to historical conditions. Individual models do, however, show significant variability with the 11 models used in the recent Christensen and Lettenmaier paper showing a range of approximately 80% to 120% of the historical average precipitation.

Studies which used empirical/statistical relationships between temperature, precipitation and runoff (Stockton and Boggess, 1979, Revelle and Waggoner, 1983, Hoerling and Eischeid, 2006) have been criticized for failing to consider how these relationships might change in a future climate due to evapotranspiration and vegetation changes, and changes in seasonality of runoff. Such changes might substantially alter the relationships between temperature, precipitation, and runoff, which could invalidate the findings.

There have been other criticisms of studies using the historical data. Karl and Reibsame (1989) criticized Langbien's 1949 work, and derivatives thereof including Stockton and Boggess, 1979 and Revelle and Waggoner, 1983 for overstating the impact of temperature on runoff. They maintain that changes in precipitation will be far more important than temperature in determining future runoff. Much of their analysis is based on looking at decadal changes in runoff. This study was in turn criticized by Rind et al. (1990) for using average warming only 1/10 that projected for doubled CO_2. Rind et al. suggest that all studies based on the observational record are flawed because the water holding capacity of the atmosphere varies strongly with temperature – potentially up to 30% for 4C warming – and this type of widespread warming and associated increase in water vapor have no analog in the historical record.

Hydrology models can potentially overcome some of the limitations inherent in the statistical/observational approach by modeling many of the physical processes which control runoff such as snow accumulation and melt, groundwater recharge, and evapotranspiration from plants. In theory as the climate changes, these models should correctly handle new physical conditions. Unfortunately, these models require large amounts of data, much of which is imprecisely known. Furthermore, in order to resolve very complex and sometimes poorly known relationships, the models may overly simplify important physical processes. For example, the VIC model uses a two-meter subsurface layer to model all interactions with soil moisture and groundwater, despite the fact that surface water/groundwater interactions frequently involve various forms of aquifers with significant storage capacity. Finally, most hydrology models do not have land cover which can respond to changes in climate. Thus, they too might suffer from inaccuracies if the climate changes enough to affect the relationship between land cover and runoff.

Three of the studies, Nash and Gleick (1993), Christensen et al. (2004) and Christensen and Lettenmaier (2006) used an operations model to project specific water system outcomes based on their future runoff results. Nash and Gleick (1993) utilized an older version of the USBR's CRSS model and the Christensen studies utilized a model (CRRM) created at the University of Washington. While the results of these two models are intriguing, it must be noted that numerous critical policy-laden decisions about how to operate the system under low flow conditions have never been addressed and thus these implementations either ignore these issues, or implement a solution that has no standing in the Law of the River. For example, neither the bookkeeping associated with Present Perfected Rights in the Upper Basin nor shortages in Upper Basin are present in these models. Hence, modeled reservoir storage and hydropower production are directly tied to modeling decisions which may be founded on unrealistic assumptions about the management and operational strategies that would be pursued in the face of severe drought. Assumptions about reservoir starting contents also can significantly alter results. Christensen et al. (2004) noted these problems and suggest that the operational results should only be used in a comparative sense. Thus, for the purposes of this document, these operational results should be of less interest than the findings for streamflow.

All recent studies specific to the basin (Christensen et al., 2004; Christensen and Lettenmaier, 2006; Hoerling and Eischeid, 2006,) and the Milly et al. study which later produced results specifically for the CRB[7] indicate that by mid- to late-21st Century, the central expectation is for decreased runoff in the Colorado River Basin. Furthermore, when precipitation is assumed to be constant or slightly decreased, an assumption consistent with the central projections of recent studies, all past studies (Stockton and Boggess, 1979; Revelle and Waggoner, 1983; Nash and Gleick, 1991, 1993) also indicate less future runoff. However, the range of results still spans increased to decreased runoff conditions through the late 21st century (e.g., Christensen and Lettenmaier, 2006).

If future precipitation remains approximately the same or decreases slightly, it seems likely that the basin will see less runoff. This leaves open the question of the magnitude of the decline. The two most recent studies have a very large range in future declines from -11% by 2100 by Christensen and Lettenmaier (2006) to -45% projected by Hoerling and Eischeid (2006) by about 2050. Although the Hoerling and Eischeid method can be questioned for using relatively crude techniques, its calibration and verification statistics are quite good. In contrast, the Christensen and Lettenmaier study (2006) is far more sophisticated and shows some results consistent with theories such as increased winter precipitation and increased summer and fall temperatures.

The Seager et al., and IPCC findings are both based on the recent AR4 climate models and at the large scale of these studies there is also general agreement that runoff in the “American Southwest” in the future will be reduced. It should be noted that the term “American Southwest” in the case of the IPCC is not defined, and in the case of Seager et al. covers far more area than is typically associated with the reference. While it is easy to criticize these studies for using GCMs which lack the sophistication seen by many to be necessary to model the complex topography and mid-continental location of the Colorado River basin[8], their collective findings are important for several reasons. These include the large number of models agreeing on the same projections as well as supporting theories on Hadley cell expansion, storm track movement and evidence from the paleoclimate record. At the least, these efforts suggest that additional research to understand the bases for model concurrence should be undertaken. This overall paradigm of projected future dryness in an existing dry subtropical area also has analogs in other parts world including the Mediterranean. This analog does fall short, however, in explaining how a relatively wet mountainous area close to an existing dry area should respond to future warming.

Finally, it is worth emphasizing that runoff and operations impacts in the CRB are highly sensitive to projected precipitation changes. It is notable that the sign and range of projected precipitation over the CRB (e.g., Christensen and Lettenmaier 2006, Appendices A1-A2 and Figure U-23) seems somewhat insensitive to future projection period, unlike sign and range

[7] Seager et al and the IPCC findings are excluded here because the Seager et al study did not include the Green River basin and the extent of the IPCC’s ‘Southwestern United States’ is not clear. Both of these studies did find reduced runoff likely in their respective study areas noted above.

[8] This point applies to Milly et al. as well.

of runoff change. This raises several questions. If precipitation change has no obvious trend related to warming, then what is driving the modeled period-to-period precipitation variability over the CRB? Put another way, what is the paradigm of CRB precipitation response to global and regional temperature increase? How does the fact that global atmospheric moisture should increase with global warming due to Clausius Clapyron physics apply in the CRB? The answers to both of these questions would provide a framework for analyzing GCM precipitation output. Without answers, we have limited basis for judging the band of precipitation projection uncertainty produced by GCMs. This band may be physically realistic, or it may be an artifact of having a diverse number of imprecise and adolescent GCM approaches & implementations. Section W.9.3 discusses these questions, additional current knowledge limitations and potential research paths forward.

U.7 Potential Methods for Relating Climate Change Information to Long-Term Reservoir Operations Analysis

Chapter W.5 presented impacts assessments that have been completed for the Colorado River basin. Those studies were conducted for a variety of climate change scenarios and using a number of different methodologies. This chapter categorizes method options for translating climate projections into operations response information. It then identifies analytical designs among those options that Reclamation's Lower Colorado region (LC) planning analysts might consider when using LC's planning model, CRSS (Section W.3). A number of design considerations are also discussed including climate scenario data availability, choice of runoff analysis tool, process simulation versus statistical methods for analyzing runoff response, treatment of natural water demands, and treatment of future precipitation assumptions.

U.7.1 Context

Following more recently developed methodologies discussed later in this section, a long-term operations analysis under assumed climate change would involve three core steps:

1) select a simulated climate scenario that overlaps with observed historical conditions and extends into a future planning horizon (e.g., a 1950-2100 time series), that has been bias-corrected during the historical overlap period (Section W.4.2.3), and has been spatially downscaled to a basin-relevant resolution necessary for planning;

2) relate downscaled climate conditions over the basin to natural runoff response; and

3) relate simulated natural runoff response to water supply and operations response.

Implementation of these steps follows the presumption that the tool development and validation has already been completed. More specifically, the hydrology model used in step (ii) and both the streamflow impairment scheme (if present) and operations model used in step (iii) have been calibrated, validated, and demonstrated to reproduce observed behavior of the system during some historical period. Implementation of these steps also implies that relations between runoff, precipitation, and air temperature are largely preserved as climate changes. Admittedly, climate will modulate conditions that affect these relations (e.g., potential evapotranspiration, land cover, etc), which introduces uncertainty into the analysis. Such uncertainties are discussed in Sections W.6.3 and W.6.6.

For convenience, steps (ii) and (iii) would be completed using one coupled model of basin hydrology and system operations. In practice, there is often a division between the hydrologic and operations modeling. The division exists for various reasons. Sometimes it is because hydrologic and operations models were developed relative to different historical periods. For example, runoff models are typically calibrated using reliable and recent meteorological input conditions, which typically mean calibrating models to conditions since approximately 1960. In contrast, operations models have often been developed relative to longer periods-of-record streamflow and water supply information. Sometimes geographical issues are a cause – e.g., where runoff simulations might be designed to simulate natural hydrology in a given watershed while the operations model might be developed to reflect a sub-area of the watershed where perimeter "system" inflows are affected by upstream impairments elsewhere in the watershed. An additional reason can relate to time-scale issues, where decisions in a given operations model (e.g., monthly) are made during time steps that are not consistent those necessary to simulate natural hydrologic processes, leading to challenges with model coupling. This all contributes to a likely situation of having to conduct steps (ii) and (iii) separately, with runoff simulation data being processed separately and input into the operations model.

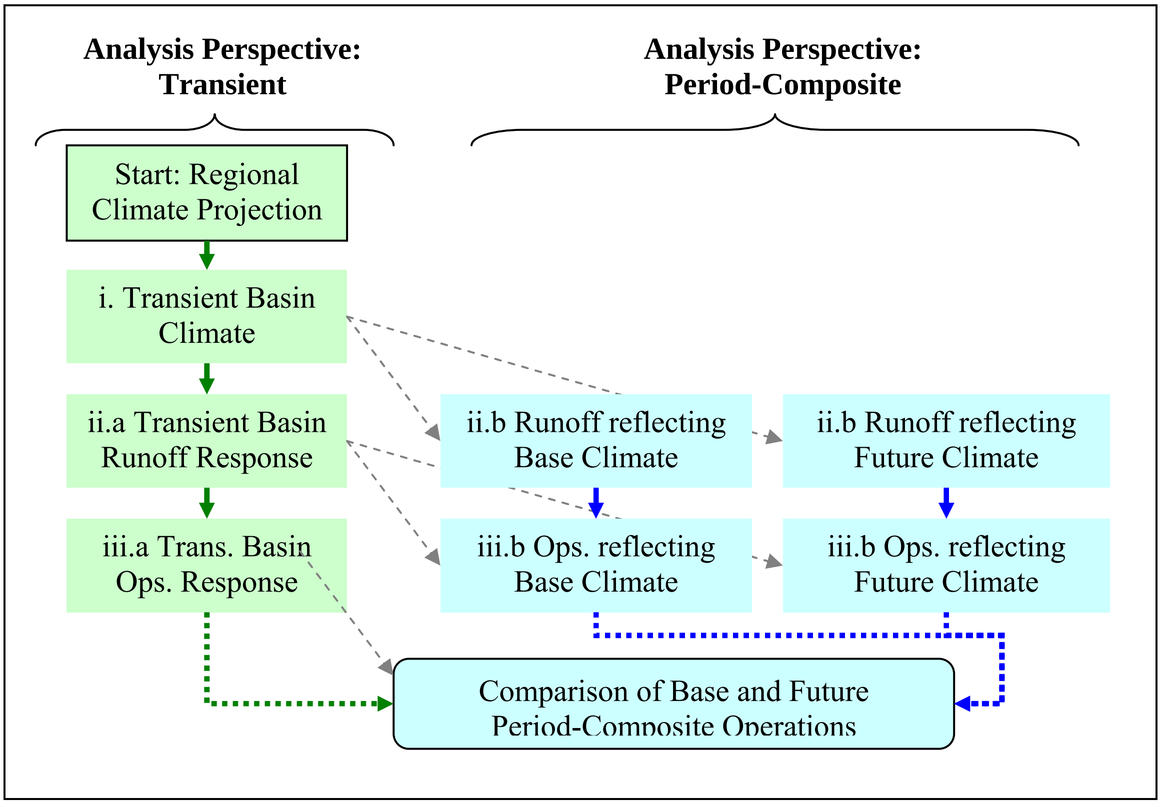
Within steps (ii) and (iii), several method options have been demonstrated in peer-review literature. For this discussion, the options are categorized under two analytical perspectives: transient or period-composite (Figure U-19). Under either perspective and considering a single-scenario analysis, the starting point is step (i) where an evolving simulated climate time-series is selected, describing historical to future evolution of climatic conditions over the basin of interest. The ending point after (iii) is comparative information describing period-composite performance of different operations variables during "recent historical" and "future" periods (e.g., variable being water deliveries to user group "A" and performance measured by long-term annual average amount). The main point is that the process starts with a transient perspective (step (i)), ends with a period-composite perspective (step (iii)), and that there are options for when to make the transition between perspectives (i.e. gray lines on Figure U-18).

U.7.2 Options for Analyzing Runoff and Operations Response

The transition can be made prior to runoff assessment, prior to operations assessment, or after operations assessment depending on the tools and methods used. Three-types of transitions are discussed in the following sections:

- Transient Runoff and Operations
- Transient Runoff and Period-composite Operations
- Period-composite Runoff and Operations

Figure U-18
Method Options for Relating Climate Change Scenario Information
to Long-Term Operations (Ops.) Response



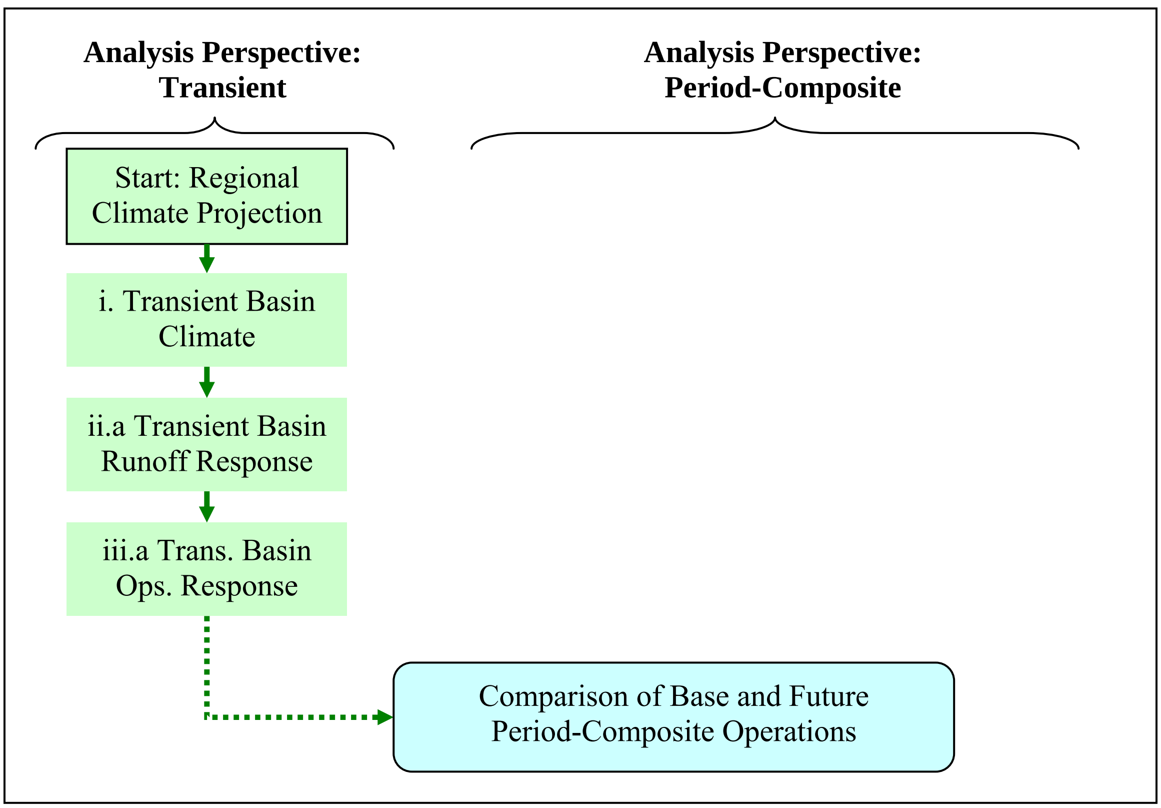
To illustrate each type, several examples from literature are highlighted in the following sections. Discussions in these sections all assume that step (ii) will be conducted using a process simulation of runoff rather than a statistical approach, although that may not be necessary, as will be discussed in Section W.6.3.

U.7.2.1 Transient Runoff and Operations

An example of this type was demonstrated by Christensen and Lettenmaier (2006), highlighted in Section W.5.1.6. Their study involved repeating steps (i)-(iii) for a 22-member ensemble of climate change scenarios. For each member, step (i) begins with a simulated climate time series having been bias-corrected relative to a 1950-1999 observed historical period and then spatially downscaled to 1/8 degree latitude-longitude resolution using methods described by Wood et al. (2004) and Maurer et al. (2007). Downscaled climate scenario time series are then converted into time series meteorological inputs for the runoff model used in the analysis, a Colorado River basin application of the Variable Infiltration Capacity (VIC) macroscale hydrology model (Liang et al. 1994; Nijssen et al. 1997). Runoff results from the VIC model were then routed to key reservoir inflow and system "gain" locations in a system simulation model analogous to the Colorado River Simulation System (CRSS) (Reclamation 1985), and aggregated into monthly values at these locations, providing time series inflow inputs for scenario operations analysis. Once complete, period-composite VIC runoff and CRSS operations statistics were computed to assess runoff and operations response to climate change by measuring statistics in future relative to "recent historical" periods.

Working within the options outlined in Figure U-18, the options selected by Christensen and Lettenmaier (2006) are indicated on Figure U-19. Implementation of these options generally involves a more intensive effort to develop meteorological inputs prior to runoff analysis, but a less intensive effort thereafter as full-period runoff information for a given scenario is well-aligned with operations model input. On developing scenario meteorological inputs for VIC, the step (i) output is already at a spatial resolution and position common to the runoff model. Given that the output is monthly time-step information for only precipitation and temperature conditions, additional data processing is required to translate the data into sub-monthly timestep conditions (daily) and other meteorological inputs required by VIC (e.g., wind speeds and surface radiative variables following methods described by Maurer et al. [2002]).

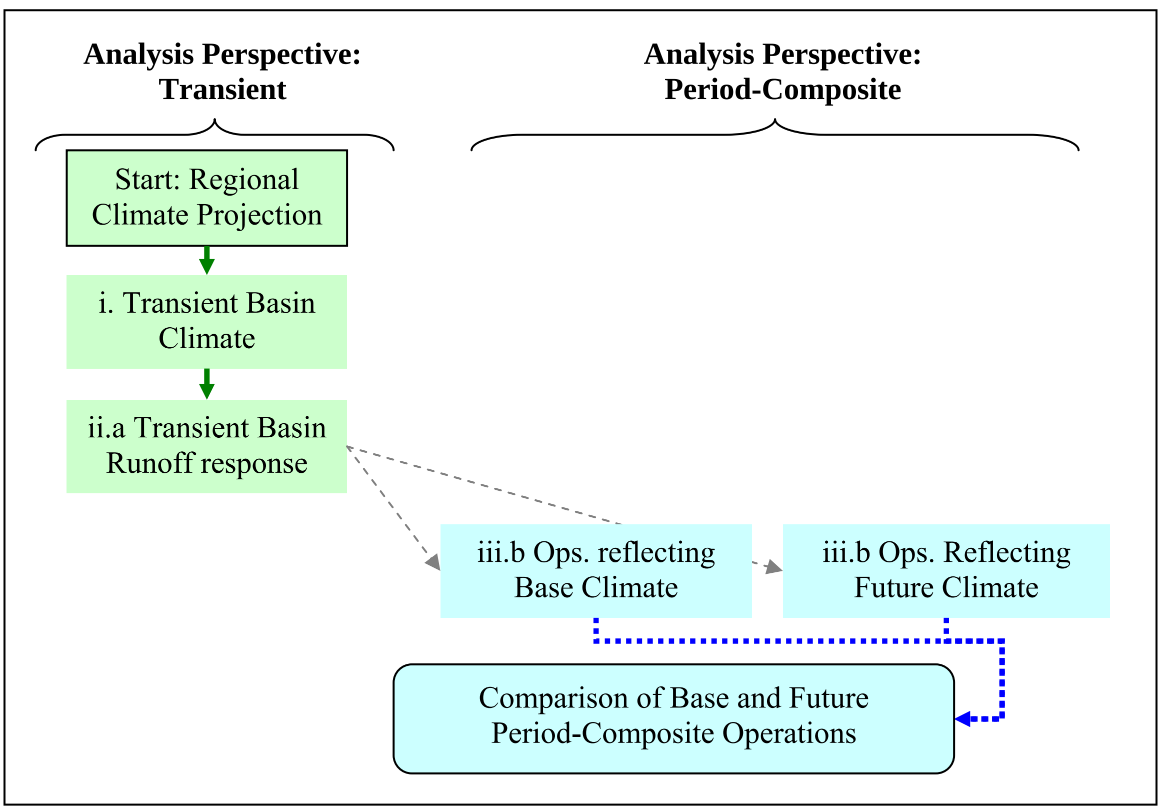
Figure U-19
Example Selection of Options following Christensen and Lettenmaier (2006)



U.7.2.2 Transient Runoff and Period-composite Operations

An example of this type was described in the California Department of Water Resources in their report "Progress on Incorporating Climate Change into Management of California's Water Resources" (CA DWR 2006). In their application, step (ii) reflected similar methods featured in Christensen and Lettenmaier (2006) and Maurer et al. (2007). Specifically, the runoff analysis was conducted using a California Central Valley application of VIC (Van Rheenan et al. 2004), and featured the same methods of preparing climate scenario meteorological inputs for the VIC application as described in Christensen and Lettenmaier (2006). The need to adopt a period-composite perspective for step (iii) was driven by the choice of operations model, which did not easily couple with the VIC application in several respects. For example, the VIC model simulated natural flow but not watershed impairments whereas the operations model simulated decisions relative to impaired river inflows at an interior sub-area of the watershed, located below other reservoir systems at higher elevation. The VIC model simulated natural flow during post-1950 conditions whereas the operations model featured a base inflow sequence coincided with observed weather during 1922-2003 and a study assumption was to continue using that historical sequence to reflect inflow variability. Consequently, rather than attempting to couple the VIC runoff model to the operations model, or adjust the base sequence of the latter, a perspective transition was implemented between steps (ii) and (iii) (Figure U-20).

Figure U-20
Example Selection of Options following CA DWR 2006



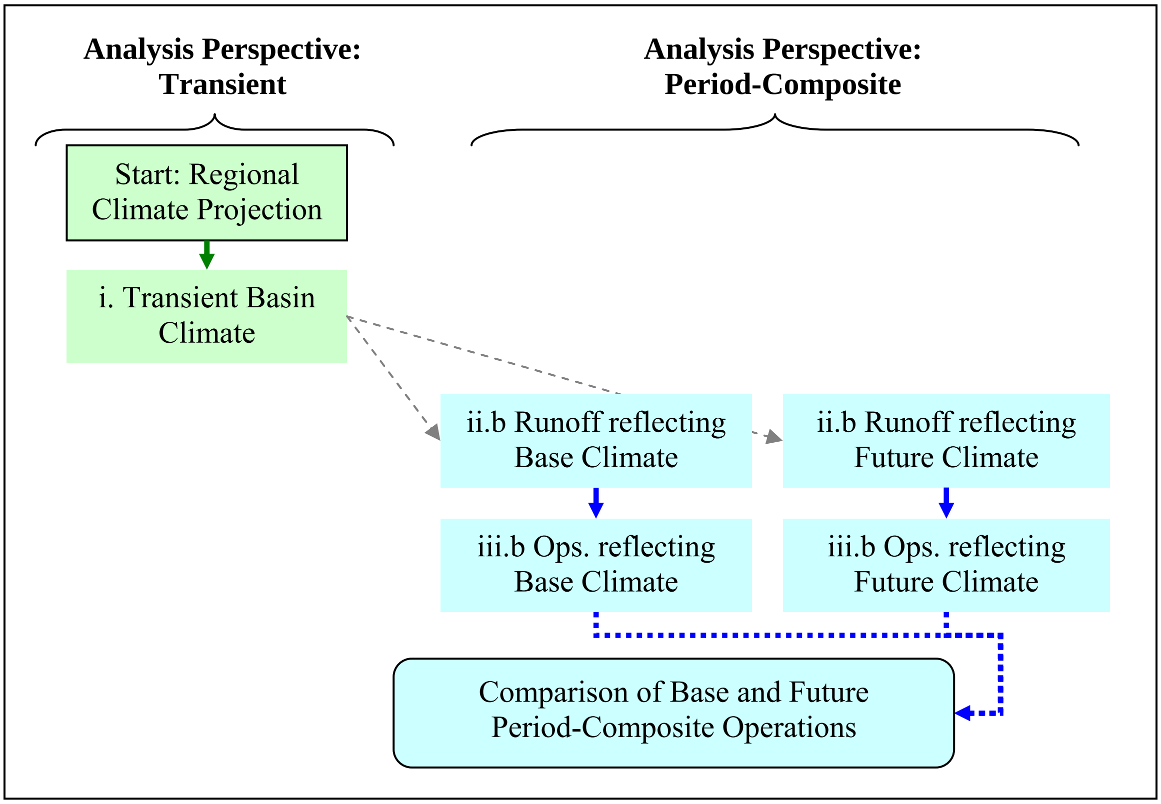
The mechanics of transition occurred using the following steps:

- Adopt "historical" and "future" periods of interest from the simulated runoff time series (CA DWR 2006 reports that simulated runoff during "1961-1990" and "2035-2065" periods were considered).
- Route VIC runoff results during these periods to key system inflow locations of the operations model.
- At each routed runoff location,
  - compute mean monthly runoff during each period.
  - compute month-specific inflow adjustment factors, defined as ratios of runoff, "future" divided by "historical" (i.e. natural runoff sensitivities).
  - adjust the operations model's "base case" inflow time series on a month-specific basis using the inflow adjustment factors. For example, at a given location, if the January ratio of runoff change is 1.2, inflate all January inflows in the operations model's input time series by +20%.
  - As it was applied, it is understood that this approach introduced discrepancy into the analysis since natural runoff responses were used to perturb "impaired" inflows in the operations model. However, such discrepancy may be unavoidable if water management decisions upstream of the operations model's geographic domain are not incorporated or cannot be feasibly incorporated into the operation model.

U.7.2.3 Period-composite Runoff and Operations

An example of this type is illustrated by the sequential analyses outlined in Miller et al. (2003) and Zhu et al. (2005). The operations analysis (step (iii)) by Zhu et al. (2005) follows a period-composite approach, similar to CA DWR 2006. However, the preceding runoff analysis (Miller et al 2003) also follows a period-composite perspective (Figure U-21).

Figure U-21
Example Selection of Options following Miller et al. (2003) and Zhu et al. (2005)



The starting points for the runoff analysis were (a) the simulated "monthly" climate time series over the given basin of interest, and (b) the "observed historical" basin meteorological time series at a 6-hour timestep used to calibrate the runoff model. The spatial resolution of (a) is not compatible with that of (b), requiring GIS data processing to develop monthly climate time series aggregated over the basin area. For example, in Miller et al. (2003), the information in (a) was downscaled during step (i) to a 10-km gridded resolution. These data had to be related to mean area "upper" and mean area "lower" basin areas for which the calibrated model had "observed historical" meteorological inputs. The need for this GIS exercise was set up by choice of runoff model (i.e. lumped basin applications of the Sacramento Soil Moisture Accounting (Burnash et al. 1973) and SNOW17 models (Anderson 1973) developed and provided by the National Weather Service CA-NV River Forecast Center). For these models, (b) consists of mean area "upper" (MAU) and mean area "lower" (MAL) precipitation and temperature observations from 1963-1992.

Given these starting points and a given basin, the transition from the transient to period-composite perspective in Miller et al. (2003) was accomplished as follows:

- Adopt "historical" and "future" periods in the simulated climate time series overlying the basins.

- From the simulated monthly climate time series aggregated to MAU and MAL boundaries, compute mean monthly temperature and precipitation during each period.
  - Compute month-specific shifts in temperature, future minus historical.
  - Compute month-specific ratios of precipitation change, future divided by historical.
- Create a "future period" meteorological input sequence for the given basin's runoff model by adjusting a duplicate version of that model's "observed historical" sequence on a month-specific basis according to mean monthly shift- or ratio-changes in temperature and precipitation, respectively. For example, given a future-minus-base January temperature change of +1.1 °C, all January time-step values in the "observed historical" sequence would be adjusted +1.1 °C. Likewise, for a given future-to-base December precipitation ratio of 1.2, all December time-step values in the "observed historical" precipitation sequence would be scaled 20% higher.

The basin's runoff model is then simulated for both the "historical" and "future" meteorological input sequences, producing runoff output that can be compared to compute monthly inflow adjustment factors as discussed in the preceding method (Section W.6.2.2). Subsequent procedures are unchanged relative to the preceding method.

U.7.3 Analysis Design Considerations

U.7.3.1 Climate Scenario Data Availability

The public and water resource analysts (including those at LC) can access a multitude of GCM "raw output" in the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3) multi-model dataset, which includes projection-specific datasets that vary by GCM and by greenhouse gas scenario simulated, as discussed in Section W.4. The multi-model dataset has been made available by the Program for Coupled Model Diagnosis and Intercomparison (PCMDI) at Lawrence Livermore National Laboratory (http://wwU-pcmdi.llnl.gov/) and WCRP's Working Group on Coupled Modeling. Support of this dataset is provided by the Office of Science, U.S. Department of Energy.

Projection-specific datasets are at "climate model" resolution, which is too coarse for hydrologic and operations studies conducted by LC analysts. Before such studies can be conducted, it is necessary to bias-correct and spatially downscale the climate model output into distributed climate conditions at more local resolution (Section W.4.2.3). The availability of downscaled climate projection datasets over the Colorado River basin is currently limited. LC might acquire such data through collaboration with research groups currently studying climate impacts in the region (e.g., NOAA-RISA centers at the University of Washington (Climate Impacts Group), University of Arizona (CLIMAS) or Colorado University (Western Water Assessment)). If studies of this nature are envisioned in the future, it might be useful for Reclamation to develop the ability to perform bias-correction and spatial downscaling procedures internally.

U.7.3.2 Choosing a Runoff Model

Runoff model options range from those supporting operational hydrologic forecasting services (e.g., Sacramento-Soil Moisture Accounting and SNOW17 applications (Sac-SMA) developed for Western U.S. basins by the National Weather Service River Forecast Centers) to hydrologic simulation tools used in research (e.g., the Variable Infiltration Capacity macroscale hydrologic model applications developed for various areas in the Western U.S. (e.g., the CA Central Valley application discussed by Maurer et al, 2007; the Columbia-Snake River Basin application discussed by Nijissen et al, 1997; or the Colorado River basin application discussed in Christensen and Lettenmaier, 2006). A common trait among process simulations is that they feature an interplay of lumped and linked watershed characteristics, where watershed processes are simulated in base level units (e.g., mean area upper or lower units in NWS RFC's Sac-SMA applications or regular grid cell units in VIC applications) and runoff between these units is governed by a routing scheme.

Any model option may be suitable as long as it has been well-calibrated in the basin of interest. Model familiarity, model access, and computing requirements are likely to be factors determining which hydrologic model is preferred. Some other distinguishing factors might relate to physical representations in the model. For example, in basins where there is significant elevation variability, a higher spatial resolution model might be able to more accurately show snowpack and snowmelt response to climate change. Likewise, in basins where groundwater baseflow contributes significantly to discharge conditions during low flow months, a model with a better treatment of subsurface hydrology might be preferred.

U.7.3.3 Analyzing Runoff Response Using Statistical Resampling

It has been suggested that step (ii) could be conducted using statistical techniques rather than runoff process simulation. There are several potential motivations for a statistical approach. First, operations analysts may not have easy access or have familiarity with the runoff models and data, particularly if the latter are maintained and operated by a separate agency (e.g., Reclamation operations analysts needing access and familiarity with models and data used by NWS RFC staff). Second, the computational requirements associated with runoff simulation and data handling may be an issue for some project situations. Finally, the step of translating natural runoff simulation response into adjusted "impaired system inflows" of an operation's models may introduce significant error (although this is not a concern for CRSS application, which is forced by natural system inflows; see Section W.3).

It has been proposed that such process modeling could be circumvented if a statistical model can be identified where an historical "inflows like-year" is selected as a function of climate parameters. For example, such a model might relate seasonal runoff volumes to antecedent or coincident season(s) temperature and/or precipitation. If such a model can be rationalized, then it would be possible to force such a model using a simulated climate time series (historical or projected) to determine lookup climate conditions from a historical database of paired climate and inflows data.

An attractive aspect of this approach is that the generated inflow time series complies with both (a) simulated climate conditions, and (b) the observed historical relationship between climate conditions and system inflows. For studies involving operations models that require "impaired system inflow" inputs, this would be an improvement over the process-based approaches to step (ii) featured in Section W.6.2, where natural runoff response to climate change from the runoff process modeling was taken as proxy information for the response of the operations model's impaired inflows.

Other advantages relate to implementation and compatibility with paleoclimate information. The statistical approach would seem to be cheaper and easier to implement, as it does not involve the model setup, or likely the computational and data processing requirements associated with runoff process simulation. It would also seem to offer an easily applied framework for developing "paleo" system inflows, where the observed historical inflows-climate relation is applied with reconstructed time series of paleoclimate conditions to produce paleo-inflows. That said, until the statistical relation between observed historical inflows and climate is established, it is uncertain which paleoclimate indicators would need to be surveyed and whether sufficient indicators could be identified. Nevertheless, paleoclimate reconstructions continue to be developed, and may be applicable to this conceptual framework. For example, summer season temperature reconstructions have been reconstructed from 1600-1983 for the general area of the Upper Colorado River basin (Briffa et al. 1992). A follow up summer season temperature reconstruction for a region just north of the Upper Colorado River basin dating back to 1350 is also under development (Connie Woodhouse, 6 March 2007, *personal communication*).

A potential disadvantage of the statistical approach is that it is limited to the assumption of persisting land cover conditions associated with the observed historical inflows-climate relation. However, runoff process simulations (Sac-SMA or VIC applications) are also limited by the same assumption (discussed in Section W.6.3.3). Additional model development would be required to identify time-changing model calibrations (i.e. model parameterizations) relative to time-changing land cover during the calibration period. It is not certain whether such time-changing model calibrations could be identified.

Another potential disadvantage of the statistical approach is that its application in this context has been less developed than approaches involving runoff process simulation that have been demonstrated in peer-review literature (e.g., Miller et al. 2003, Maurer et al. 2007, Christensen and Lettenmaier 2006). The approach has been primarily developed for shorter-term (seasonal) runoff-projection applications. For example, Regonda et al. (2006) developed a statistical resampling scheme conditioned on climate predictors and applied it to prediction of runoff conditions at multiple sites. Although their prediction look-ahead was only seasonal, the use of climate variables to condition the resampling would seem to be extensible to longer-term look-ahead horizons.

U.7.3.4 Treatment of Evapotranspiration and Land Cover

In many watersheds, the loss of water from the land surface via evapotranspiration (ET) is a significant term in the surface water budget. Treatment of this term in hydrologic process-models tends to vary. For example, in the Sac-SMA applications, evapotranspiration is simulated in response to simulated soil moisture conditions and input potential evapotranspiration demands. The latter demands are area-lumped historical average values that vary with month and day during the calendar year (NWS OHD 2005). In contrast, more recently developed hydrologic models such as VIC simulate evapotranspiration based on input land cover (bare soil to various vegetation classes) and input or derived meteorological forcings (temperature, wind speed, vapor pressure, shortwave radiation, and net longwave radiation).

As temperature and radiation increases, it is reasoned that potential ET would also increase. However, coincident changes in CO_2 (which affects plant stomata response) and other surface radiative variables introduce uncertainties on this ET response. Nevertheless, if process-simulation is selected for the runoff response analysis to climate change, it would seem that the more dynamic ET simulations of recently developed hydrologic models (e.g., VIC) would be preferred for capturing dynamic ET responses to meteorological changes. If the statistical approach of Section W.6.3.2 is selected, such dynamic ET responses would be implicitly represented when statistically selecting runoff conditions based on associated climate conditions.

When discussing natural ET response to climate change, it is also relevant to discuss potential land cover changes since the landscape composition also determines watershed ET. Most available hydrologic model applications (Sac-SMA, VIC, or otherwise) treat land cover as a static condition during model development and scenario simulation. In other words, while historical period climate and runoff observations are used to calibrate hydrologic process parameters (e.g., during 1960-2000), the coincidental land cover conditions in the watershed are either period-averaged or assumed to equal a recent land cover survey. The latter assumption is likely incorrect, understanding land cover has always evolved and will likely continue to do so in the future. This raises issues for step (ii) in the analytical sequence, whether it is done with process simulation or through the statistical concept of Section W.6.3.2. That said, land cover issues may be of secondary significance in simulation of seasonal-to-annual inflows, given that models like VIC have been used to explain a considerable majority of annual flow variance (Andrew Wood, 25 May 2007, *personal communication*).

Drivers of land cover change range from societal to natural. Our capabilities to project land cover in response to societal changes have received more research attention. For example, projections for Western U.S. land cover have been developed for the year 2040, and reflect an expectation that urban areas will occupy a greater proportion of the Western U.S. landscape during the coming decades (Travis et al. 2005). Capabilities in projecting land cover response to natural changes are less developed, but there have been attempts in recent years. For example, coarse models have been developed that simulate vegetation succession in response to climate change (Bachelet et al. 2001). Other studies have been conducted on potential vegetation responses to changes in atmospheric gases composition (Iverson and Prasad 2001; other references in the U.S. National Assessment of The Potential Consequences of Climate Variability and Change – Sector: Forests (USGCRP 2000)). However, questions remain surrounding land cover response to climate change, related to characterizing land-cover dynamics, drivers behind those dynamics, and the interactions between societal change, climate change, and land-cover dynamics (USCCSP 2003).

U.7.3.5 Treatment of Groundwater and Surface Water Interactions

Rivers and groundwater are intimately connected. That said, typical methods for studying runoff response to climate change (e.g., studies cited in Sections W.5 and W.6) have not featured direct simulation of groundwater response to surface climate changes. Ideally, analysis of surface water response to climate change would be performed with knowledge of how groundwater coincidentally responds, both in terms of migration and spatial/temporal distributions of aquifer stock. In contrast, typical methods for assessing runoff response to climate change feature use of models where groundwater interactions with surface water are more implied than prescribed.

Several areas of research must be advanced further in order to permit more definitive messages about how natural runoff will respond to climate change in the context of coincidental groundwater response. It will be necessary to understand the entire recharge process and its response to climate change. This in turn will require better understanding of groundwater recharge and movement at scales relevant to regional runoff analysis, and in turn require understanding on the aggregate process of mountain block recharge (K. Redmond, 2 June 2007, *personal communication*). Further, the role of root zone and riparian vegetation in mitigating this interaction will have to be better understood, which segues into questions already posed in Section W.6.3.4 about on how basin land cover and natural evapotranspirative demand will respond to climate change.

U.7.3.6 Treatment of Future Precipitation Assumptions

Current capabilities in projecting regional precipitation response to global climate change are limited. As discussed in Section W.4, raw GCM simulations of precipitation will likely put the precipitation in the wrong places, perhaps at the wrong time, and with wrong amounts. Bias-correction and spatial downscaling can be used to remove regional GCM biases (Section W.4.2.3). However, such data-processing does not provide more reliable information or increase confidence in a particular GCM scenario for climate change.

For planning studies, the problem with GCM-simulated precipitation projections is a matter of how to regard the data rather than how to use the data. Methods on how to use the data have been developed (Sections W.4.2.3 and W.6.2). The problem is that the variation among GCM-simulated precipitation projections can be quite broad for a given study region (e.g., Figure U-9a, b showing greater than +/- 50% change intervals for annual average precipitation over the Colorado River basin). Notably, a paradigm does exist suggesting that global precipitation should increase in response to global warming because increased temperatures cause a net-global increase in evaporation and subsequently precipitation. However, at a regional scale, there's no established paradigm suggesting *direction* or *limit* of precipitation change. Such a paradigm would have to factor in a multitude of drivers that affect the regional surface climate (e.g., for the

Colorado River basin: the influence of climate change on North Pacific storm track position, North American monsoon, tropical pacific variability related to ENSO, and other interannual/interdecadal climate phenomena that will be presented in Section W.8).

This issue is significant when conducting water management impacts analyses for storage-rich systems like the Colorado River basin. Storage-rich systems are sensitive to trends in mean-annual precipitation and runoff, more so than to changes in seasonal runoff patterns. An impact assessment conducted on such a system would produce a range of impacts significantly influenced by the range of precipitation changes considered (presumably from GCM results). Given that GCM-based precipitation changes can vary considerably (Figure U-9a, b) and may not exhibit consensus towards wetter or drier (Figure U-9a, b), some critical thought is invited as to whether the precipitation projections should be considered altogether at this stage in impacts study.

An alternative path forward might involve focus on only the more reliable aspects stemming from GCM-simulated climate projections (i.e. temperature changes), and combining this focus with either an assumption of no precipitation change or precipitation variability from some period of the observed or paleo-past (see Section W.7). Using this approach, any of the method options presented in Section W.6.2 could still be implemented, but instead with consideration limited to only GCM temperature projections and alternative methods used for defining future precipitation.

U.7.4 Potential Analysis Designs using Reclamation's CRSS

This section explores potential analytical designs that LC staff might consider, combining the use of LC's operations model, CRSS (Section W.3), with the method options discussed in Sections W.6.2 and W.6.3.

U.7.4.1 Transient Runoff and Period-composite Operations

This design would be similar to that implemented by CA DWR (2006), and illustrated in Figure U-21. It is assumed that the LC study might involve exploring how simulated operations are sensitive to a climate assumption (e.g., base versus future), or how operations alternatives vary under an assumed climate change scenario. The study might begin with selection of one or more of the scenarios and natural runoff simulation datasets recently documented in Christensen and Lettenmaier (2006). Scenario selections are subjective (e.g., choice of lower and higher rate-of-warming scenarios). CRSS inflow data preparations would follow, beginning with selection of "historical" and "future" climate periods. The results would be examined from a "period-composite" perspective, computing monthly mean runoff conditions near CRSS inflow locations during both "historical" and "future" periods. Ratios of monthly mean runoff would be computed, future relative to base period values, and be used as monthly runoff adjustment factors to scale the historical CRSS system inflows (month by month) into a future set of system inflows, reflecting observed inflow variability with means reflecting future climate.

Before developing the monthly runoff adjustment factors, the runoff datasets may need to be post-processed to report routed runoff at CRSS system inflow locations, and it may be necessary to bias-correct the routed natural runoff time series at these locations as it is possible that the modeled-historical and observed-historical natural runoff during the common historical overlap period will be different. A "distribution mapping" method could be used, similar to that discussed in section W.4.2.3 as it is used to bias-correct climate simulations (Wood et al, 2004).

U.7.4.2 Transient Runoff and Operations

This design is similar to the preceding design in that it uses the same starting points and potentially involves runoff-routing and bias-correction procedures during procedures to prepared CRSS inflow datasets. The only difference is that rather than adopt a period-composite perspective when relating Christensen and Lettenmaier (2006) runoff data to CRSS system inflows, a transient perspective is adopted instead. The time series of climate-scenario simulated runoff are routed to CRSS inflow locations (potentially bias-corrected) and used directly to force the CRSS simulation. This would permit the CRSS simulation to show how operations would evolving under evolving runoff conditions associated with the given climate scenario.

U.7.4.3 Transient Runoff and Operations with Statistical Runoff Analysis

This design would be similar to the preceding design, except that the transient runoff information under a given climate scenario would not be produced using hydrologic process simulation. Instead, statistical resampling schemes based on historical relations between observed inflows and climate variables, and driven by projected conditions for the climate variables, could be utilized to develop climate-scenario CRSS system inflows. The scenario starting points from the two preceding designs might be used here, aggregated into annual or monthly climate variable time series as required by the statistical resampling scheme. Generation of system inflows at the various CRSS inflow locations might be performed in direct relation to the climate conditions, or through an intermediate step of first relating the basin climate to Lees Ferry flow and then disaggregating spatially and temporally using procedures discussed in Prairie et al. (2007).

U.7.5 Potential Approach to First-Order Sensitivity Analysis for Near-Term Studies

For studies and decisions concerned with longer-term look-ahead horizons (e.g., greater than 20-years) and undergoing evaluation on the near-term, a *first-order* quantitative sensitivity analysis might be conducted on operations response to projected climate change. Such analysis would ideally reveal the significance of assumed climate in determining study results and informing decisions. Given Reclamation's current limited ability to easily conduct internally produced simulations of runoff response to climate change in the CRB, such near-term studies might be framed using literature-reported projections of climate <u>and</u> related runoff response.

For such studies evaluated on the near-term, it is recommended that scoping of sensitivity analysis begin with a "filtered" consideration of available literature. Rather than try to frame the analysis on all climate change and runoff impacts studies that have been conducted for the CRB (e.g., representing all studies listed in Table U-3), it is recommended that the following criteria be adopted to focus the analysis:

1) require that scenario climate change projections reflect the latest IPCC assessment on future greenhouse gas emissions pathways and climate science (i.e. the Fourth Assessment Report (AR4) from the IPCC (2007))

2) require that scenario climate change projections be produced by GCMs referenced in the latest IPCC assessment (i.e. coupled atmosphere-ocean GCMs listed in Table U-7 in IPCC (2007) report from Working Group 1, “The Physical Basis for Climate Change”).

3) require that an ensemble of GCM projections be considered, representing the range of available GCMs and future emission pathways reported by IPCC, and permitting consideration of uncertain climate change over the CRB and how that translates into uncertain runoff response.

4) require that GCM *projection* data be bias-corrected over the Colorado River Basin (CRB), accounting for GCM tendencies to be warmer, cooler, wetter, or drier when used to simulate 20th century (Section W.4.2.3.2, W.6.1).

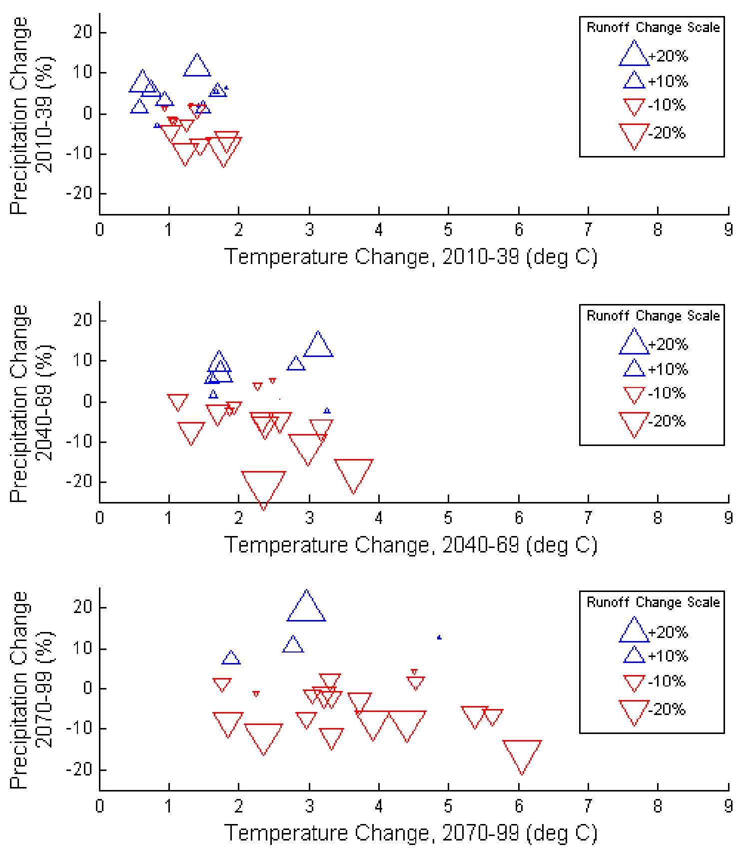
5) require that *bias-corrected GCM projection* data be spatially downscaled over the CRB, preserving larger- to smaller-scale climatic relations, and permitting more disaggregate consideration of runoff response to climate change distributed over the basin.

6) require that *bias-corrected and spatially downscaled (BCSD) GCM projection* data be translated into natural runoff response using a peer-reviewed methodologies.

Criteria 1 and 2 are meant to steer attention to the most recent understanding of climate change science and implications for the CRB. Criterion 3 recognizes that a survey of BCSD climate projections over CRB, representing multiple GCMs and emissions pathways, can reveal uncertainties of temperature and precipitation change as well as associated runoff change. Criterion 4 is based on the philosophy that simply starting from a multi-GCM projection ensemble is not sufficient, and that GCM-specific datasets should be adjusted to reflect the given GCM’s tendencies to give biased climate information (i.e. revealing how the given GCM has a tendency to be too wet, dry, cool or warm when simulating past conditions). Criterion 5 is based on the philosophy that studies consider spatially distributed climate change within the CRB are better prepared to indicate spatially distributed impacts to runoff, and how these impacts aggregate to upper basin inflow to the lower basin. And finally, criterion 6 recognizes that a philosophy that literature information framing these studies should have undergone peer-review within the scientific community and that use of multiple methodologies may be appropriate to reflect model uncertainty. As for the tool choice for modeling runoff response, options exist for using statistical or process simulation. Statistical modeling may have merit in its relative ease of implementation. Physical process simulation may offer more transparent accounting of how basin-distributed climate change impacts distributed runoff, soil moisture, and evapotranspiration, as well as how evapotranspiration interacts with computed soil moisture and climate forcing conditions.

Applying these criteria to the studies mentioned in Table U-3 leads to focus on the climate scenarios and runoff changes reported in Christensen & Lettenmaier (2006) (Figure U-22). Using this information to illustrate climate and runoff change scenarios, the next recommended step is to choose a projection period relevant to the management decision being informed by the operations study. For example, the purpose of the study may be to inform evaluation of how scenario operations affect other basin resources several decades from the present (e.g., Figure U-22, top panel showing changes for early 21st Century), or how scenario operations might translate into economic value during an even longer term service life (e.g., Figure U-22, middle and bottom panels, showing changes for middle and late 21st Century).

Figure U-22
Data from Christensen and Lettenmaier (2006), (Appendices A1 and A2) Change in 30-Year Mean Annual Runoff (%) from Historical (1950-1999), Given 22 Projections of Mean-Annual Climate Change Over the CRB, Sampled for Three Future Periods: 2010-39, 2040-69, and 2070-99



The 22 projections were simulated by 11 GCMs, each simulating either SRES A2 and B1 greenhouse gas emissions.

After filtering the literature information by the projection period of interest, the next step might involve characterizing distributional aspects of period-mean climate and runoff across projections considered in the literature (Figures U-23 through U-25). This step focuses attention on change in mean annual runoff as it relates to underlying scenarios of climate change. Change in *runoff seasonality* or *variability* is not the focus in this example, which may be appropriate for CRB studies that depend on assumptions of aggregate upper CRB runoff into Lake Powell, which is more sensitive to trend in mean annual runoff than trend in runoff seasonality.

Figure U-23
Histogram and Box-and-Whisker Distributions of 2010-39 Precipitation Change relative to Historical (1950-1999) Corresponding to Scenarios Represented on Figure U-23

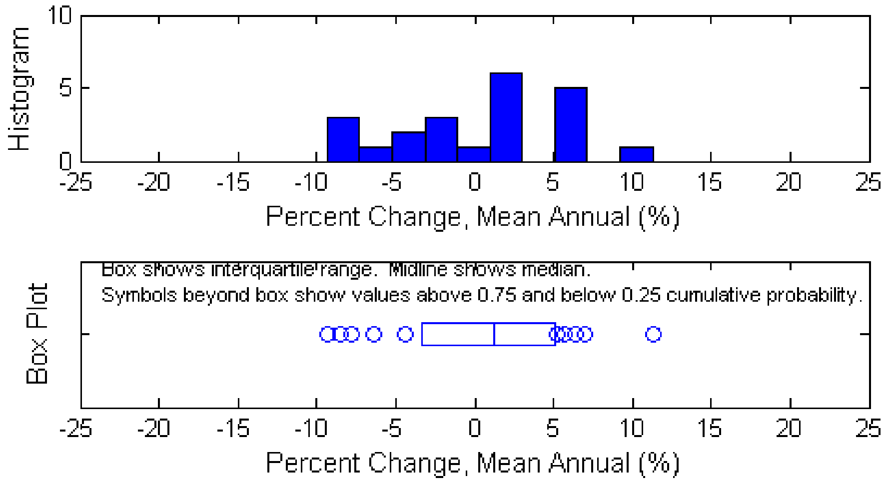


Figure U-24
Histogram and Box-and-Whisker Distributions of 2010-39 Temperature Change Relative to Historical (1950-1999) Corresponding to Scenarios Represented on Figure U-23

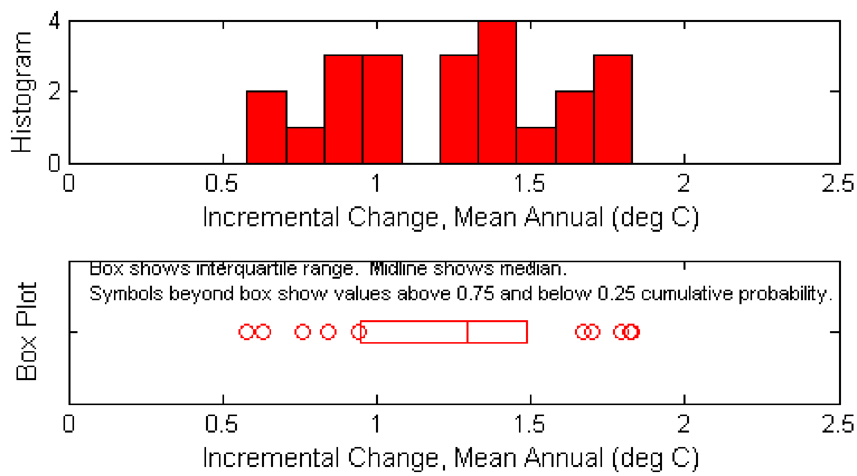
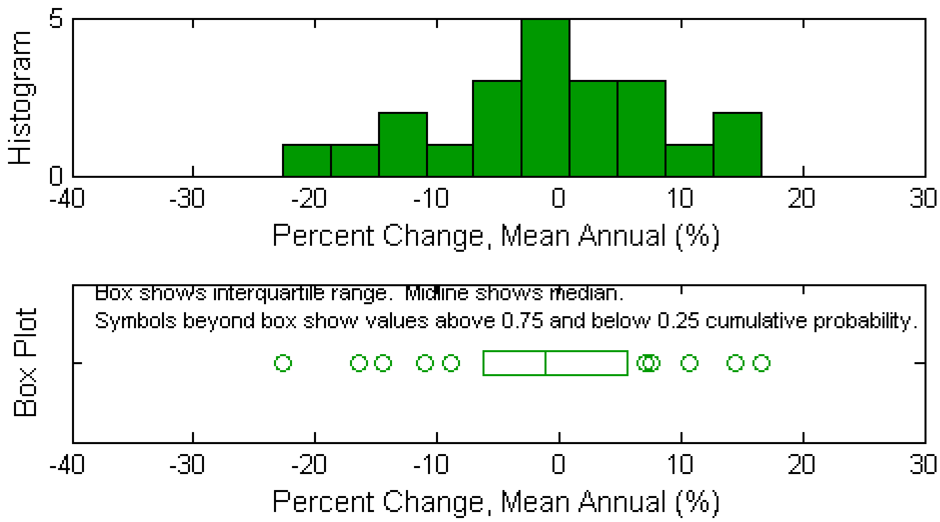
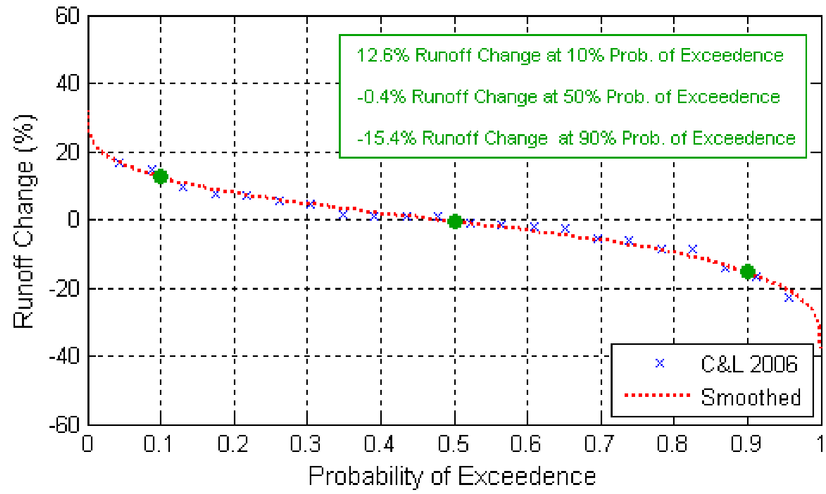


Figure U-25
Histogram and Box-and-Whisker Distributions of 2010-39 Runoff Change relative to Historical (1950-1999) corresponding to Scenarios represented on Figure U-23



After identifying these period-mean changes, the final step in setting up the sensitivity analysis is to construct a (optionally smoothed) empirical distribution of period mean-annual runoff change (Figure U-26), and adopting "risk-perspective" threshold for sampling runoff change from the smoothed empirical distribution. On this latter step, a risk-neutral decision-maker might focus on median projected change in the distribution. A risk-averse decision-maker might focus on temperature change exceeded by only 10 percent of the projections, or precipitation change exceeded by 90 percent of the projections. Upon identifying threshold annual runoff changes, sensitivity analyses could be conducted where CRSS monthly inflows (Section W.3.1) are scaled by threshold scenario changes in period mean-annual runoff.

Figure U-26
Smoothed Empirical Distribution of 2010-39 Runoff Change (%) Relative to Historical (1950-1999), Fit to Scenario Runoff Changes Shown on Figure U-26 (labeled here as C&L 2006)



Three example thresholds of runoff change are shown (green circles), as sampled from the Smoothed Empirical Distribution, where smoothing was accomplished by fitting a nonparametric density function to the 22 cases fitting cases (C&L 2006). (Note: "Probability of Exceedence" in this case represents *relative* probability based on surveyed projections and runoff analyses, not *absolute* probability.)

U.7.6 Uncertainties

The process of relating projected climate change to operations response involves a number of uncertainties introduced by the methods outlined above. These uncertainties interact with those discussed in Chapter 4.0 concerning development of downscaled climate projections and simulated climate time series. Some key uncertainties associated with analyzing runoff and operations response include:

- Assumptions on how to convert simulated climate time series into a meteorological input sequence for runoff analysis. For process-simulation, this can involve temporal disaggregation and variable extrapolation depending on the hydrologic model used.

- Assumption on where to make the perspective transition from transient to period-composite (e.g., before step [ii], before step [iii], or after step [iii]).

- Assumptions on how to structure the hydrologic model used in the analysis, with suitability of structure indicated by model skill and calibration metrics produced during model development (e.g., the ability to reproduce observed runoff given observed weather conditions).

- Assumptions for relating climate change responses in natural runoff to adjusted "impaired system inflows" in operations analysis.

- ♦ Assumptions on how to structure the operations model used in the analysis, indicated by model verification efforts (e.g., the ability to approximate real-life decisions occurring on variable daily to weekly time-scales in the context of a decision model with a uniform daily or monthly time-scale).

- ♦ Assumptions on how to represent system operations within the operations model under a changing climate, understanding that climate changes may trigger different operational strategies and discretionary operational "rules" not present in the "present climate" rendition of the operations model.

- ♦ Assumptions that historical land covers underlying both runoff and operations model development will represent future period land cover, and that historical relations between the meteorological forcings and runoff will persist.

U.8 Paleoclimatic Information for the Colorado River Basin

With the growing recognition of the inadequacy of the gaged record as a baseline for planning, the use of paleoclimatic data has received increased interest in the water resources profession. Previous sections of this report (W.3.4.2. and W.3.4.4.) described the use of paleoclimatic data in Reclamation hydrologic analyses, capitalizing on the extended perspective on past hydrology provided by these data. In addition to "looking back" up to 500 years or more, there is potential for using these data to look forward and evaluate potential future hydrologic scenarios. This section summarizes the state of science for paleoclimatic information in the Colorado River basin and how this might be used with future climate projections.

U.8.1 Paleoclimate Indicators of Hydrology in the Colorado River basin

Paleoclimatic data from environmental records can be used to extend instrumental records back in time. Tree rings are the best source of high resolution, precisely-dated proxy records of hydroclimatology over the past centuries, and they have proven useful for reconstructing a range of hydroclimatic variables, including temperature, precipitation, and streamflow (Meko and Woodhouse, 2007). In the Upper Colorado River basin, tree-ring data have been used to reconstruct streamflow over the past five centuries and longer using dendrochronological techniques.

Research exploring the relationships between annual streamflow and tree growth began in the 1940s with Edmond Schulman whose early work investigated the feasibility of tree rings as a proxy for streamflow. He was motivated, in part, by the need for an extended record of Colorado River flow to assess the reliability of long term power generation, addressed in a 1942 report he authored for the Los Angeles Bureau of Power and Light entitled "A tree-ring history of runoff of the Colorado River, 1366-1941" (Schulman 1945, Stockton and Jacoby (1976). Later work expanded upon this (Schulman 1945, 1951, 1956).

The first reconstructions for the Colorado River based on a statistical calibration of tree-ring data with the natural flow records were undertaken by Stockton in 1975, and updated with additional tree-ring data by Stockton and Jacoby in 1976. Stockton and Jacoby (1976) generated three versions of a Lees Ferry reconstruction, based on two different gage records.

They considered an average of the two reconstructions based on the common time period 1914 to 1961 to be the most reliable estimate of past flow. This reconstruction, which extended from 1521-1961, was the basis for a set of multidisciplinary studies that assessed the impacts of a severe sustained drought on hydrologic, social, and economic impacts sectors (Young 1995 and others). Two more recent studies used similar sets of tree-ring data (all with the common tree-ring end date in the early 1960s) but different statistical approaches to reconstruct Lees Ferry flow. These resulted in reconstructions that shared the main features of Stockton and Jacoby's reconstruction but varied with regard to the magnitude of the high and low flows (Michaelsen et al. 1990, Hidalgo et al. 2000). (See Table U-6 for a summary)

Woodhouse et al. (2006) used an updated and expanded set of tree-ring data and a variety of data treatment and reconstruction approaches to reconstruct Lees Ferry flows extending from 1490-1997. Most recently, Meko et al. (2007) expanded the work of Woodhouse et al. (2006) to extend the reconstruction of Lees Ferry flow back to AD 762 using remnant material (stumps, logs, and standing dead trees) along with living tree chronologies using a nested reconstruction approach (See Figure U-27). This reconstruction, which extends seven centuries prior to any of the previous reconstructions, allows the first assessment of Colorado River flows during a period of time known as the Medieval Climate Anomaly (e.g., Cook et al, 2004). During this period, approximately AD 900-1300, the reconstruction documents a period of sustained low flow in the 1100s that includes a stretch of 62 years with a marked absence of any high flow years.

This set of reconstructions illustrates the robustness of the estimated flows with regard to the temporal pattern of flow over the past five centuries. One difference between the reconstructions is the long-term averages, which range from 13.0-14.7 maf, all of which are significantly less than the gage records average, 1906-1995, 15.2 maf.

U.8.1.1 Scientific Basis and Methodology

Tree-ring based reconstructions of Colorado River flow build upon the strong association between the annual ring widths of low elevation conifer species, (primarily *pinus ponderosa, pinus edulis,* and *pseudotsuga menzeseii*) and water year streamflow (Schulman 1956, Hidalgo et al. 2001). These conifers, particularly those growing on arid slopes with rocky soils, are sensitive to the same climate conditions that contribute to water year flows, primarily winter snowpack, but also precipitation and evapotranspiration over the course of the water year streamflow (for more detailed discussions on tree growth and streamflow, see Meko et al. 1995). In the field, careful site selection and sample replication (about 20 trees per site are cored, taking two cores per tree) further enhance the common signal, related to hydroclimatic variability, in the trees.

Table U-6
Summary of Lees Ferry Reconstructions

Reconstruction	Calibration years	Source of gauge data	Chronology type[c]	Regression approach[d]	Variance explained	Reconstruction years	Long-term mean[e] MAF
Stockton and Jacoby (1976)	a.1899-1961	Hely, 1969	Standard	PCA with lagged predictors	0.75	1512-1961	14.15
	b.1914-1961	Hely, 1969	Standard		0.78	1512-1961	13.9
	c.1914-1961	UCRSFIG, 1971	Standard		0.87	1511-1961	13.0
	Average of b and c					1520-1961	13.4
Michealsen et al. (1990)	1906-1962	Simulated flows[a]	Residual	Best subsets	0.83	1568-1962	13.8
Hidalgo et al. (2000)	1914-1962	USBR, see Hidalgo et al. 2000	Standard	Alt. PCA with lagged predictors	0.82	1493-1962	13.0
Woodhouse et al. (2006)							
Lees-A	1906-1995	USBR[b]	Residual	Stepwise	0.81	1490-1997	14.7
Lees-B	1906-1995		Standard	Stepwise	0.84	1490-1997	14.5
Lees-C	1906-1995		Residual	PCA	0.72	1490-1997	14.6
Lees-D	1906-1995		Standard	PCA	0.77	1490-1997	14.1
Meko et al. (2007)	1906-2003	USBR[b]	Residual	2-step regression with PCA	0.60	762-2003	14.7[f]
	1906-2002				0.74	1182-2002	
	1906-2002				0.77	1365-2002	
	1906-2004				0.57	1473-2005	

NOTES:

[a] Simulated flows developed from the U.S. Bureau of Reclamation's Colorado River Simulation System.

[b] J. Prairie, USBR, personal communication, 2004 (Woodhouse et al,), 2006 (Meko et al).

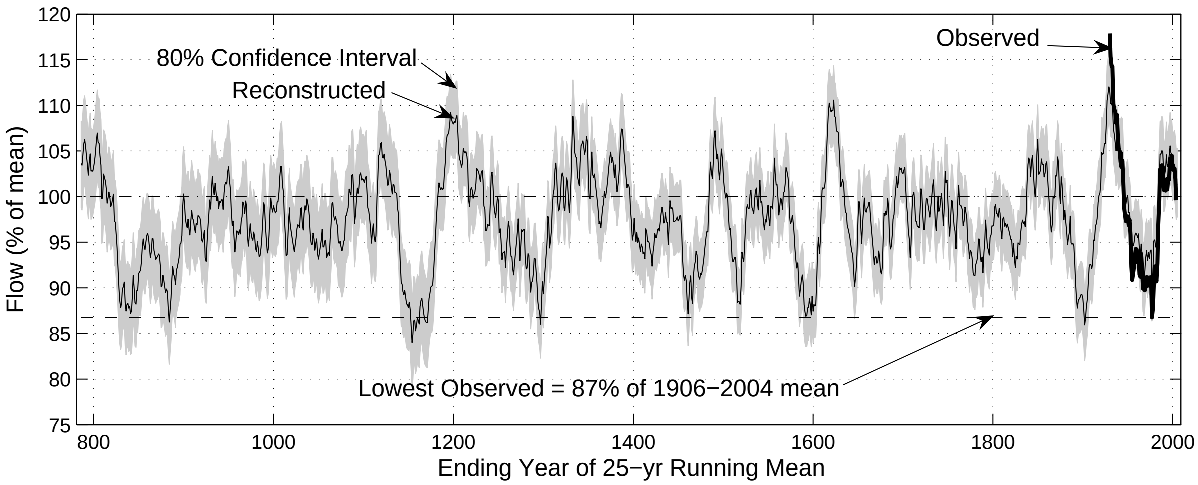
[c] Standard chronologies contain low order autocorrelation related to biological persistence; residual chronologies have been prewhitened and contain no low order autocorrelation.

[d] Regression approach: PCA is principle components regression. Best subsets is multiple linear regression, using Mallow's Cp to select best subset. Alternative PCA used an algorithm find the best subset of predictors on which to perform PCA for regression. Stepwise is forward stepwise regression.

[e] Long-term mean based on 1568-1961 except for Michaelsen et al., 1990, based on 1568-1962

[f] Long-term mean is from full nested reconstruction

Figure U-27
Reconstruction of Lees Ferry streamflow from Meko et al., 2007



A tree-ring chronology, which is derived from the average of the dated, measured, and standardized (to remove age/size related trends) tree-ring samples from a single site (Cook and Kairiukstis, 1990; Stokes and Smiley, 1968), is the basic unit used for streamflow reconstructions. Chronologies often contain significant low order autocorrelation, believed to be at least partially biological in origin, which may be removed through autoregressive modeling (chronologies with this persistence removed are residual chronologies, while those with persistence retained are standard chronologies). Tree-ring chronologies, which have been screened for a stable and significant relationship with streamflow, are calibrated with a natural flow record, typically using some type of multiple linear regression (see Loaciga et al., 1993 for a review of these approaches). Models generated through the calibration process are validated with independent data withheld from the calibration or through cross-validation, which tests the skill of the set of chronologies used rather than the specific model. Models are also evaluated to ensure results meet the assumptions of multiple linear regression.

A number of preliminary models may be generated using different data treatments (e.g., removal of persistence or not), different sets of predictor chronologies, and/or different regression approaches. The final model is selected on the basis of the amount of variance explained and the validation results. The full reconstruction is produced by applying the full-length chronologies to the selected regression equation.

U.8.1.2 Uncertainties

Uncertainty is inherent in the reconstruction because the tree-ring data are not perfect predictors of streamflow. The model uncertainty is the unexplained variance, and error bars for the reconstruction can be estimated from the average difference between the gage and estimated values. Model uncertainty is only one source of uncertainty. Other sources can come from changes in tree-ring sample size with time, the set of chronologies used as potential predictors, data treatment (including standardization which affects the preservation of low frequency information), modeling choices, the calibration period used, and the quality of the gage record. Uncertainty related to changes in tree-ring sample size over time can be reduced by truncating series when the strength of the common signal in the samples reaches a threshold, commonly 85%. The sensitivity of the reconstruction to data treatment, modeling choices, and calibration period can be assessed by comparing reconstructions generated in different ways (for an example of this, see Woodhouse et al. 2006, who evaluated reconstructions generated with different pools of chronologies, standard and residual chronologies, and stepwise and principle components regression). In addition, reconstructed flows that are higher or lower than the range of values in the gauge record may be based on tree-ring values beyond the "predictor space" on which the model is based and are thus potentially less reliable than other reconstructed values (Graumlich and Brubaker, 1986; Meko and Graybill, 1995; Meko et al., 1995).

U.8.1.3 Data Availability

Tree-ring data used in the reconstructions of the Colorado River at Lees Ferry are available through the National Climatic Data Center, Paleoclimatology Branch, International Tree-Ring Data Bank (http://www.ncdc.noaa.gov/paleo/treering.html) in both uncompiled ring width measurement files and the tree-ring chronologies. The reconstructions of Lees Ferry from Stockton and Jacoby (1976),Woodhouse et al. (2006), and Meko et al. (2007) are also archived in the NCDC Paleoclimatology Branch and are available online (http://www.ncdc.noaa.gov/paleo/recons.html#hydro).

U.8.2 Applications of Streamflow Reconstructions to Water Resource Management

Tree-ring based reconstructions of streamflow are being applied in a variety of ways to water resource management. These approaches correspond well to Ray's (2004) categorization of four types of use of climatic information: *consulted*, when information is received or looked up; *considere*d, when information is potentially influential to decisions; *incorporated*, when information is actually used in an operational model for decision-making; and *communication of risk*, when the information and its implications are conveyed to others to prompt or justify action. For example, the Denver Water Board is incorporating reconstructed streamflow data into their water system model to test the ability of the system to meet demands during a broad range of conditions. They have found that the most severe drought in the reconstruction would require level 4 conservation measures. At the other end of the spectrum, the Rio Grande Water Conservation District is still in the process of considering the information provided by the reconstruction, and this information may yet become a part of their decision-making process in assessing sustainable pumping. Other water providers are using the information to advise planning and prompt boards to recognize the potential risks of drought, based on the record of the past (Woodhouse and Lukas 2006).

Paleohydrologic reconstructions from tree rings provide a record of long-term natural variability, with a broader range of values, especially with regard to drought characteristics, than provided by the gage record alone. In addition, these reconstructions provide a richer variety of sequences of annual flows, that include a greater persistence of below or near average years than in the gage records, that particularly test water supply systems. Although the climate of the past is unlikely to be replicated in the future, there is no reason to believe that the range of variability and sequences that have occurred in the past could not recur in the future. The latest IPCC reports a widespread increase in extreme precipitation events and increases in evaporation across many areas of the U.S., along with drier conditions in the Southwest in the future (Christensen et al. 2007). Taken together, these conditions may lead to a broader range of hydroclimatic variability, in which case, the extended records of flow provide a useful analogue for future variability. Consequently, this information can play an important role in helping to anticipate the nature of future droughts.

Reclamation, recognizing that the gage record contains only a subset of the flow conditions that have occurred in the past, is utilizing the reconstructions of Colorado River at Lees Ferry in modeling studies of the Colorado River system. In one case, the broader variety of sequences of flow years in the reconstructed flow record, including longer dry spells, is being incorporated into model input (see section W.3.4.2). In another approach, the full range of reconstructed values as well as the sequences of flow are being used in the modeling (see section W.3.4.4.).

The low frequency (decadal to multidecadal) characteristics in the tree-ring based reconstructions, which represent long-term natural variability, may be exploited to project future flows. For example, Kwon et al. (2007) used spectral analysis to define dominant spectral peaks in reconstructions for southern Florida, and then extracted these using wavelet analysis. The spectral information was then combined with simulated flow projections based on the autocorrelation structure in the reconstructions to generate scenarios of future flows. This approach assumes that the underlying low frequency variability in the past flows will continue into the future, but as of yet, there is no reason to believe this is will not persist.

With regard to climate change projections, experiments that utilized tree-ring based reconstructions to run water supply models which are then altered to simulate warming are being performed (Smith et al. 2007). Incremental warming is added to test the ability of a water supply system to meet demands (in this case, the City of Boulder system). Increases are then compared to those projected for the region from range of general circulation models (GCMs). This approach utilizes the broader range of hydroclimatic variability that has occurred in the past and is likely to occur in the future, along with the certain increase in temperature due to the human-induced global warming. To date, models are not yet able to replicate regional precipitation very well, and model projections of the regional precipitation response to global warming are inconsistent. Consequently, combining the variability in the paleohydrologic records with the more certain future warming seems to be a productive approach for assessing possible future scenarios.

Seager et al. (2007) argue that model results indicate a consensus that a warmer climate will cause a general aridification of southwestern North America. Seager et al. hold that periodic droughts will still occur, precipitated by oscillations in climate conditions, but these will be perturbing a drier base state (See discussion in Section W.4.4.2). Seager et al.'s work provides support for using paleohydrologic reconstructions of streamflow as a proxy for the pattern of future inflows. Their notion that a drier base state will continue to be modulated by droughts caused by climate oscillations supports an assumption that the variability in streamflow captured by the paleohydrologic record can be used (with caution) as one proxy for the variability of future flows. Thus, an approach like the non-parametric paleo-conditioned method (NPC, described in Section W.3.4.2) could be adapted to synthesize streamflow data consistent with Seager et al.'s conclusions by scaling the flows to reflect the drier base state he projects will occur. Seager et al. estimate that precipitation minus evaporation (P-E) will decrease approximately 10% by the 2060-2080 timeframe. This is in the middle of the range of changes to streamflow projected by others, as summarized in Section W.5, and lends support to changes in streamflow of that magnitude.

U.9 Interannual/Interdecadal Climate Variability

There is an increasing awareness that in addition to gradual changes (long-term trends) in climate conditions, there is also a large degree of interannual and interdecadal variability in climate which may dominate the climate experienced in a basin in the short term (10-20 years in the future). This section describes the major modes of interannual/interdecadal variability, summarizes studies that have linked these to hydrologic variability in the Colorado River basin, and discuss the predictability of these phenomena.

U.9.1 Description of Major Modes of Climate Variability

The identification of major modes of interannual/interdecadal climate variability has been an ongoing area of research. Currently the NOAA Earth System Research Laboratory at (http://www.cdc.noaa.gov/ClimateIndices/List/) archives a wide range of climate indices representing oceanic and atmospheric variability. The major modes of interannual/interdecadal climate variability that have been investigated for possible linkages in the Colorado River Basin include the El Niño-Southern Oscillation (ENSO); the Pacific Decadal Oscillation (PDO); the Atlantic Multidecadal Oscillation (AMO); the Pacific North America, and the North Atlantic Oscillation (NAO). These phenomena have frequencies that vary from 2-80 years. Other climate indices may be significantly correlated with Colorado River Basin hydrology; however, there have not been studies to document these linkages.

ENSO is a contraction of names of two phenomena that were recognized to be different expressions of the same process: "El Niño" refers to anomalous strong warming of the surface waters of the eastern equatorial Pacific Ocean, while "Southern Oscillation" refers to concurrent changes in surface barometric pressure in the tropical Pacific. The ENSO phenomenon is now understood to span the equatorial Pacific and to have opposite phases with a 2-7 year periodicity, and with impacts that occur in many parts of the world. The warm phase of ENSO is called El Niño, while the cold phase is called La Niña (Philander 1990). Common indices used to describe ENSO conditions include the Southern Oscillation Index (SOI), equatorial Pacific sea surface temperatures (e.g., NINO12, NINO3), the Multivariate ENSO index (MEI), and the Oceanic Niño Index (ONI).

The **PDO** is a pattern of ocean variability in the North Pacific that is similar to ENSO in some respects, but has a much longer cycle (20 - 50 year) (Mantua et al., 1997, Mantua and Hare, 2002). Specifically, it is defined as the standardized difference between sea surface temperatures (SSTs) in the north-central Pacific and Gulf of Alaska.

The **AMO** is defined as the leading mode of low frequency, north Atlantic Ocean (0 to 70°N) sea surface temperature (SST) variability with a periodicity of 65 to 80 years (Kerr, 2000; Gray et al., 2003). Any linear trend in the data has been removed, so the time series represents a natural variability absent of long terms trend from global warming. Research has the AMO correlated with the number of tropical storms in the Atlantic and rainfall in Florida.

The **PNA** is one of the largest-scale ocean-atmosphere patterns that varies on seasonal, interannual, and interdecadal time scales. The PNA is a measure of atmospheric pressure anomalies at four locations in the northern hemisphere (Horel and Wallace 1981). The pressure near the Aleutian Islands and the southeastern U.S. have the same sign pressure anomaly, and the pressure near Hawaii and central Canada have the opposite sign pressure anomaly. The PNA index is a standardized measure of these pressure differences and is most pronounced in the winter and disappears in the summer months of June and July.

The **NAO** is an oscillation of pressure differences between the subtropical high pressure system located in the tropical Atlantic near the Azores and the subpolar low pressure system located near Iceland (Hurrell, 1995). The difference in surface pressure generally influences the surface winds and the steering of storms from west to east. The NAO has quasi-biennial and quasi-decadal periodicity (Hurrell and Van Loon, 1997).

U.9.2 Interannual/Interdecadal Signals in the Colorado River basin

The influence of interannual (e.g., ENSO) and interdecadal (e.g., PDO, AMO, NAO) variability on the hydrology of the Colorado River basin has been studied since the late 1980s. The linkages between these modes of variability and Colorado River Basin climate is a statistical relationships and the actual mechanisms still need to be understood.

A summary of the potential impacts are noted in Table U-7. First, the relationships between ENSO and western U.S. hydrology were studied by several researchers (e.g., Cayan and Peterson, 1989; Redmond and Koch, 1991; Cayan and Webb, 1992; Kayha and Dracup, 1993; Piechota and Dracup, 1996). In the Colorado River basin, El Niño events bring generally wetter conditions to the Lower Basin and La Niña events, drier conditions. The linkage of ENSO with conditions in the Upper Basin is not as clear. The wet/dry relationship does not hold true for all ENSO events and the strength of the event can influence the general relationship. For instance, the 1982/83 El Niño event was one of the strongest on record and much of the basin (upper and lower) experienced wet conditions. However, the recent 2002 El Niño event corresponded with dry conditions in much of the basin for 2002 and 2003. This was part of an ongoing drought that started in 2000.

Table U-7
Summary of Hydrologic Conditions During ENSO, PDO, AMO and NAO Phases
and Coupled Impacts for the Colorado River Basin

	ENSO Phase		PDO Phase		AMO Phase		NAO Phase	
	+	-	+	-	+	-	+	-
All Years	Dry	Wet	Wet	Dry	Dry	Wet		
El Niño (-)	--	--	Wet					
La Niña (+)	--	--		Dry	Dry	Wet	Wet	Dry
AMO +				Dry	--	--		
AMO -		Wet	Wet		--	--		

Blank boxes represent no significant impact to hydrologic conditions. Dashed boxes represent coupling that is not possible (e.g., AMO+ and AMO+)

More recently, researchers have investigated other oceanic/atmospheric phenomena such as the AMO, PDO, and NAO. The strongest relationships have been found with the AMO. When the AMO is in a positive phase, dry conditions were noted in the Colorado River basin, while the negative phase was associated with wet conditions (Enfield et al., 2001; McCabe et al., 2004; Hidalgo, 2004; Tootle et al., 2005; Hunter et al., 2006; McCabe et al., 2007). A weaker relationship is present between streamflow and the PDO. During the PDO positive phase, wet conditions occurred in the basin, and the negative phase had dry conditions (McCabe and Dettinger, 2002; Hidalgo and Dracup, 2003; McCabe et al., 2004; Hidalgo, 2004; Tootle et al., 2005; Hunter et al., 2006; and McCabe et al., 2007). A limitation in much of this research on AMO and PDO is that the analysis contains only 1-3 cycles of the multidecadal oscillations, so the confidence in the results is not as strong as ENSO studies. The use of paleoclimatic data may enhance the understanding of these multidecadal phenomena.

The coupled relationships between ENSO and the PDO, AMO, and NAO have also been evaluated. These studies focused on coupling the interannual variability present in ENSO with longer term (decadal) variability present in the PDO, AMO, and NAO. The coupling of ENSO and PDO has been shown to result in enhanced (diminished) wet conditions during El Niño events when PDO is positive (negative). Similarly, the dry conditions during La Niña are diminished (enhanced) when the PDO is positive (negative) (Gershunov and Barnett, 1998; Hidalgo and Dracup, 2003; Tootle et al., 2005; Hunter et al., 2006). However, Rajagopalan et al. (2000) examined the coupled effects of ENSO and PDO on summer season Palmer Drought Severity Index (PDSI) values for the U.S. and determined that PDO does not enhance (or dampen) ENSO's effect.

The coupling of ENSO and AMO has been studied by Tootle et al., (2005), and Hunter et al., (2006). During La Niña years with a positive AMO phase, dry conditions occurred in the basin. This could likely be enhancement of drought conditions since La Niña years and AMO positive years are both associated with dry conditions. During the La Niña years with a negative AMO phase, wet conditions were noted in the Upper Colorado River basin (Hunter et al., 2006). The reversing of La Niña impacts (dry) was also noted by Hunter et al., (2006) in SWE values during La Niña years that corresponded with NAO positive years. In addition, La Niña years associated with NAO negative years had dry conditions.

Lastly, AMO and PDO have been noted as possibly coupled and leading to enhanced or diminished impacts to hydrology. For instance, Hidalgo (2004), McCabe et al., (2004), and McCabe et al., (2007) found that dry conditions occurred during AMO + and PDO – phases. In addition, Hidalgo (2004) found that wet conditions occurred during AMO – and PDO + phases. This represents enhancement of wet or dry conditions when the PDO and AMO phases are opposite in sign.

A clear understanding of the dynamics behind the couplings between these circulation indices and between the indices and Colorado River basin climate is still lacking. More research is needed to better understand how these indices and the circulation features they describe impact the basin climate and hydrology.

U.9.3 Predictability of Intercadal/Interannual Variability

The increased research and develop of tools to predict phenomena such as ENSO, AMO, and PDO could lead to improved long-term forecasting of hydrologic conditions for the Colorado River basin. In general, the predictability of these phenomena are limited to 9-12 months in advance with decreasing skill as lead time increases. Currently, the National Weather Service (NWS) Climate Prediction Center (CPC) provides ENSO forecasts in the form of sea surface temperatures (SSTs) for the tropical Pacific up to nine (9) months in advance (http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/ensoforecast.shtml). This may assist in forecasting streamflow conditions in Lower Basin tributaries, but does not help in the forecasting of Upper Basin streamflow.

Currently, there are no publicly available tools available to forecast AMO and PDO conditions. However, researchers have noted that the PDO is a red noise process [i.e., the autocorrelation (or memory) is proportional to the size the anomaly] forced by ENSO, so the predictability of PDO would follow that of ENSO forecasts (Philip Mote, personal communication, 2007). The potential for predicting the AMO may be more promising. Griffies and Bryan (1997) and Collins and Sinha (2003) have noted that Atlantic SSTs and the thermohaline circulation have potential predictability of one to two decades into the future.

It is also important to highlight the usefulness of interannual/interdecadal variations on water resources planning with a 20-year planning horizon. The ability of a phenomenon such as AMO to persist for 10-20 years suggests that in the short term, these phases should be closely watched and corresponding hydrologic impacts evaluated. This could be just as important as evaluating the impacts of climate change that may not really be noticed in the basin for 20-50 years.

U.9.4 Relevance to Hydrologic Scenarios for Planning

As noted earlier, the hydrologic scenarios used by Reclamation for planning over a 20-50 year time period include historical streamflow data from 1906 to the present and reconstructed streamflow data from about 1500 to the present. These scenarios include all years of data and encompass all phases of ENSO, AMO and PDO. In this section, the potential of using the phase of ENSO, AMO, or PDO is demonstrated for developing hydrologic scenarios.

Figure U-28 presents the average streamflow conditions at Lees Ferry during the different phases of AMO from 1906 to the present. Evaluating the average conditions during each phase (as represented by the box plots), there appears to be a shift in the monthly streamflow values where flows are higher during an AMO negative phase and lower during an AMO positive phase. These differences are further demonstrated in Figure U-29 where the historical traces of streamflow (light gray lines) during AMO positive and AMO negative phases are presented along with the long-term monthly average (dark line). These are hydrologic scenarios that could be used for long-range outlooks for streamflow.

Lastly, the relative change in streamflow conditions during the various phases of ENSO, PDO, and AMO are important to note in the context of projected changes in streamflow under climate change scenarios. Figure U-29 presents the distribution of the median streamflow for the Upper and Lower basins during the positive and negative phases of ENSO, PDO, and AMO, along with the projected changes in streamflow for the period 2010-2039 based on output from 11 climate models and 2 different climate change scenarios (Christensen and Lettenmaier, 2006). It is noteworthy that the changes in streamflow corresponding to interannual and interdecadal climate phenomenon is comparable (if not larger) than the projected changes in streamflow under climate change scenarios.

Figure U-28
Monthly Streamflow at Lees Ferry for AMO + and AMO – Phases from 1906 to the Present

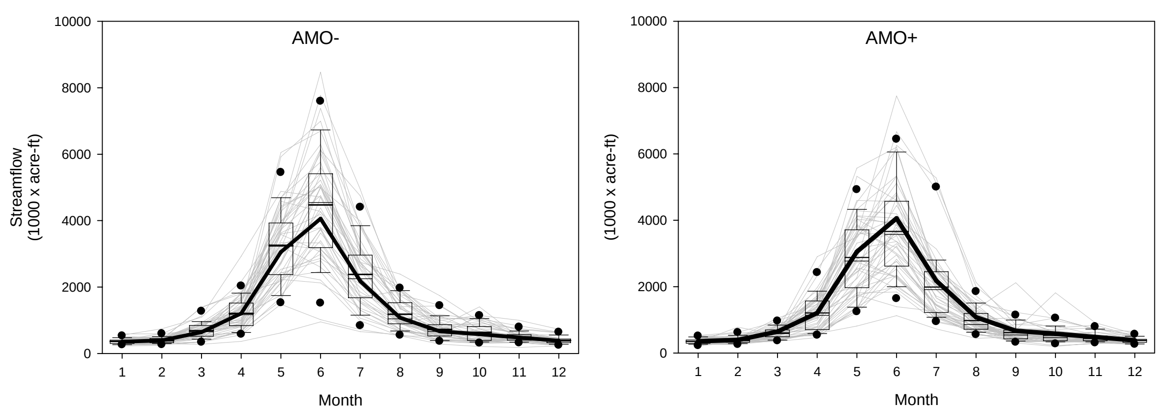
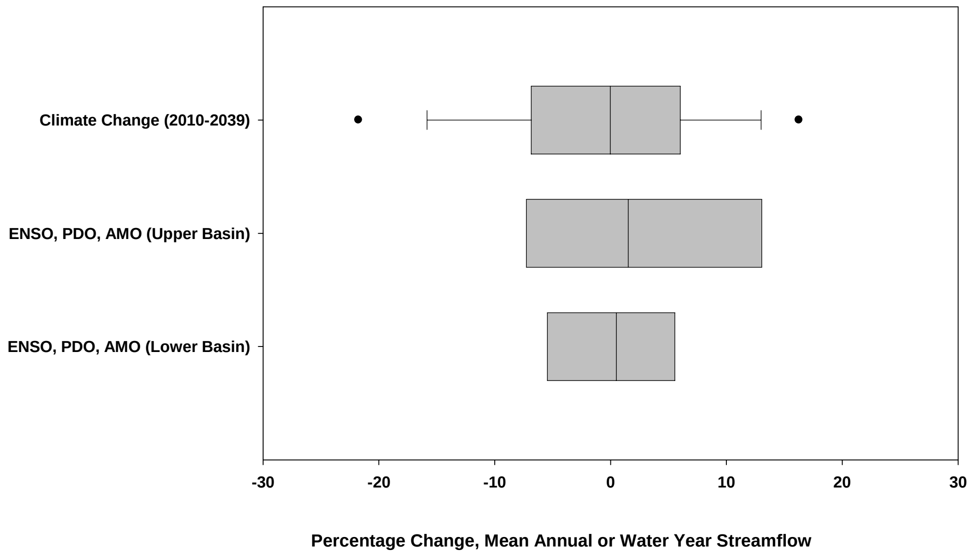


Figure U-29
Box-and-Whisker Distributions of 2010-39 Runoff Change Relative to Historical (1950-1999) Corresponding to Various Climate Change Scenarios



The whiskers represent the 10th and 90th percentiles, the box represents the 25th and 75th percentiles, and the dots represent the outliers. In addition, distributions are provided of the runoff change during all phases (+ and -) of ENSO, PDO, and AMO for the Upper and Lower Colorado River Basin

U.10 Summary of Analysis Options and Future Needs

The information presented in this report highlight several important areas where Reclamation may use past and future climate information in the planning of water resources for the Colorado River basin.

U.10.1 Summary Points

- Climate models project that temperatures will increase globally by 1 to 2ºC in the next 20-60 years. The projections are fairly consistent for the next 20 years with a 1ºC increase, with larger uncertainty in the 40-year projections. The downscaling of global temperature increase to Colorado River Basin (CRB) climate change is less certain; however, it is expected that regional temperatures will also increase. Regional precipitation response is even less certain with comparable evidence suggesting wetter or drier conditions.

- The potential impacts of climate change on the CRB's water resources have been a subject of research for several decades. Initial studies related assumed regional climate change to region runoff response. Recent studies have been refined in several ways, including (a) how assumed climate changes are derived from global climate projections produced by various GCM simulations that reflect a range of global climate forcing scenarios, (b) how GCM output is bias-corrected and downscaled, and (c) how this output translated into region runoff response. Various analytical design options are represented by the survey of studies referenced in Section W.5 (Table U-3). Although an aggregate message from these studies may be that the *typical runoff response averaged across climate projections* spanning wetter to drier and less-warming to more-warming conditions is generally a mean annual decrease, the *range of runoff response across these same scenarios* is considerably broader and varies from increase to decrease. Note that due to advances in knowledge, technical abilities, and other factors, not all past studies retain the same significance today.

- Studies highlighted in Section W.5 show that system storage is very sensitive to changes in mean inflows as well as sequences of dry and wet years. This highlights the importance of properly investigating changes in both mean and variability in analyses of future system operations.

- Studies considered in Table U-3 feature varied treatment of projected climate *variability*, ranging from earlier studies where variability change was essentially not considered to more recent studies where GCM transient climatic conditions, bias-corrected or not, are used as input to the runoff response analysis. The significance of projected "change in climate variability" and its interaction with "change in climate norms" remains a question for research and affects ability to evaluate projected runoff uncertainty in the CRB.

- Paleoclimatic information suggests that long term average of natural flows from the upper CRB is 13.0 to 14.7 maf, compared to the gage record average of 15.2 maf. The paleoclimatic information may not necessarily represent future climate scenarios, but could be useful in framing assumed variability in future planning hydrologic sequences, with or without the joint consideration of future climate change. In particular, paleoclimate information offers evidence on drought spell potential beyond what has been experienced during the instrumental record, indicating a broader range of drought possibilities for the future.

- Interannual/interdecadal oscillation phenomena such as ENSO, PDO and/or AMO are *very significant* in the context of water resources planning within a 10- to 20-year horizon because such oscillations can persist in a given phase for a decade or longer. Evaluating the state of these oscillations and understanding their forcing mechanisms may be more important than evaluating impacts of projected climate change within a 10- to 20-year horizon.

U.10.2 Recommendations for Planning Studies

U.10.2.1 Shorter Look-Ahead Studies

For studies and management decisions involving shorter look-ahead horizons (e.g., less than 20 years), an appropriate level of analysis might involve a qualitative discussion of climate change and how interannual to decadal variability during the study's look-ahead horizon could be a more significant uncertainty than that associated with near-term projected climate change. This decision would be based on the limited projected change in climate trends over the near term and general inability to predict phase shifts in the interdecadal oscillations (e.g., AMO, PDO, etc.) that might overwhelm the trend signal during the same period. (See Figure U-29). Alternatively, if the role of shorter-term climate is critical to the study, the proposed qualitative discussion might be accompanied by a quantitative sensitivity analysis, where a range and distribution of 10- to 20-year hydrologic conditions are estimated based on instrumental record and paleoclimate evidence (in terms of mean, variance, and sequence; perhaps conditioned by understood relations with climate oscillations) and subsequently related to operations during the same look-ahead horizon.

U.10.2.2 Longer Look-Ahead Studies completed during the Near-Term

For studies and decisions concerned with greater than 20-year look-aheads and being evaluated on the near-term, it is suggested that a quantitative sensitivity analysis be conducted on operations response to projected climate change. By comparing system performance using projected climate change hydrology to historical hydrology, useful knowledge about system sensitivity should be ascertained. Given Reclamation's current limited ability to easily simulate runoff response to climate change in the CRB, which are highlighted in Section W.9.3, near-term studies should be framed using existing projections of climate and related runoff response. For such studies addressed during the near-term, scoping of sensitivity analysis should begin with a focused consideration of available literature. Rather than try to frame the analysis on all climate change and runoff impacts studies that have been conducted for the CRB (e.g., representing all studies listed in Table U-3), it is recommended that the criteria listed in Section W.6.5 be considered when reviewing available information.

U.10.2.3 Longer Look-Ahead Studies initiated beyond the Near-Term

Recommendations from section W.9.2.1 and Section W.6.5 are still relevant for studies that may be scoped beyond the near-term. However, we recommend that research and development be pursued as described in section W.9.3 to improve Reclamation's ability to consider and incorporate climate change information in future CRB studies. Some of the research and development can be pursued in-house, but much will need the broader assistance of scientists and engineers from the research and consulting communities.

U.10.3 Recommendations for Research and Development

- **Improved Availability and Temporal Resolution of Regional Climate Projection Datasets.** Currently, there is limited access to bias-corrected and downscaled climate projection datasets over the Colorado River basin. For example, there are more than 140 archived IPCC AR4, SRES A2, A1b, and B1 projections archived at LLNL PCMDI, compared to the 22 SRES A2 and B1 projections considered in Christensen and Lettenmaier (2006). Bias-correction and spatial downscaling procedures should be applied to the raw GCM outputs before they can be used to support regional to local hydrologic and water management impacts studies (see criteria in Section W.6.5)[9]. An archive of such data should be made available to researchers and the public. In addition, as dynamically downscaled datasets become available, these datasets should be added to the archive. Reclamation should encourage PCMDI and others to make daily and potentially sub-daily data available rather than the current monthly data which requires an additional and unnecessary temporal downscaling step for many hydrologic models.

- **Improved Ability to Model Runoff Under Climate Change.** Currently there are only a few runoff models available to generate CRB natural flow given climate inputs and Reclamation does not have easy access to these models. Reclamation needs to build internal staff expertise with available runoff model applications in the basin, and build coalitions with external groups that use such applications (e.g., working with groups familiar with UW's VIC hydrologic model, or NWSRFS). Ideally, such runoff applications would also report other hydrologic processes' response to climate change (e.g., soil moisture, evapotranspiration, groundwater interactions with surface water), which might involve development of applications that involve coupling of rainfall-runoff (e.g., NWSRFS) or land-surface model applications (e.g., VIC) with groundwater models (e.g., ModFlow). Several analytical designs (Section W.6.4) involve statistical methods that do not require runoff simulation. These methods should also be investigated by Reclamation.

- **Investigate Paradigm for Colorado River basin Precipitation Response.** While there is an evolving paradigm for how the American Southwest and other existing dry subtropical areas of the globe should respond to climate change, it is not clear how nearby relatively wet mountainous areas such as the Rockies should respond. In addition, the ability of GCMs to simulate future precipitation conditions at this spatial scale is questionable. Both the lack of a paradigm and current modeling capabilities constrain assumptions about future precipitation over the basin, and necessitate probabilistic or scenario-based approaches that explicitly recognize these uncertainties, to the extent that they might be quantified.

- **Diagnose and Improve Existing Climate Models Before Adding Additional Features.** Given known GCM limitations in simulating regional precipitation, climate research groups should focus a portion of their efforts on diagnosing and correcting biases in the current collection of IPCC AR4 AOGCMs, even though such efforts would compete for human and computational resources currently reserved for the development of new "Earth System Models" (i.e. ESMs, or AOGCMs modified to include interactive

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[9] As of Summer 2007, Reclamation has begun working with research collaborators at Lawrence Livermore National Laboratory and Santa Clara University to produce an archive of bias-corrected and downscaled IPCC AR4 climate projections. The objective is to produce archived datasets featuring monthly 20th to 21st century time-series of surface air temperature and precipitation at eighth degree spatial resolution, and with geographic coverage spanning the contiguous United States (i.e. encompassing all of Reclamation's service areas). Bias-correction and downscaling procedures are being implemented using methods featured in Maurer (2007) and Christensen and Lettenmaier (2006). This effort may partially fulfill this need, but it is uncertain.

carbon cycle, chemistry, computed aerosols, and dynamic vegetation.)[10]. There is evidence that systematic errors in AR4 AOGCMs would still be present after coupling with additional ESM components and hence waiting for ESM models to solve existing problems is unlikely to be entirely satisfactory.

- **Investigate Changes in Modeled Climate Variability at Multiple Time Scales.** It is well appreciated that the Colorado River is sensitive to changes in mean flow. However, variability as represented by drought spells, wet refill periods, and extended decadal and longer periods of above and below average flow are also critical for determining system yield. Therefore, investigation of such variability in modeled sequences of precipitation, runoff and other climatic variables is critical. While future variability may not be similar to past variability, the variability in models should be characterized and explained both in the context of the historical record and the paleo record. In addition, the ability of the current generation of GCMs and the hydrology models to reproduce the historical variability of the CRB has not been studied.

- **Improve Understanding of Surface water, Groundwater and Land cover Interaction.** Because rivers and groundwater are intimately connected, understanding the entire recharge process and its response to climate change is critical. Hence, research is required on groundwater recharge and movement at scales relevant to regional runoff analysis, and this in turn requires understanding the aggregate process of mountain block recharge and the role of riparian and root zone vegetation. The latter leads to additional research questions on how basin land cover and natural evapotranspirative demand will respond to global climate change (Section W.6.3).

- **Improve Prediction of Interdecadal Oscillations.** The predictability of interdecadal climate oscillation phases (e.g., AMO, PDO) and their associated hydrologic impacts on the Colorado River basin are not well understood. Shorter-term planning may be more influenced by phase persistence and transition among these oscillations than by projected changes in climate means. Reclamation should actively support, either materially or otherwise (i.e., through partnerships and inter- or extra-agency interactions), efforts in the science and the applications community to advance knowledge in this area (i.e., 2- to 10-year climate prediction research).

- **Investigate use of Paleo Record to Inform Modeled Streamflow Variability.** Reclamation has funded some paleo-climate research on how to use information from the paleoclimate record in modeling studies. While the past will not repeat, the paleo record contains a wealth of information on natural variability that should not be ignored. For example, there may be valuable ways of combining paleo data with modeled and or historical data to modify the variability in these sequences in useful ways.

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[10] (Jerry Meehl, 16 February 2007, presentation comments at WGNE/PCMDI Systematic Errors Workshop, 12-16 February 2007, San Francisco, CA; P. Chris Milly, 31 May 2007, personal communication)

- **Interact with Federal Climate Change Science Program and other Climate Change Research Initiatives.** Although Reclamation can pursue and fund some of the Research and Development work described above, many of these problems will require the assistance of the larger scientific and engineering community. The Department of the Interior is one of thirteen agency members of the approximately $2 billion per year federal Climate Change Science Program, the umbrella under which all federal climate change activity is pursued. In order to raise the profile of these issues and obtain resources to help solve them, Reclamation should engage the CCSP. In addition, Reclamation should collaborate with NOAA, the National Center for Atmospheric Research, and the University research community.

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Attachment 1: Climate Technical Workgroup

Invited Climate Scientists

Balaji Rajagopalan, University of Colorado/CIRES/WWA
Marty Hoerling, NOAA
David Yates, NCAR.
Claudi Tebaldi, NCAR
Kelly Redmond, Desert Research Institute.
Jonathan Overpeck, University of Arizona
Dan Cayan, Scripps Institute of Oceanography
Kevin Trenberth, NCAR
Dennis Lettenmaier, University of Washington
Tom Piechota, University of Nevada, Las Vegas
Randall Dole, NOAA
Phil Mote, University of Washington

Climate Meeting (November 8, 2006) Attendees

Climate Scientists
Balaji Rajagopalan
Marty Hoerling
David Yates
Kelly Redmond
Tom Piechota
Randall Dole

USBR
Terry Fulp
Nan Yoder
Levi Brekke
John Redlinger
Paul Miller
Amber Cunningham
Jim Prairie
Chris Cutler
Don Frevert

USBR Contractors
Ruben Zubia
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Levi Brekke, USBR
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David Yates, NCAR
Tom Piechota, University of Nevada, Las Vegas
Ben Harding, Hydrosphere
Connie Woodhouse, University of Arizona

Attachment 2: Glossary of Terms

Abrupt climate change: The nonlinearity of the climate system may lead to abrupt climate change, sometimes called rapid climate change, abrupt events or even surprises. The term abrupt often refers to time scales faster than the typical time scale of the responsible forcing. However, not all abrupt climate changes need be externally forced. Some possible abrupt events that have been proposed include a dramatic reorganization of the thermohaline circulation, rapid deglaciation and massive melting of permafrost or increases in soil respiration leading to fast changes in the carbon cycle. Others may be truly unexpected, resulting from a strong, rapidly changing forcing of a nonlinear system.

Atlantic Multi-Decadal Oscillation (AMO): The Atlantic Multi-Decadal Oscillation (AMO) is defined as the leading mode of low frequency, North Atlantic Ocean (0 to 70o) sea surface temperature (SST) variability with a periodicity of 65 to 80 years.

Analogue (or Analogs): Two observed states of the atmosphere that are very close by some measure, also applies to states of a model. Formal measures of closeness include anomaly correlation, root-mean-square distance, and covariance. Usually one expects analogs to occur only during the same time of year. Atmospheric analogs that are close compared to current levels of observational error are unlikely to be found unless one studies a single variable confined to a very small area, or otherwise reduced the degrees of freedom to a very small number.

Anthropogenic: Resulting from or produced by human beings.

Anthropogenic forcing: *Radiative* forcing resulting from or produced by human beings.

Atmosphere-Ocean General Circulation Model (AOGCM): Coupled Atmosphere-Ocean General Circulation Models (AOGCMs) provide a representation of the climate system that is near the most comprehensive end of the spectrum currently available. These models simulate atmosphere and ocean circulation and their interactions with each other, land, and cryospheric processes. Simulations are forced by several factors, including time series assumptions on atmospheric greenhouse gas and aerosol concentrations.

Baseflow: The sustained low flow of a stream, usually groundwater inflow to the stream channel.

Beneficial use: A use of water resulting in appreciable gain or benefit to the user, consistent with state law, which varies from one state to another.

Climate: Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. It is typically characterized in terms of suitable averages of the climate system over periods of a month or more, taking into consideration the variability in time of these averaged quantities. The relevant quantities are most often surface variables such as temperature, precipitation and wind.

Climatic classifications include the spatial variation of these time-averaged variables. Climate in a wider sense is the state, including a statistical description, of the climate system. Beginning with the view of local climate as little more than the annual course of long-term averages of surface temperature and precipitation, the concept of climate had broadened and evolved in recent decades in response to the increased understanding of the underlying processes that determine climate and its variability.

Climate change: Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. See also *Climate variability*.

Climate Model: A numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for all or some of its known properties. The climate system can be represented by models of varying complexity, that is, for any one component or combination of components a spectrum or hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical or biological processes are explicitly represented, or the level at which empirical parameterizations are involved. Climate models are applied as a research tool to study and simulate the climate, and for operational purposes, including monthly, seasonal and interannual climate predictions.

Climate variability: Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or *anthropogenic* or external *forcing* (external variability). See also *Climate change*.

Colorado River basin: The drainage basin of the Colorado River in the United States. The Colorado River watershed area encompasses over 246,000 square miles and is a primary water supply for residents in seven states including Colorado, Utah, Wyoming, New Mexico, Arizona, Nevada, and California.

Colorado River Compact: The Colorado River Compact is a 1922 agreement among seven U.S. states in the basin of the Colorado River in the American Southwest governing the allocation of the river's water. The compact divides the river basin into two areas, the Upper Basin (comprising Colorado, New Mexico, Utah and Wyoming) and the Lower Basin (Nevada, Arizona and California). The compact requires the Upper Basin states to deliver water at a rate of 7.5 million acre feet per year averaged over a moving ten-year average.

Colorado River Simulation System (CRSS): An operational model of the Colorado River system based on a monthly timestep. CRSS is a simulation model consisting of a database and a modeling code. The database describes the physical configuration of the natural and man-made features of the Colorado River system, the operating rules for the man-made features, the natural gains and losses of water that enter and leave the system, and the water used by or requested for use for human activities. The modeling code simulates the physical processes and institutional drivers that determine the system conditions, according to the data contained in the database.

Compact deliveries: Water allocations, diversions, and deliveries mandated under the Colorado River Compact of 1922.

Confidence: The level of confidence in the correctness of a result is expressed using probability confidence intervals.

Decadal: Occurring over a 10-year period.

Dendrochronology: The analysis of the annual growth rings of trees, leading to the calculation of significant indices of climate and general chronology of the past. The width of a tree-ring is determined by the temperature and/or moisture that prevailed during the year of its formation. Since stress from temperature and/or moisture variations reduces the width of the seasonal growth of a tree ring, dendrochronology has important application in the study of long-term climatic variations.

Domestic use: Also called residential water use or domestic withdrawals. Water used for household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and water lawns and gardens. The water may be obtained from a public supply or may be self-supplied.

Direct Natural Flow Record (DNF): The Index Sequential Method (ISM) applied to the 1906 to 2004 Colorado River natural flow record.

Downscaling techniques: Techniques to generate climate scenarios at a point or watershed based on climate scenarios produced by global climate models at a larger spatial scale.

> **Bias-correction:** Simulations or forecasts of climate from dynamical models do not always correspond to reality (i.e., observations), thus, resulting in 'bias'. There are statistical methods to correct this and often referred to as 'bias correction' tools. Typically, they involve fitting a statistical model between the dynamical model simulations and the observations over a period. The fitted regression is used to correct future model simulations.
>
> **Disaggregation:** Breaking down a single indicator into subgroups variables. In section W.4 of this report, disaggregation is the second component of a downscaling technique where 2-degree lat-long climate projections are disaggregated into 1/8 degree projection data; and the second method, streamflow at an aggregate gauge (usually a gauge at the downstream) is disaggregated (or split) to flows at several upstream gauges - such that

the disaggregated flows add up to the flow at the aggregate gauge.(This enables the simulation of flow scenarios at all the required gauges in a parsimonious manner).

Drought: A period of abnormally dry weather sufficiently long enough to cause a serious hydrological imbalance. Drought is a relative term; therefore any discussion in terms or precipitation deficit must refer to the particular precipitation-related activity on a regional or continental scale.

Earth System Model (ESM): Models based on AOGCM (with various levels of simplification) that also include interactive carbon cycle, chemistry, computed aerosols, and dynamic vegetation. Earth System Models of Intermediate Complexity (EMIC) are discussed in the IPCC AR4 report from Working Group I, and are described as "reduced-resolution models that incorporate most of the processes represented by AOGCMs, albeit in a more parameterized form. They explicitly simulate the interactions between various components of the climate system. Similar to AOGCMs, but in contrast to simple climate models, the number of degrees of freedom of an EMIC exceeds the number of adjustable parameters by several orders of magnitude. ... like simple climate models, EMICs can explore the parameter space with some completeness and are thus appropriate for assessing uncertainty."

Empirical: Relying upon or derived from observation or experiment; Based on experimental data, not on a theory.

ENSO: A contraction of names of two phenomena that were recognized to be different expressions of the same process: “El Niño” refers to anomalous strong warming of the surface waters of the eastern equatorial Pacific Ocean, while “Southern Oscillation” refers to concurrent changes in surface barometric pressure in the tropical Pacific. The ENSO phenomenon is now understood to span the equatorial Pacific and to have opposite phases with a 2-7 year periodicity, and with impacts that occur in various parts of the world. The warm phase of ENSO is called El Niño, while the cold phase is called La Niña (Philander 1990). Common indices used to describe ENSO conditions include the Southern Oscillation Index (SOI), equatorial Pacific sea surface temperatures (e.g., NINO12, NINO3) and the Multivariate ENSO index (MEI).

Evapotranspiration: 1. The combined process through which water is transferred to the atmosphere from open water and ice surfaces, bare soil, and vegetation that make up the earth’s surface. 2. (Also called flyoff, water loss, total evaporation.) The total amount of water transferred from the earth to the atmosphere. This is the most general term for the result of this composite process; duty of water and consumptive use has more specific applications.

General Circulation Models (GCMs): *see climate model*.

Green house gases: Those gases, such as water vapor, carbon dioxide, ozone, methane, nitrous oxide, and chlorofluorocarbons, that are fairly transparent to the short wavelengths of solar radiation but efficient at absorbing the lower wavelengths of the infrared radiation emitted by the earth and atmosphere. The trapping of heat by these gases controls the earth’s surface temperature despite their presence in only trace concentrations in the atmosphere. Anthropogenic emissions are important additional sources for all except water vapor. Water vapor, the most important greenhouse gas, is thought to increases in concentration in response to increased concentrations of the other greenhouse gases as a result of feedbacks in the climate system.

Groundwater: Subsurface water that occupies the zone of saturation; thus, only the water below the water table, as distinguished from interflow and soil moisture.

Hydro-Climate Data Network (HCDN): USGS streamgages minimally affected by anthropogenic regulation or effects with sufficient periods of record.

Hydrology: The scientific study of the waters of the earth, especially with relation to the effects of precipitation and evaporation upon the occurrence and character of water in streams, lakes, and on or below the land surface.

Impaired inflows: In contrast to natural flows, these are reservoir or water system inflows affected by an upstream combination of natural runoff, human use, diversion, management, and/or allocation.

Indexed Sequential Method (ISM): A block bootstrap approach to resample a historic streamflow record. ISM cycles through each year in the natural flow record and extracts a sequence of flows beginning at that year and extending through the desired scenario length.

Inflow points: A specific location in which water flows into a body of water expressed in acre-feet per day or cubic feet per second.

Interim: Belonging to, serving during, or taking place during an intermediate interval of time; temporary: an interim agreement.

Interim shortage agreement: An interim shortage agreement in the context of this report is temporary operational guidelines for coordinated operation of Lakes Powell and Mead during times of shortage on the Colorado River.

Interpolation: The estimation of unknown intermediate values from known discrete values of a dependent variable.

IPCC: The Intergovernmental Panel on Climate Change (IPCC) established by World Meteorological Organization (WMO) and United Nations Environmental Programme (UNEP) provides an assessment of the state of knowledge on climate change based on peer-reviewed and published scientific/technical literature in regular time intervals.

IPCC Fourth Assessment Report: The Fourth Assessment Report "Climate Change 2007", also referred to as AR4 is a series of reports by the IPCC and provides an assessment of the current state of knowledge on climate change including the scientific aspects of climate change, impacts and vulnerabilities of human, natural, and managed systems, and adaptation and mitigation strategies.

Jet stream: Relatively strong winds concentrated within a narrow stream in the atmosphere. While this term may be applied to any such stream regards of direction (including vertical), it is coming more and more to mean only a quasi-horizontal jet stream of maximum winds embedded in the midlatitude westerlies, and concentrated in the high troposphere. Currently, in the analysis of upper-level charts, a jet stream is indicated wherever it is reliably determined that the wind speed equals or exceeds 50 knots.

Law of the River: The water law and appropriation requirements on the Colorado River mainstem and its tributaries.

Lees Ferry: A reference point in the Colorado River 1 mile below the mouth of the Paria River in Arizona which marks the Upper/Lower Colorado River Basins. Lees Ferry is the site of the USGS stream gage above the Paria River confluence.

Linear regression: Method dealing with a straight-line relationship between variables. It is in the form of y = a + bx, whereas nonlinear regression involves curvilinear relationships such as exponential and quadratic functions.

Long-wave radiation: In meteorology, a term used loosely to distinguish radiation at wavelengths longer than about 4 µm, usually of terrestrial origin, from those at shorter wavelengths (shortwave radiation), usually of solar origin.

Lower Basin: The part of the Colorado River watershed below Lees Ferry, Arizona; covers parts of Arizona, California, Nevada, New Mexico and Utah.

Million acre-feet (maf). The volume of water that would cover 1 million acres to a depth of 1 foot.

North Atlantic Oscillation (NAO): NAO is an oscillation of pressure differences between the subtropical high-pressure system located in the tropical Atlantic near the Azores and the subpolar low-pressure system located near Iceland (Hurrell, 1995). The difference in surface pressure generally influences the surface winds and the steering of storms from west to east. The NAO has quasi-biennial and quasi-decadal periodicity (Hurrell and Van Loon, 1997).

National Environmental Policy Act (NEPA): The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS). EPA reviews and comments on EISs prepared by other federal agencies, maintain a national filing system for all EISs, and assures that its own actions comply with NEPA.

Natural inflows: Inflows absent of any human use, diversion, management, or allocation; also called virgin flows.

Nonparametric: Problems for which a distribution curve cannot be drawn, either because the parameters of the equation are not known, or because there is no equation at all.

North American Monsoon: The North American monsoon (NA monsoon), variously known as the Southwest United States monsoon, the Mexican monsoon, or the Arizona monsoon, is experienced as a pronounced increase in rainfall from an extremely dry June to a rainy July over large areas of the southwestern United States and northwestern Mexico. These summer rains typically last until mid-September when a drier regime is reestablished over the region. Geographically, the NA monsoon precipitation region is centered over the Sierra Madre Occidental in the Mexican states of Sinaloa, Durango, Sonora and Chihuahua. The regime extends northward into the Arizona, New Mexico and Colorado. Typically, the NA Monsoon region is defined by sites that receive at least 50% of its annual precipitation in July, August and September.

Outflows: The amount of water passing a given point downstream of a structure, expressed in acre-feet per day or cubic feet per second. Water flowing out of a body of water.

Paleo-climate (or “Paleo”): Climate for periods prior to the development of measuring instruments, including historic and geologic time, for which only proxy climate records are available. (Paleoclimatolgoy: The study of past climate throughout geologic and historic time (paleoclimates), and the causes of their variations.

Paleo streamflow reconstruction: Using analyses from tree-ring reconstructions, streamflow volumes prior to the gage record can be estimated using a statistical model, which captures the relationship between tree growth and the gage record during their period of overlap. Then, this model is applied to the tree-ring data for the period prior to the gage record.

Palmer Drought Severity Index (PDSI): An index formulated by Palmer (1965) that compares the actual amount of precipitation received in an area during a specified period with the normal or average amount expected during that same period. The PDSI is based on a procedure of hydrologic or water balance account by which excesses or deficiencies in moisture are determined in relation to average climatic values. Values taken into account in the calculation of the index include precipitation, potential and actual evapotranspiration, infiltration, of water into a given soil zone, and runoff. This index builds on Thornthwaite’s work (1931, 1948), adding 1) soil depth zones to better represent regional change in soil water-holding capacity; and 2) movement between soil zones and, hence, plant moisture stress, that is, too wet or too dry.

Parts per million, ppm: Parts per million ("ppm") denotes one particle of a given substance for every 999,999 other particles.

Pacific Decadal Oscillation (PDO): The Pacific Decadal Oscillation (PDO) is a pattern of ocean variability in the North Pacific that is similar to ENSO in some respects, but has a much longer cycle (20 - 50 year) (Mantua et al., 1997, Mantua and Hare, 2002). Specifically, it is defined as the standardized difference between sea surface temperatures (SSTs) in the north-central Pacific and Gulf of Alaska.

Pacific North American pattern (PNA): The Pacific North America pattern (PNA) is one of the largest-scale ocean-atmosphere patterns that vary on seasonal, interannual, and interdecadal time scales. The PNA is a measure of atmospheric pressure anomalies at four locations in the northern hemisphere (Horel and Wallace 1981). The pressure near the Aleutian Islands and the southeastern U.S. have the same sign pressure anomaly, and the pressure near Hawaii and central Canada have the opposite sign pressure anomaly. The PNA index is a standardized measure of these pressure differences and is most pronounced in the winter and disappears in the summer months of June and July.

Present Perfected Rights: A water right to which the owner has applied for and obtained a permit, has complied with the conditions of the permit, and has obtained a license or certificate of appropriation. In the context of the Colorado River Compact (Compact), under Article VIII, "present perfected rights" refers to established beneficial use water rights prior to the Compact that will not be impaired.

Climate Projection: A projection of the response of the climate system to emission or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Climate projections are distinguished from climate predictions in order to emphasize that climate projections depend upon the emission/concentration/ radiative forcing scenario used, which are based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized and are therefore subject to substantial uncertainty.

Quantile: A generic term for any fraction that divides a collection of observations arranged in order of magnitude into two specific parts.

Return flows: The water that reaches a ground or surface water source after release from the point of use and thus becomes available for further use; water that re-enters the water system used further downstream.

Radiative forcing: In radiation, the net flux of radiation into or out of a system. As a consequence of radiative forcing there must be some change to the nonradiative energy states of the system (e.g., its temperature may change).

Rim inflows: Flows at the upper most gauges of tributaries and also the main stem.

Riparian: Of, on, or pertaining to the bank of a river, pond, or lake.

Scenario (Climate Scenario): A plausible and often simplified description of how the future may develop based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined with a narrative storyline.

Shortage: In a given watershed, a water supply deficit attributed to below average streamflow volumes due to natural or managerial attributions.

SNOTEL: Abbreviation for SNOwpack TELemetry. A west-wide system for obtaining snow water equivalent, precipitation, air temperature, and other hydrologic measurements from remote data sites via radio transmission.

SNOW17 snowmelt model: The SNOU-17 model is one of operations available in the National Weather Service River Forecast System (NWSRFS). It is a conceptual model in which each of the significant physical processes affecting snow accumulation and snowmelt is mathematically represented. The model uses air temperature as the sole index to energy exchange across the snoU-air interface and was developed to run in conjunction with a rainfall-runoff model. Developed by Anderson, (1973), (1976).

SnoU-water equivalent (SWE): The amount of water contained within the snowpack. It can be thought of as the depth of water that would theoretically result if you melted the entire snowpack instantaneously.

SRES scenarios: SRES scenarios are emission scenarios developed by Nakićenović and Swart (2000) and used, among others, as a basis for some of the climate projections shown in Chapter 10 of this report. The following terms are relevant for a better understanding of the structure and use of the set of SRES scenarios:

> **Scenario family:** Scenarios that have a similar demographic, societal, economic and technical change storyline. Four scenario families comprise the SRES scenario set: A1, A2, B1 and B2.
>
> **Illustrative Scenario:** A scenario that is illustrative for each of the six scenario groups reflected in the Summary for Policymakers of Nakićenović and Swart (2000). They include four revised scenario markers for the scenario groups A1B, A2, B1, B2, and two additional scenarios for the A1FI and A1T groups. All scenario groups are equally sound.
>
> **Marker Scenario:** A scenario that was originally posted in draft form on the SRES website to represent a given scenario family. The choice of markers was based on which of the initial quantifications best reflected the storyline, and the features of specific models. Markers are no more likely than other scenarios, but are considered by the SRES writing team as illustrative of a particular storyline. They are included in revised form in Nakićenović and Swart (2000). These scenarios received the closest scrutiny of the entire writing team and via the SRES open process. Scenarios were also selected to illustrate the other two scenario groups.
>
> **Storyline:** A narrative description of a scenario (or family of scenarios), highlighting the main scenario characteristics, relationships between key driving forces and the dynamics of their evolution.

Static: Fixed; stationary.

Stochastic hydrology: The science that pertains to the probabilistic description and modeling of the value of hydrologic phenomena, particularly the dynamic behavior and the statistical analysis of records of such phenomena.

Storage: The retention of water or delay of runoff either by planned operation, as in a reservoir, or by temporary filling of overflow areas, as in the progression of a flood wave through a natural stream channel.

r2: Statistical measure of how well a regression line approximates real data points; an r-squared of 1.0 (100%) indicates a perfect fit.

Temporal: Of, relating to, or limited by time, i.e. temporal boundaries.

Trajectories: see projection

Trigger: Procedure that is automatically executed in response to certain threshold events; event-driven programming.

Upper Basin: The part of the Colorado River watershed above Lees Ferry, Arizona; that covers parts of Arizona, Colorado, New Mexico, Utah and Wyoming.

Variable Infiltration Capacity (VIC) Model: VIC is a macroscale hydrologic model that solves full water and energy balances. VIC is a research model and in its various forms it has been applied to many watersheds including the Columbia River, the Ohio River, the Arkansas-Red Rivers, and the Upper Mississippi Rivers, as well as being applied globally.

Water balance (Water budget): An analytical tool whereby the sum of the system inflows equals the sum of the system outflows. A summation of inputs, outputs, and net changes to a particular water resource system over a fixed period.

Watershed: All the land and water within the confines of a certain water drainage area; the total area drained by a river and its tributaries.

Water supply: Process or activity by which a given amount of water is provided for some use, e.g., municipal, industrial, and agricultural.

Water year: A continuous 12-month period selected to present data relative to hydrologic or meteorological phenomena during which a complete annual hydrologic cycle normally occurs. The water year used by the U.S. Geological Survey runs from October 1 through September 30, and is designated by the year in which it ends.

RECLAMATION
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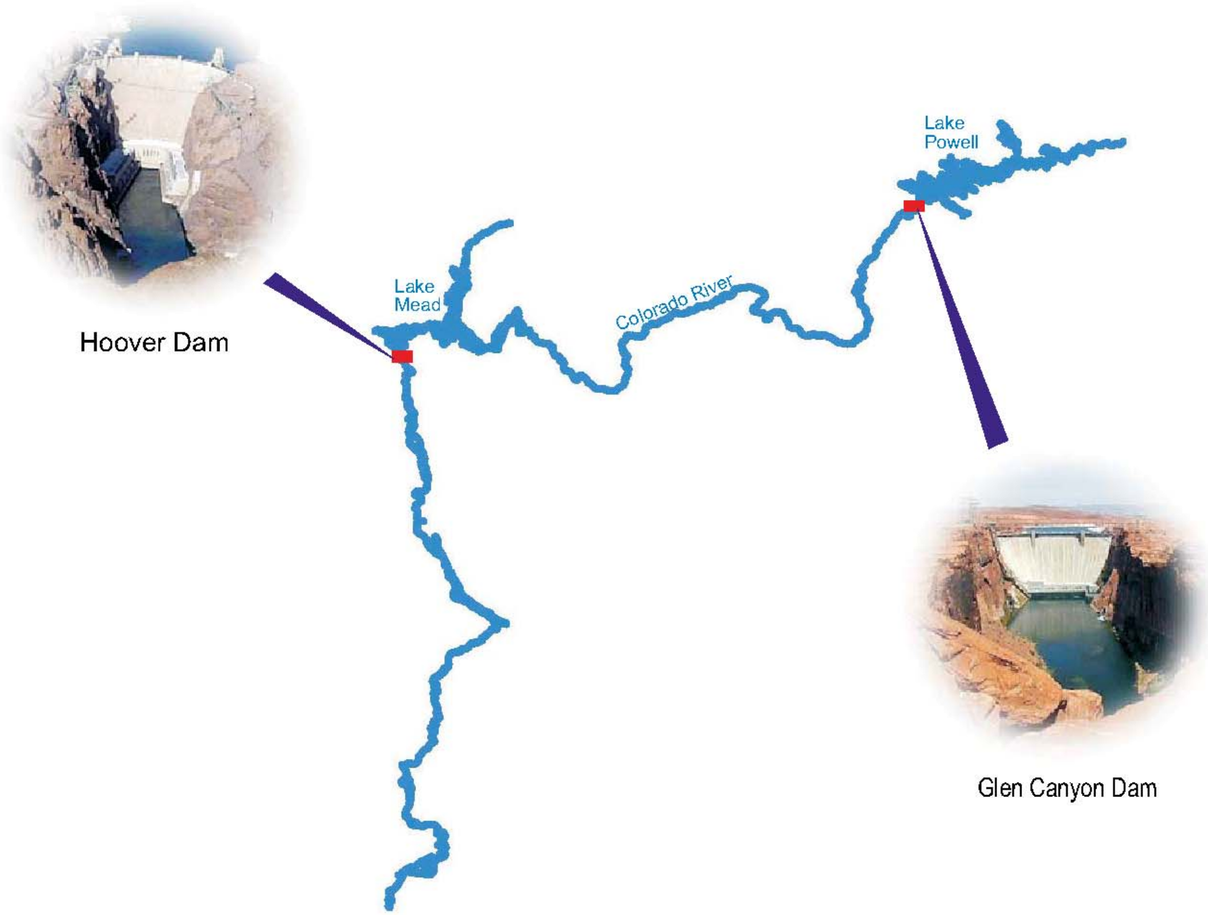
Final

Environmental Impact Statement



Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Volume IV – Responses to Comments

U.S. Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions

October 2007

Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Final
Environmental Impact Statement

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October 2007

Table of Contents

Volume IV – Responses to Comments: Table of Contents

COMMENTS SUBMITTED BY INDIVIDUALS

COMMENTS SUBMITTED BY INDIAN TRIBES

COMMENTS SUBMITTED BY LOCAL AGENCIES

COMMENTS SUBMITTED BY PUBLIC COMMENT

COMMENTS SUBMITTED BY STATE AGENCIES

PART 2 – PUBLIC HEARING TRANSCRIPTS

Introduction

The Bureau of Reclamation (Reclamation), acting on behalf of the Secretary of the Department of the Interior (Secretary), published a Notice of Availability (NOA) of a Draft Environmental Impact Statement (EIS) for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, and a schedule of public hearings, in the *Federal Register* on February 28, 2007 (72 Fed. Reg. 9026). The NOA commenced a public review period that ended on April 30, 2007.

Over 500 copies of the Draft EIS were distributed to interested federal, Tribal, state, and local entities and members of the general public for review; and the document was also available for public viewing at several local libraries and on Reclamation's Upper Colorado Region and Lower Colorado Region websites.

Three public hearings were held to receive oral comments on the Draft EIS during the month of April 2007. These three public hearings took place on April 3, 4, and 5, 2007 in Henderson, Nevada; Phoenix, Arizona; and Salt Lake City, Utah, respectively.

Two individuals provided oral comments during the public hearings. In addition to these oral comments, Reclamation received 78 letters with comments on the Draft EIS. The comment letters were submitted by a wide-range of interested parties that included businesses; federal, state and local agencies; Indian tribes; special interest groups; and individuals. Reclamation has reviewed all of the comments received during the Draft EIS public comment period.

As a result of Reclamation's review of comments received on the Draft EIS, and pursuant to the requirements of NEPA, Reclamation has prepared this Final EIS. Volume IV contains in Part I, reproductions of the letters and oral comments received, and Reclamation's responses to these comments; and in Part II copies of transcripts of the three public hearings.

Reclamation received a significant number of comments regarding climate change and hydrologic variability during the Draft EIS review period. In particular, questions were asked regarding the uncertainty of future inflow conditions and how this uncertainty was considered in the modeling of the alternatives. Reclamation believes that, it is appropriate to provide the following general response to the climate change and hydrologic variability questions.

General Response Pertaining to Climate Change and Hydrologic Variability

The potential impacts of climate change and hydrologic variability on the Colorado River have been subjects for discussion for many years. The continuing drought in the Colorado River Basin which began in 2000, coupled with recent advances in scientific knowledge regarding the potential impacts of climate change, has heightened this interest. The Fourth Assessment Report (Summary for Policymakers) of the Intergovernmental Panel on Climate Change (IPCC), published in April 2007, presented a selection of key findings regarding projected changes in precipitation and other climate variables as a result of a range of climate change scenarios projected by IPCC over the next century. Although annual average river runoff and water availability are projected to decrease by ten to 30 percent over some dry regions at mid-latitudes, information with regard to potential impacts on specific river basins is not included. Recently published projections of potential reductions in natural flow on the Colorado River Basin by the mid 21st century range from approximately 45 percent by Hoerling and Eischeid (2006), to approximately 6 percent by Christensen and Lettenmaier (2006). A recent analysis of future precipitation minus evaporation (a surrogate for runoff) in the basin suggests an "imminent transition to a more arid climate in southwestern North America" (Seager et al. 2006).

While these projections are of great interest, additional research is both needed and warranted to quantify the uncertainty of these estimates in terms of the actual uncertainty in the climate response as well as the uncertainty due to differences in methodological approaches and model biases in order to better understand the risks of current and future water resource management decisions.

Reclamation has been involved in a multi-faceted research and development program over the past three years to improve its risk assessment capabilities regarding projected climate change in the Colorado River Basin. Key components of this program include:

- Sponsorship of National Research Council's (NRC) Committee on the Scientific Bases of Colorado River Basin Water Management in collaboration with the California Department of Water Resources, the Metropolitan Water District of Southern California, the Southern Nevada Water Authority, and the NRC's Water Science and Technology Board.

  The above noted NRC study culminated in a report published in early 2007, titled *Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability*. Among several conclusions and recommendations, this report concluded that the trend of increasing mean temperatures across the Colorado River Basin over the 20th century and into the 21st century is likely to continue, and although there is less consensus regarding future trends in precipitation and runoff, the preponderance of the scientific evidence suggests warmer future temperatures will reduce future streamflow and water supplies and contribute to increase the severity, frequency, and duration of future droughts. The executive summary of this report is included as Appendix T;

- Collaboration with several climate researchers to assess the state of knowledge regarding the potential impacts of climate change on the Colorado River Basin, to assess methodologies that would be appropriate to quantify future conditions, and to prioritize future research and development needs.

  This work culminated in a report titled *Review of Science and Methods for Incorporating Climate Change Information into Reclamation's Colorado River Basin Planning Studies.* Among several conclusions and recommendations, this report concluded that for shorter look-ahead horizons (e.g., less than 20 years), interannual and decadal variability is likely to be a more significant source of uncertainty than the uncertainty due to near-term climate change. Although paleoclimatic information may not necessarily represent future climate scenarios, this information may be useful in framing assumed variability in future hydrologic sequences, particularly with respect to drought potential. For longer look-ahead horizons (20+ years), further research and development is needed to translate climate projections from General Circulation Models (GCM) to the spatial scales necessary for use in Colorado River planning studies. This report is included in its entirety in Appendix U;

- ♦ Collaboration with several research partners including the United States Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), and various universities to improve the accuracy and spatial resolution of the output data from climate change models to enable use in Reclamation's planning model (CRSS); and

- ♦ Improvements to the decision-modeling framework (including the CRSS model and associated data handling and analysis tools).

Based on the current inability to precisely project future impacts of climate change to runoff throughout the Colorado River Basin at the spatial scale needed for CRSS, the primary hydrologic analysis for this Final EIS was based on the resampled historical record. However, in order to understand the potential effects of future inflow sequences outside the range of the historical flows (i.e., future sequences with increased variability including the severity, frequency, and duration of droughts), particularly during the 19-year period of the application of the proposed federal action, Reclamation analyzed the sensitivity of the hydrologic resources (including reservoir storage, reservoir releases, and river flows) to hydrologic scenarios derived from alternative methodologies. These methodologies, including stochastic hydrology methods and paleo-reconstruction methods and the analyses results were included in Appendix N of the Draft EIS. An additional analysis has been added to Appendix N in this Final EIS that incorporates newly published tree-ring reconstruction data (Meko et al. 2007) that extends the estimate of annual flow at Lees Ferry back to the year 762, a record length of 1,244 years.

Acknowledging the potential for impacts due to climate change and increased hydrologic variability, the Secretary proposes that these guidelines be interim in duration and extend through 2026, providing the opportunity to gain valuable operating experience for the management of Lake Powell and Lake Mead, particularly for low reservoir conditions, and improve the basis for making additional future operational decisions, whether during the interim period or thereafter. In addition, the Preferred Alternative has been crafted to include operational elements that would respond if potential impacts of climate change and increased hydrologic variability are realized. In particular, the Preferred Alternative includes a coordinated operation element that allows for the adjustment of Lake Powell's release to respond to low reservoir storage conditions in Lake Powell or Lake Mead as described in Section 2.7 and Section 2.3. In addition, the Preferred Alternative will enhance conservation opportunities in the Lower Basin and the retention of water in Lake Mead through adoption of the ICS mechanism. Finally, the Preferred Alternative includes a shortage strategy at Lake Mead that would result in additional shortages being considered, after appropriate consultation, if Lake Mead elevations drop below 1,025 feet msl.

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Part 1
Comments and Responses

This section contains copies of comment letters received by Reclamation in response to the public review of the Draft EIS. This section also includes two oral comments that were received during the public hearings. Finally, Reclamation's responses to each of the specific issues raised in the letters and comments are provided in this section. The contents of this section are organized as follows:

- ♦ Comment letters and the oral comments from the public meetings have been grouped according to their entity type (i.e., business; federal agency; special interest or non-governmental organization; individual; Indian tribe; local agency, city or water district; state agency; and oral comment). Comments were assigned a code and source identification according to the following method:
    - the grouped comments were assigned a letter code (i.e., business [B]; federal agency [F]; special interest or non-governmental organization [G]; individual [I]; Indian tribe [IT]; local agency, city or water district [L]; state agency [S]; and oral comment [PC]);
    - a number code was then assigned to identify the multiple comment letters within each grouping (e.g., the first letter in the local agency category is assigned code L-1 and the second letter is assigned code L-2); and
    - each comment letter has been further subdivided into issues which are marked with vertical lines and numbered sequentially within the right margin of the comment letter. The issue number is displayed after the comment letter group and number (e.g., L-1-1, L-1-2).
- ♦ Reclamation's response to each comment letter and oral comment immediately follows the respective letter and oral comment. The responses are numbered in the same method as the comment letter or oral comment and its respective issues.

Comments Submitted By Business Groups

This section contains comment letters submitted by the following business groups:

B-1 Avalex Inc.

VIA EMAIL

April 30, 2007

Bureau of Reclamation
Lower Colorado Region, Attention: BCOO–1000
P.O. Box 61470
Boulder City, Nevada 89006–1470

Re: Draft EIS - Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

The following comments are provided concerning the Draft Environmental Impact Statement (EIS) for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.

On page ES-15 of the Executive Summary the statement is made that "With respect to other electrical power resource issues, the Water Supply Alternative has a higher potential for total loss of generation at the Glen Canyon Powerplant and the Hoover Powerplant than the other action alternatives and the No Action Alternative". This seems obvious for Glen Canyon; however, it isn't so obvious with respect to Hoover? The EIS should identify the basis for this statement. 1

Chapter 2 – Alternatives: The Draft EIS assesses four action alternatives: (1) Basin States Alternative, (2) Conservation Before Shortage Alternative, (3) Reservoir Storage Alternative, and (4) Water Supply Alternative. Each of these alternatives, with the exception of the Water Supply Alternative, includes a mechanism for the storage and delivery of conserved system and non-system water in Lake Mead (i.e., intentionally created surplus). The omission of a mechanism for storage and delivery under this alternative is arbitrary and does not allow this alternative to be evaluated on an equal basis against the other alternatives. This is particularly evident with respect to the probability distributions concerning shortage occurrences presented in Chapter 4, where had such a mechanism been included in the Water Supply Alternative even fewer shortages would likely occur. 2 The EIS should include an analysis of the Water Supply Alternative with a similar mechanism for the storage and delivery of water. Likewise, the No Action Alternative should also be evaluated with a similar mechanism for storage and delivery. 3

On page 2-5 in the discussion concerning the No Action Alternative, Table 2.2-1 shows that under a Stage II shortage California will take a 60-65 percent of the shortage. The basis for this conclusion or assumption should be identified in the EIS. 4

Similarly, on page 4-121, Table 4.4-11 shows different Lower Basin shortage volumes and the portion of the shortage that was assumed to be distributed to Arizona. 5 Similar tables are subsequently provided for California and Nevada. The basis for these assumptions should be identified in the EIS. 6

B-1

Bureau of Reclamation
Lower Colorado Region
April 30, 2007
Page 2 of 2

Beginning on page 5-7, the EIS briefly discusses a number of proposed water supply
projects of the SNWA that the proposed Colorado River Interim Guidelines would 7
presumably facilitate. A complete description of these projects is needed to adequately
assess the impact of the various shortage alternatives. Likewise, a more complete 8
description of the Systems Conveyance and Operations Program (SCOP) is needed. It is 9
unclear whether the water quality modeling performed in Chapter 4 of the EIS incorporates
the SNWA water supply proposals and the SCOP, which it should if the analysis is to
accurately assess the impacts of the various shortage alternatives.

Thank you for considering these comments.

Sincerely,

/c/ Craig W. Morgan

Craig W. Morgan, P.E.
Principal Engineer
Avalex Inc.

Cc: Michael Abatti
James Abatti

B-1

Reponses to Comment Letter B-1

B-1-1

Your comment is noted. The Executive Summary (Section ES 2.10) has been modified to more clearly summarize the results of the electrical power resources analysis (Section 4.10).

B-1-2

Reclamation does not concur with this comment. The action alternatives were developed to include different formulations of each of the four operational elements. The Water Supply Alternative was developed to analyze a scenario that would maximize water deliveries at the expense of retaining water in storage in the reservoir for future use (see description of Water Supply in Section 2.5 of the EIS).

B-1-3

Reclamation does not concur with this comment. Under NEPA, the No Action Alternative represents a projection of current conditions to the most reasonable future responses or conditions that would occur during the life of the proposed federal action without any action alternative being implemented (Section 2.2.2). Therefore, since a mechanism for the storage and delivery of conserved water currently does not exist, it would be inappropriate to include this in the No Action Alternative.

B-1-4

The information requested is provided in the EIS. Please refer to Section 2.2.2 of the EIS which explains the assumptions of how the distribution of water under Stage 1 and Stage 2 shortages is determined.

B-1-5

The information requested is provided in the EIS. Please refer to Section 2.2.2, Section 4.2, Appendix A, and Appendix G of the EIS for detailed explanations on the assumptions of how the distribution of water for Arizona under shortage conditions is determined.

B-1-6

The information requested is provided in the EIS. Please refer to Section 2.2.2, Section 4.2, Appendix A, and Appendix G of the EIS for detailed explanations on the assumptions of how the distribution of water for California and Nevada under shortage conditions is determined.

B-1-7

The information in the Draft EIS has been modified in the Final EIS (Section 4.16). More detailed information regarding the proposed SNWA projects has been included in Section 4.16 of the Final EIS and can also be found on SNWA's website at the following internet address: http://www.snwa.com/html/wr_instate.html

B-1-8

A description of the Systems Conveyance and Operations Program (SCOP) is provided in Section 4.5.2 and in Section 5.1.25 of the EIS. Additional information on the SCOP can be found at the Clean Water Coalition's website at the following internet address: http://www.cleanwatercoalition.com

B-1-9

The proposed SNWA water supply proposals are assumed to occur under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and under the Preferred Alternative, due to the assumed existence of a storage and delivery mechanism. Under the SCOP EIS preferred alternative, impacts to water quality are considered insignificant for Lake Mead elevations down to 1,000 feet msl (Section 4.5.2). For the Preferred Alternative (Section 4.3.4, Figure 4.3-24) under the assumptions described in Section 4.2, the probability of Lake Mead elevations below 1,000 feet msl is zero over the interim period.

Comments Submitted By Federal Agencies

This section contains comment letters submitted by the following federal agencies:

- F-1 Department of Energy, Western Area Power Administration
- F-2 United States Fish and Wildlife Service
- F-3 United States Environmental Protection Agency, Region IX
- F-4 International Boundary and Water Commission, United States Section
- F-5 International Boundary and Water Commission, Mexico Section
- F-6 National Oceanic and Atmospheric Administration

Department of Energy
Western Area Power Administration
Desert Southwest Customer Service Region
P.O. Box 6457
Phoenix, AZ 85005-6457

APR 2 6 2007

CERTIFIED MAIL REQUESTED

Regional Director
Bureau of Reclamation
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

Dear Regional Director:

On February 28, 2007, the Bureau of Reclamation (Reclamation) published the Draft Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (Draft EIS) and requested that comments on the Draft EIS be submitted no later than April 30, 2007. The Desert Southwest Region of the Western Area Power Administration (Western) would like to take this opportunity to provide comments in regard to the Draft EIS.

Western has the responsibility for the marketing of the generation from Federal hydropower in much of the Western United States, including generation on the Colorado River. The Desert Southwest Region has responsibility for projects on the Lower Colorado River including the Boulder Canyon (Hoover generation) and Parker-Davis Projects. Western has followed the development of the Draft EIS with great interest because of the potential impacts to our power customers for these projects. The power and benefits provided from these projects are currently distributed to millions of customers in Arizona, California, and Nevada. Due to the unique characteristics of hydropower generation, the Federal generation facilities on the Colorado River contribute greatly to the reliability of the entire interconnected electrical power system in the Southwest.

While our responsibility is for the marketing of federal hydropower, we recognize that Reclamation must manage the Colorado River, consistent with applicable federal laws, for all the affected resources including water supply, power, recreation, and environmental. Western's comments are therefore provided with consideration of all affected resources and are focused on issues that significantly affect the projected impacts of the alternatives analyzed and on the selection of a preferred alternative.

Comparison of Alternatives (by Operational Elements)

Reclamation has stated that it may combines aspects of more than one alternative in its preferred alternative, therefore we will provide comments on each of the Operational Elements presented in the Matrix of Alternative in Table 2.7-1.

F-1

Shortage Guidelines

The efficacy of the shortage guidelines for the alternatives may be demonstrated to a large extent
by the Lake Powell and Lake Mead elevation projections by the end of the interim guideline
period. The 50th percentile projection for lake elevations in 2026 show that for three (Basin
States, Conservation Before Shortage, and Water Supply) of the four action alternatives, the total
combined storage of the lakes are essentially unchanged or even lower than the initial storage at 1
the start of the study period and less than No Action. This is even with inflow projections that
we believe are overestimated as discussed in our comments on Modeling and Hydrologic
Resources. Only under the Reservoir Storage alternative is a substantial increase in the total
combined storage projected in 2026 at the 50th percentile, due primarily to the shortage 2
guidelines for this alternative. Water storage at the 10th percentile is also much higher for the
Reservoir Storage alternative.

It seems that shortage guidelines that do not show an appreciable increase in water storage in
almost 20 years (even with overly optimistic inflow projections) from relatively low levels 3
reached after a 7-year drought are inadequate. This would leave the reservoirs languishing in the
middle to lower range of storage during normal inflows and thus without sufficient storage to
handle significant drought periods without drastic cuts in water deliveries. The proposal under
the Basin States alternative for a re-consultation once Lake Mead drops below elevation 1025' 4
appears contrary to the purpose of having shortage guidelines. We believe that shortage
guidelines that do not address shortages at lower lake elevations do not fulfill the need set forth
in Purpose and Need "for more specific guidelines …to assist in the Secretary's determination
of annual water supply conditions in the Lower Basin under low reservoir conditions." Specific 5
guidelines would be absent at the lowest reservoir elevations at which they are most critical.

The shortage guidelines under the Reservoir Storage alternative result in much higher water
storage under the full range of probabilities. This would result in much better capability to meet
water demands during periods of drought which is a primary purpose for developing these 6
interim guidelines. In addition, other purposes for which these dams were built such as power 7
production and recreation will also benefit from these higher storage levels. We find the
shortage guidelines under the Reservoir Stage alternative are superior and recommend that they 8
be incorporated into the preferred alternative.

Coordinated Reservoir Operations

Coordinated releases from Lake Powell based upon the elevations or volumes at Lake Mead and 9
Lake Powell at lower elevations provides an overall benefit to the system resources. We do not
believe that there is an appreciable difference in the impacts based upon the triggers used in the
Basin States and Conservation Before Shortage alternatives versus the Reservoir Storage 10
triggers. We recommend either the Coordinated Reservoir Operations from the Basin States and
Conservation Before Shortage alternatives or the Reservoir Storage alternative be implemented. 11

F-1

Storage and Delivery of Conserved System or Non-System Water

We support the concept of Intentionally Created Surplus (ICS) mechanism for storage and 12
delivery of conserved water. The increase storage in Lake Mead resulting from the ICS would 13
provide positive impacts to many of the affected resources including power production. We
support the higher maximum levels of ICS in the Reservoir Storage alternative.

We strenuously oppose the proposal in the Conservation Before Shortage alternative that would
be funded in part by a surcharge assessed on the power rates for the Hoover electrical service 14
contractors and a Federal government contribution. As noted in the Draft EIS, this funding
proposal would be contrary to existing federal legislation and outside of the authority of 15
Reclamation.

Interim Surplus Guidelines (ISG)

We feel that it is counterproductive to provide for surplus deliveries not necessitated by the
potential of flood control releases when we are entering a period of time where the probability of 16
shortages is greatly increasing. While eliminating the Domestic Surplus provisions of the ISG
would only have a small effect on water storage, we still believe that this justifies elimination of 17
these surpluses. We support the Reservoir Storage proposal to eliminate the ISG Domestic
Surplus releases and make surplus releases only during Quantified and Flood Control conditions. 18

Environmental Consequences

Methodology and Hydrologic Resources

The first two stated purposes of the Draft EIS are to: 1) improve management of the Colorado River considering the tradeoffs between the frequency and magnitude of reductions of water deliveries and the effects on water storage, water supply, power production, recreation, and environmental resources; 2) provide Colorado River water users with a greater degree of predictability with respect to the amount of annual water deliveries in future years, particularly
under drought and low reservoir conditions. The most critical factor affecting the analysis of the
alternatives in regards to theses purposes is the water supply model. The reductions in water 20 19
deliveries and uncertainty in water deliveries are issues only as the reservoirs reach low levels
due to water deliveries that exceed the water supply over a period of years.

In the Draft EIS, Reclamation modeled the future inflows to the Colorado River Basin using 99 years of recorded data from 1906 through 2004 (Direct Natural Flow Record) and applying these years of inflows (or traces) and the projected initial conditions to models of the alternatives. The
use of historical recorded inflows for projection of future inflows has been used by Reclamation 21
in previous environmental impact studies and other analysis, however we believe that it is very
ill suited for the current Draft EIS.

As noted above, the primary purpose of the Draft EIS is to determine guidelines for operating at 22
low reservoir levels. We feel the use of this 99 year historical record of inflow data significantly

F-1

overstates the probable future inflows and therefore calls into question the validity of the analysis
of the alternatives. There are two factors that cause us to believe this use of recorded data would 22
overstate the probable future flows. First, the historical period includes the early 20th century, a
time of extraordinarily high inflows. All reconstructions of earlier inflows (through tree ring
analysis) have determined this to be the period of highest sustained inflows in the past 500 years.
By including and not adjusting for these abnormally high inflows results in an over-projection of
the probable inflows based on the full picture of historical inflows. Comprehensive analysis of
tree rings in the Colorado River Basin have shown average inflows over the past 500 years are 23
0.5 MAF to over 1.0 MAF less than the average inflows used in the Draft EIS. There is a
sensitivity analysis in Appendix A which did include one analysis (Direct Paleo) which used
such reconstructed water inflow data. The result was that at the 10th percentile in 2026, Lake
Powell elevation was about 50 feet lower for most alternatives and Lake Mead was about 20 feet
lower for the action alternatives when compared to the Direct Natural Flow Record used in the
body of the Draft EIS.

The second factor is the effects of climate change on the future inflows. There is almost
complete consensus in the scientific community in regards to increasing temperatures in the
Colorado River Basin as evidenced by the National Research Council report earlier this year.
Average temperatures in the Colorado River Basin have already increased over the last century
and higher average temperatures in the future will result in increased evaporative losses and 24
earlier snowmelts, reducing the future inflow. We have experienced this situation several years
in the current drought, where precipitation and snowpack levels were near average until about
March at which time warm, dry conditions ensued and resulted in runoff levels far below
average.

In addition, the current state of hydrologic conditions has changed substantially since the August
2006 data used in the analysis. Due to another poor snowpack in the Colorado River Basin, the 25
inflow for the current year will be far below the previous projections. This change would
significantly reduce the initial reservoir levels used in the Draft EIS.

In summary, we do not believe that the water supply model in the Draft EIS accurately portrays
the probabilities of future conditions due to overestimation of inflows and initial reservoir 26
conditions. It does not seem reasonable to us to analyze alternatives for creating guidelines to
address primarily the river operation during drought and low reservoir conditions using data that 27
would likely overestimate the available water supply. We suggest that the alternatives should be
re-analyzed using more conservative projected water inflows that would result from 28
incorporation of the information from recent scientific studies in this area, not solely the
recycling the limited period of recorded inflows.

Water Deliveries

Figure 4.4-6 demonstrates the impact on future deliveries that will likely occur because of
inadequate reductions of deliveries under all alternatives except for Reservoir Storage. Very 29
large shortages may be required immediately after the interim period in all the other alternatives
when the demands for water are only going to be greater. There does appear to be discrepancies 30

F-1

between Figure 4.4-6 and Table 4.4-10. The data points in the table do not match the corresponding data points in the figure. 30

Electrical Power Resources

The analysis in the Draft EIS presents a comparison of the impacts on power generation on an average basis and at various ranges of hydrologic conditions. The total economic values of the electrical power generation presented are greatly understated due to use of outdated (2004) data for the underlying prices and application of a net discount rate that reduced the value of generation in later years. 31 The comparison of impacts for each of the alternatives appears reasonable in terms of the change in electrical power production. This comparison shows that Hoover is the most impacted of the Federal generation facilities. The Reservoir Storage alternative provides for significantly higher power production at Hoover than the others alternatives as well as higher overall power production from the Colorado River generation facilities in total. 32

Recreation

We would just note that the Reservoir Storage clearly is the most beneficial alternative in terms of recreation at both Lake Powell and Lake Mead. 33 Each of the other alternatives has a negative impact on Lake Powell recreation compared to No Action. 34

Recommendation

In our review of the Draft EIS, we find that each of the alternatives, except Reservoir Storage, do not provide for adequate water storage on the Colorado River and therefore have negative impacts on resources, such as power and recreation, and leave future water deliveries vulnerable. 35 We believe these alternatives are likely to result in drastic reductions in water deliveries during or immediately after the interim period and/or result in the need to reconsider or modify the guidelines during the interim period. 36 Therefore, Western recommends that Reclamation selects Reservoir Storage as the preferred alternative in the Final Environmental Impact Statement based upon its most favorable impact to the resources and environment effected by the adoption of interim guidelines. 37

We thank you for this opportunity to comment on the Draft EIS. For any questions on this matter, please contact Mr. Brian Young at (602) 605-2594 or byoung@wapa.gov.

Sincerely,

Mary Oretta for

Deborah K. Emler
Assistant Regional Manager
for Federal Power Programs

F-1

bcc:
G0000 (Carlson)
G1580 (CF)
G0200 (Casey)
G6001 (RF)
G6300 (Ramsey)

G6006:BYoung:x2594:wts:04-24-07:R:\Groups\G6000\BOR\Letter to USBR draft EIS 4-24-07.d042407_wts.doc

F-1

Reponses to Comment Letter F-1

F-1-1

Your comment is noted. No change to the Final EIS was necessary.

F-1-2

Your comment is noted. No change to the Final EIS was necessary.

F-1-3

Reclamation does not concur with this comment. The action alternatives were formulated to permit an evaluation of a wide range of operating conditions and to permit an evaluation of several trade-offs, including the trade-offs between water deliveries and retaining water in storage for future use.

F-1-4 and F-1-5

Reclamation does not concur with these comments. The Basin States Alternative and the Preferred Alternative include provisions for stepped water delivery reductions associated with specific Lake Mead elevations that begin at elevation 1,075 feet msl and continue down to elevation 1,025 feet msl. The re-consultation that would occur under these alternatives when the Lake Mead water level falls below elevation 1,025 feet msl is expected to consider among other factors, projected inflow conditions, the need for and magnitude of additional shortages, and the ability of water users to manage additional delivery reductions at that point in time. Therefore, the shortage guidelines provided in the Basin States Alternative and the Preferred Alternative meet the purpose and need of the proposed federal action.

F-1-6

Your comment is noted. No change to the Final EIS was necessary. The trade-offs between reducing water deliveries and retaining water in storage for future use is clearly demonstrated in the analysis of the alternatives.

F-1-7

Your comment is noted. No change to the Final EIS was necessary.

F-1-8

Your comment is noted. No change to the Final EIS was necessary.

F-1-9

Your comment is noted. No change to the Final EIS was necessary.

F-1-10

Your comment is noted. No change to the Final EIS was necessary.

F-1-11

Your comment is noted. No change to the Final EIS was necessary.

F-1-12

Your comment is noted. No change to the Final EIS was necessary.

F-1-13

Your comment is noted. No change to the Final EIS was necessary.

F-1-14

Your comment is noted. No change to the Final EIS was necessary.

F-1-15

Your comment is noted. No change to the Final EIS was necessary.

F-1-16 through F-1-18

Reclamation does not concur with this comment. Consistent with the purpose and need of the proposed federal action, Reclamation believes that it is important to provide operational guidelines that address the operation of the reservoirs throughout the full range of water levels. This includes the availability of surplus water when water levels in the reservoirs are in the upper range.

F-1-19

Your comment is noted. No change to the Final EIS was necessary.

F-1-20

Your comment is noted. No change to the Final EIS was necessary.

F-1-21

Reclamation does not concur with this comment. The foundation of the analysis in the EIS is a relative comparison between alternatives. Use of the historical record, tree-ring reconstructions and other techniques to project future inflows (Section 4.2 and Appendix N) provides a valid relative comparison of the alternatives.

F-1-22

See response to Comment No. F-1-21.

F-1-23

Your comment is noted. No change to the Final EIS was necessary.

F-1-24

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

F-1-25

Reclamation concurs with this comment. Actual inflow from August 2006 through May 2007 was substantially lower than the projected inflow that was used in the hydrologic modeling that was conducted in the fall of 2006 for the Draft EIS. The modeling for the Final EIS was updated in June 2007 and incorporated the most current conditions and inflow projection information at that time. The different initial conditions that were used in the modeling for the Draft EIS and Final EIS are presented in Appendix A.

F-1-26 through F-1-28

See response to Comment No. F-1-21.

F-1-29

In the modeling of the alternatives, all action alternatives are assumed to revert back to the assumptions used to represent the No Action Alternative after in 2026. Figure 4.4-6 shows the maximum modeled shortage amounts in each year for all alternatives and the large maximum shortages occurring after 2026 are primarily the result of this assumption.

F-1-30

Reclamation concurs with this comment. The referenced table and figure have been revised in the Final EIS.

F-1-31

Reclamation concurs not concur with this comment. As noted in Section 4.11.1.3, the underlying hourly prices used in the analysis of economic values were based on 2004 price data. However, these prices were escalated by 2.2 percent per year to estimate 2008 prices. This escalation method is commonly used in the industry, was determined to be appropriate for this analysis, and provided results that could be used in the relative comparison of the action alternatives to the No Action Alternative.

F-1-32

Your comment is noted. No change to the Final EIS was necessary.

F-1-33

Your comment is noted. No change to the Final EIS was necessary.

F-1-34

Your comment is noted. No change to the Final EIS was necessary.

F-1-35

Your comment is noted. No change to the Final EIS was necessary.

F-1-36

See response to Comment No. F-1-3.

F-1-37

Your comment is noted. No change to the Final EIS was necessary.

United States Department of the Interior
U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 242-0210 Fax: (602) 242-2513

In Reply Refer to:
AESO/SE
22410-2007-TA-0224

April 24, 2007

Memorandum

To: Area Manager, Bureau of Reclamation, Boulder City, Nevada (Attn: Nan Yoder)

From: Field Supervisor

Subject: Draft Environmental Impact Statement (DEIS) on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations of Lake Powell and Lake Mead – Comments

Thank you for the opportunity to assist as a Cooperating Agency in the development of this important DEIS. The Fish and Wildlife Service (FWS) provides the following comments for your consideration on the subject DEIS. We are providing these comments in accordance with the Council of Environmental Quality regulations addressing cooperating agency status (40C.F.R. 1501.6 & 1508.5).

We note that the FWS provided comments as a Cooperating Agency by memorandum dated January 19, 2007, and discussed these further at your January 22, 2007, meeting of Cooperating Agencies. We do not see acknowledgement of the following comments, even though during discussion of our written comments you did not express any concerns indicating that you could not use them. We therefore assumed that they were acceptable for incorporation into the EIS. We reiterate these comments and offer to discuss them if that would be helpful. 1

1) Page 1-13: Add Minute 306, December 12, 2000 to the Minutes noted in Table 1.7-1 for United States-Mexico Water Treaty of 1944, since it refers to collaborative efforts between the U.S. and Mexico to ensure use of water, i.e. quantity as noted for the 1944 Treaty on Page 1-12, lines 15 and 16, for ecological purposes in Reach 9. 2

2) Page 4-170, lines 10-29: The NIB-to-SIB, which is shared by the U.S. and Mexico, represents an important wildlife area, especially for migratory neotropical songbirds and waterfowl and other wetland birds. Also, various native and non-native fish species exist in the upper portion of the river that is maintained by sources including leakage at Morelos Dam, agricultural return drain flows, subsurface sources, and occasional releases. We continue to believe that effects to fish and wildlife resources should be addressed by this document in the NIB to SIB reach. 3 4

F-2

3) Page 6-5, lines 20-22: The FWS requests, pursuant to Executive Order 12114 as applied to the National Environmental Policy Act and development of this EIS, that our agency be included in investigations of the effects of this Federal action in the Colorado River delta area of Mexico due to our migratory bird and endangered species responsibilities. 5

The following are general comments as well as specific comments addressing specific sections, pages, and line numbers in the text.

Chapter 1

Page 1-3, lines 32-35: Reclamation should discuss what some of the anticipated future demands 6
might be that could result in low reservoir elevations. Increased water use in the Upper Colorado
River Basin is one likely cause. The reference to Colorado River Compact Article III(d) on page 7
1-15, lines 3-4 may also be appropriate to include.

Page 1-26, lines 22-26: While the LCR MSCP does provide "mitigation" for fish and wildlife
species in the LCR corridor that are not included as covered species, it is inaccurate to state that 8
effects to these un-covered species are fully mitigated. There are several land cover types that
provide habitat for these un-covered species that are affected by LCR operations, but are not 9
included in the conservation program.

Chapter 2

Page 2-2, lines 15-16: A definition of "system water" and "non-system water" would be 10
appropriately referenced here. Also, in lines 20-22, is it Reclamation's intent to have the
regulations part of the proposed action detailed in the FEIS, or will the regulations be published 11
separately?

Page 2-13, lines 12-13: Define "bypass flow". 12

Chapter 3

Page 3-29, lines 15-21: We understand that Reclamation cannot predict how shortage would be
managed by the water users in Arizona; although Arizona has provided some details in their 13
Drought Preparedness Plan. However, since an obvious method would be to temporarily lease
water from agricultural users in the Yuma area for delivery to Phoenix and Tucson, that would
result in a decrease in the application of water to fields in the Yuma area. With less water on the 14
fields, the amount of groundwater flowing into the river might be reduced. We suggest an
explanation here (or reference to one in an Appendix) of why groundwater amounts are not 15
likely to change due to the Federal action.

Page 3-71, Table 3.8-7: Bluehead suckers are probably not found in or below Lake Mead. The 16 17
correct spelling of the species name for Yuma clapper rail is *Longirostris yumanensis*.

Chapter 4

F-2

Page 4-4, lines 35-40: Most available climate models project that the southwestern United States will experience a significantly more arid period in the 21st century, with a transition, which is now underway, to a more arid climate, dominated by a pattern similar to the current drought. We 18
recommend that Reclamation add a section discussing this information and its implications in the context of Reclamation's analysis of future hydrology.

Page 4-7, lines 1-5: The LCR MSCP includes provision for the transfer of up to 1.574 maf from downriver agricultural users to more upriver urban users. This concept is not included within the 19
common assumptions. We understand that a portion of the intent of the modeling is to show effects of the shortage alternatives and that those effects can be incorporated within the change in 20
1.574 maf, but this may not be clear to other readers. This is especially important when discussing the groundwater changes later in the section.

Page 4-8, lines 24-26: We believe it is important to include the rationale for the Drop 2 structure 21
to be in place and operating. If the environmental compliance has been completed for this project, inclusion may be appropriate. If not, please explain why Reclamation believes this 22
project has certainty.

Page 4-58, lines 6-10: This paragraph is an example of where a discussion of what is meant by 23
"non-system water" would be helpful in understanding the closing statement. How would SNWA development of non-system supplies affect the releases from Hoover Dam? 24

Page 4-65, lines 8-13: In the introduction to this section (4.3.7), it might be worthwhile noting that in the event of a Phase 1 or Phase 2 shortage, the two major entities that would receive less 25
water are CAP and MWD. Given that fact, flows entering and leaving Lake Havasu under 26
shortage conditions would be largely the same (allowing for some minor depletions). Perhaps some explanation here on that subject would be useful. Also, flows below Parker Dam may, over the course of the 50-year life of the LCR MSCP, be reduced as much as 1.574 maf due to 27
water transfers from agricultural users to the urban areas. How is that factored into the modeling?

Page 4-68, lines 7-15: Perhaps it would have been better to use the flows below Headgate Rock Dam (which would reflect diversions to CRIT) than to use those above which don't show any 28
real difference from the Parker Dam releases. Unless the major water users below Parker Dam provide leased water for use by CAP and MWD during times of shortage, one would not expect 29
these high-priority users to change their water use. Differences between the alternatives, particularly in terms of groundwater levels, are related to this.

Page 4-79, lines 6-13: Although this begins the discussion of SNWA's creation of new sources, it still does not relate how those sources would provide existing users with alternative water so 30
that SNWA could take more river water. For example, desalinization plants would have to be 31
operated near a source of non-Colorado River water in order to later affect an exchange.

Page 4-79, lines 30-40: Please explain the statement that the change in point of diversion effects 32
under the LCR MSCP are not additive to the changes due to shortage.

F-2

Page 4-94, lines 1-6: Since storage of water is a factor in reducing shortages through
maintenance of lake elevations, perhaps a discussion of how that stored water being used during
a potential shortage situation affects lake levels. Similarly, for the surplus discussion on page 4- 33
99, lines 1-13.

Page 4-162, lines 11-15: Perhaps it should be noted here that the LCR MSCP provides coverage 34
for changes in points of diversion up to 1.574 maf/year. The amount of potential shortage is
higher than that figure. It should be explained how the conservation for the LCR MSCP relates 35
to the shortage amounts, particularly in light of the increase in amount of water that had a change
in point of diversion over the 50-year life of the LCR MSCP.

Page 4-163, line 14: The summary in this section should focus on the changes in median flows
and the relationship to groundwater levels. The amount of vegetation affected is directly related 36
to those groundwater changes. The discussion should also address the frequency and multi-year
potential for these reduced flows. This should be included in the discussions in subsections 37
4.8.3.4 and 4.8.3.5. It is the changes in groundwater that may be most relevant to an effects 38
analysis since those changes can alter the vegetation structure and wildlife use.

Page 4-182, line 38- Page 4-185, line 35: This analysis would be more clear if it were organized
either by alternative, or by percentile elevations. Based on figure P-81 (on page P-88) it appears
that, at the 50th percentile, Glen Canyon Dam release temperatures would generally be colder for 39
all alternatives compared to the no action , but the effects of this are not considered in the
analysis.

Page 4-189, lines 33-34: If MacNeils sooty-wing skipper can be considered present in the lower
Grand Canyon due to known records at the Muddy River, it seems inappropriate to state that this 40
species does not occur at Lake Mead. Please review this information.

Page 4-192, lines 8-9: The woundfin is also not known from Lake Mead. 41

Page 4-194, lines 11-12 and page 4-197, lines 21-28: The Colorado River cotton rat is found
from the vicinity of Needles south to at least Ehrenburg. Please examine the data on this species 42
locations and revise these sections.

Page 5-11, lines 21-25: The Long-Term Experimental Plan for the Operation of Glen Canyon
Dam will further modify the proposed action of the DEIS by potentially altering the daily and 43
seasonal pattern of dam releases at Glen Canyon Dam which could have cumulative effects
relative to the proposed action of the DEIS.

We look forward to continuing to work with you on this important effort. Our contacts are as follows: Sam Spiller (Lower Colorado River Coordinator, Tel: 602/841-5329, Email: sam_spiller@fws.gov) as the primary contact and for National Wildlife Refuge and Mexico delta resources; Glen Knowles (Biologist, Tel: 602/242-0210 x233, Email: glen_knowles@fws.gov) for Glen Canyon Dam and associated operations (generally downriver from Glen Canyon Dam to upper Lake Mead); and Lesley Fitzpatrick (Biologist, Tel: 602/242-0210 x236, Email: Lesley_fitzpatrick@fws.gov) for the Lower Colorado River Multi-Species Conservation

F-2

Program and associated operations (generally from upper Lake Mead downriver to the Southerly International Boundary).

Steven L. Spangle

cc: Regional Director, Fish and Wildlife Service, Albuquerque, NM (ARD-ES, FR, RC (NWRS)
Lower Colorado River Coordinator, Fish and Wildlife Service, Phoenix, AZ
Director, Arizona Game and Fish Department, Phoenix, AZ
Director, California Department of Fish and Game, Sacramento, CA
Director, Nevada Department of Wildlife, Reno, NV

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F-2

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Reponses to Comment Letter F-2

F-2-1

Reclamation reviewed the comments submitted in January 2007 and as appropriate, modified the Draft EIS that was published in February 2007.

F-2-2

Reclamation concurs with this comment. A citation of Minute 306 has been added to Table 1.7-1.

F-2-3 and F-2-4

Your comments are noted. Potential impacts of the proposed federal action to fish and wildlife resources in the NIB to SIB reach are analyzed (Section 4.8).

F-2-5

Reclamation has complied with Executive Order No. 12114 and Public Law 109-432 by informing the Department of State of the proposed federal action and by providing technical support to the United States Section of the International Boundary and Water Commission (USIBWC) for its consultation with Mexico. The Final EIS incorporates appropriate information regarding potential hydrologic and water quality impacts to Mexico (at the appropriate Treaty delivery point) that have been prepared after coordination with the USIBWC, as well as with representatives of the Department of State.

F-2-6

The information requested is provided in the EIS. Reclamation's modeling of the alternatives considered various factors that could affect future reservoir water levels. These factors include future water demands, hydrologic variability, the coordinated operation for Lake Powell and Lake Mead, and the storage and delivery of conserved water via the proposed Lake Mead storage and delivery mechanism.

F-2-7

Your comment is noted. No change to the Final EIS was necessary.

F-2-8 and F-2-9

Reclamation concurs with these comments. The referenced statement in Section 1.8.5 regarding mitigation for un-covered species has been modified.

F-2-10

Reclamation concurs with this comment. The terms “system water” and “non-system water” have been defined in the glossary of the Final EIS.

F-2-11

Reclamation has included draft operational guidelines in the Final EIS (Appendix S).

F-2-12

The term “bypass flows” has been defined in the glossary of the Final EIS.

F-2-13 through F-2-15

Your comments are noted. Any presumption of temporary or long-term water transfers between specific agricultural and municipal interests is speculative since it is unknown which entities might participate and at what level of participation. Given the speculative nature of agricultural to urban transfers, it is not possible to make a quantitative assessment of the potential impacts of these types of actions on groundwater or other resources.

F-2-16

Reclamation concurs with this comment. Table 3.8-7 has been corrected in the Final EIS.

F-2-17

Reclamation concurs with this comment. Table 3.8-7 has been corrected in the Final EIS.

F-2-18

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

F-2-19 and F-2-20

Potential flow reductions resulting from shortages and changes to points of diversion (e.g. due to existing or planned water transfers, conservation activities postulated for the storage and delivery mechanism, etc.) were modeled for each alternative and the modeling assumptions are detailed in Section 4.2, Appendix A, Appendix D, and Appendix M. The groundwater analysis in the Davis Dam to Parker Dam and Parker Dam to Imperial Dam reaches was based on a relative comparison of the median flows for each alternative, including potential flow reductions as modeled.

Consistency of the Preferred Alternative with the LCR MSCP will be analyzed and submitted separately to the Fish and Wildlife Service.

F-2-21 and F-2-22

Legislation passed by Congress in late 2006 (Public Law 109-432) requires that the Secretary proceed "without delay" with the "construction, operation and maintenance" of the Drop 2 Storage Reservoir. Reclamation published a Final EA on the Drop 2 Storage Reservoir project on June 20, 2007 (http://www.usbr.gov/lc/yuma/environmental_docs/environ_docs.html). Construction is scheduled to begin in 2008 and is expected to be operational by 2010. Therefore, the inclusion of this project as part of the No Action Alternative and the action alternatives is consistent with NEPA guidelines.

F-2-23

See response to Comment No. F-2-10.

F-2-24

The effect that individual future SNWA non-system water projects will have on Hoover Dam releases will vary depending on whether the source of supply for the individual projects is located upstream or downstream of Hoover Dam. Since SNWA's intakes are in Lake Mead, non-system water projects originating upstream of Hoover Dam would have no effect on Hoover Dam releases. SNWA non-system water projects originating downstream of Hoover Dam, however, could potentially result in a reduction in Hoover Dam releases. Such projects would likely involve a water "exchange" with another agency where the other agency would take possession of the new non-system water supply developed by SNWA in exchange for an equivalent portion of the other agency's Colorado River water supply yet to be released from Lake Mead. The analysis of the storage and delivery mechanism in the EIS considered non-system water projects originating upstream and downstream of Hoover Dam.

F-2-25

Your comment is noted. No change to the Final EIS was necessary.

F-2-26

The analysis of the potential changes in flows in each reach is detailed in Section 4.3.

F-2-27

See responses to Comment Nos. F-2-19 and F-2-20.

F-2-28

Your comment is noted. No change in the Final EIS was necessary.

F-2-29

See responses to Comments Nos. F-2-13 through F-2-15.

F-2-30 and F-2-31

Conservation projects (including canal lining, desalination, etc.) would result in additional water supplies. Those projects would not necessarily need to be near a source of Colorado River water to affect an exchange.

F-2-32

This comment does not accurately reflect the information published by Reclamation in the Draft EIS. The referenced section on Page 4-79 of the Draft EIS states "The river flow reductions that were observed for the river reaches downstream of Hoover Dam under the action alternatives were similar to those previously analyzed in the LCRMSCP Final EIS and LCR MSCP BA/BO".

Also see responses to Comment Nos. F-2-19 and F-2-20.

F-2-33

Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that discuss the creation and delivery of Intentionally Created Surplus (ICS) for all Lower Basin water supply conditions (including during a Shortage Condition and a Surplus Condition).

F-2-34

Reclamation concurs with this comment. The text in Section 1.8.5 and Section 4.8.1.2 has been modified.

F-2-35

See responses to Comment Nos. F-2-19 and F-2-20.

F-2-36 through F-2-38

The discussion of the potential impacts on vegetation has been expanded in the Final EIS to more directly address the connection between changes in annual median flows, groundwater levels, and riparian and marsh vegetation impacts. Sections 4.8.3.4 and 4.8.3.5 have also been modified in the Final EIS to include discussions of the magnitude, frequency, and duration of annual median flow differences under all alternatives and the anticipated effects on riparian groundwater levels and vegetation.

F-2-39

Information presented in the Draft EIS has been modified in the Final EIS to clarify this issue. Reclamation identified that the temperature graphs used in the Draft EIS (presented in Appendix P) could be clarified by establishing a single temperature output for each month at the three Lake

Powell elevation percentiles. Accordingly, for the Final EIS, the average monthly temperature for each month at the 10th, 50th and 90th percentile were used rather than the range provided in the Draft EIS. Based on this revision, the average temperature for some of the action alternatives does fall lower than the No Action Alternative. As a result, Reclamation added additional discussion on these potential impacts to fishery resources in the Final EIS. Please refer to Chapter 4.8 for discussion of the results of these analyses.

F-2-40

Information presented in the Draft EIS has been modified in the Final EIS (see Section 4.8.4.3 and Table 4.8-5) to clarify this issue. The FEIS includes a discussion and analysis of McNeill's sooty-winged skipper and its habitat at Lake Mead.

F-2-41

The discussion regarding woundfin at Lake Mead in the Draft EIS was related to those individuals that may move downstream from the Virgin River into Lake Mead as the lake level drops and more riverine habitat is exposed in the inflow area upstream of Lake Mead and is not intended to indicate that woundfin regularly inhabit Lake Mead under current conditions.

F-2-42

Reclamation concurs with this comment. A discussion on potential impacts to the Colorado River Cotton Rat has been added to the Special Status Species discussion in Chapter 4.8 of the Final EIS and addresses the area from Davis Dam to Lake Havasu.

F-2-43

It is anticipated that the ROD for this EIS will implement guidelines for the coordinated management of the Lake Powell and Lake Mead. These guidelines will be used in the AOP process to inform the Secretary's decisions with regard to the annual release from Lake Powell for each year. The Long-term Experimental Plan (LTEP) for the operation of Glen Canyon Dam is primarily focused on implementing a structured, long-term program of experimentation (including dam operations, as well as other potential management actions such as removal of non-native fish species). Dam operations considered by LTEP will not modify Lake Powell's annual release. Potential changes to daily and seasonal patterns of release relative to the assumptions in this EIS may occur due to LTEP; however, those changes anticipated to be addressed in the LTEP EIS or other appropriate decision making processes.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX

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Federal Activities Office - 75 Hawthorne St., San Francisco, CA 94105

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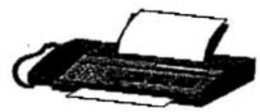

TO: Regional Director

Organization: Lower Colorado Region, Bureau of Reclamation, ATTN: BCOO-1000

Subject: Region 9 EPA comments on DEIS Lower Basin Shortage Guidelines

Ph #: 702-293-8500

Fax #: 702-293-8156

FROM: Laura Fujii, Environmental Review Office, Region 9 US EPA

Ph #: 415-972-3852

Fax #: 415-947-8026

E-Mail Address: Fujii.laura@epa.gov

Date Sent: April 30, 2007

Number of pages including cover sheet: 10

Comments: The original signed letter is being sent to you in the mail.

F-3

APR-30-2007 MON 12:11 PM U.S.E.P.A. FAX NO. 4159478026 P. 01

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

April 30, 2007

Robert W. Johnson
Regional Director
Lower Colorado Region
Bureau of Reclamation
Attn: BC00-1000
P.O. Box 61470
Boulder City, NV 89006-1470

Subject: Draft Environmental Impact Statement for Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions, Lower Colorado River Basin

The U.S. Environmental Protection Agency (EPA) has reviewed the above-referenced document pursuant to the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508), and our NEPA review authority under Section 309 of the Clean Air Act. Our detailed comments are enclosed.

EPA supports the development of shortage guidelines which will provide specific criteria for reductions in annual water deliveries during low reservoir conditions. The beneficial uses of the Lower Colorado River are diverse, providing vital environmental, economic, and public health benefits for Arizona, California and Nevada (Lower Basin States). Unpredictable, large disruptions in water deliveries or sudden changes in Lake Mead and Lake Powell operations could have significant adverse impacts on these beneficial uses. The draft environmental impact statement (DEIS) makes clear that action is required to address future shortages. All of the action alternatives would reduce the probability of shortages and increase the flexibility to operate the Colorado River water supply system for multiple purposes.

We commend the Bureau of Reclamation (Reclamation) and cooperating agencies
for evaluating a range of alternatives that define the trade-offs between different users and
benefits, such as water supply, hydropower generation, and recreation. We recognize that
Reclamation is convening a workgroup of climate change experts to evaluate the water
supply implications of climate change, and we support the consideration of this 1
information in your final decision-making on this project. EPA supports the overall
approach as proposed in the Conservation Before Shortage and Basin States alternatives,
in particular the concepts of voluntary shortages prior to involuntary shortages and the 2
storage and delivery of conserved system and non-system water (water banking).

F-3
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Based upon our review, we have rated this DEIS, and the proposed action
alternatives, Environmental Concerns - Insufficient Information (EC-2) (A *Summary of* 3
EPA Rating Definitions is enclosed) due to concerns with potential adverse effects to
beneficial uses and the need for additional information regarding the effects of climate
change, banking of conserved water, and monitoring. EPA is concerned that long-term 4
reduction of water quantities and availability due to drought, shortage declarations,
climate change, and increasing growth and water demand will result in adverse impacts to 5
in-stream resources (riparian habitat, fish and wildlife), water quality, water supply
management flexibility and associated cumulative impacts. Additional information on
changing climatic conditions and water management mechanisms will contribute to more 6
systematic water resources planning and further explain key components of proposed
actions.

We recommend Reclamation develop a comprehensive, annotated list of water
management tools available to Colorado River users to further enhance the Colorado 7
River system flexibility and the benefits of the proposed approach. In that regard, we
recommend the final environmental impact statement (FEIS) include a description of, and
commitment to, a detailed monitoring, adaptive management, and water banking 8
accounting plan. The shortage guidelines should be based upon the principles of: 1)
collaboration, partnerships, and a transparent public involvement process; 2) protection of
the environment, human health, and beneficial uses of the Colorado River; 3) 9
minimization of involuntary reductions; and 4) mitigation of direct, indirect, and
cumulative impacts. EPA supports system management for small, predictable reductions
in annual water use versus large, involuntary disruptions in water supply service and 10
Colorado River flows.

We appreciate Reclamation's February 5, 2007 presentation to EPA on this project and the opportunity to provide comments on the DEIS. We would be glad to set up a conference call to discuss the enclosed recommendations. We look forward to continued participation in this process as more information becomes available. When the FEIS is released for public review, please send <u>two</u> copies to the address above (mail code: CED-2). If you have any questions, please contact me or Laura Fujii, the lead reviewer for this project. Laura can be reached at 415-972-3852 or fujii.laura@epa.gov.

Sincerely,

for Enrique Manzanilla, Director
Communities and Ecosystems Division

Enclosure:
Summary of EPA Rating Definitions
Detailed Comments

cc: Jayne Harkins, Assistant Regional Director, Lower Colorado Region, BOR
Rick L. Gold, Regional Director, Upper Colorado Region, BOR
Terrance J. Fulp, Area Manager, Boulder Canyon Operations Office, BOR
Nan Yoder, Project Manager, Boulder Canyon Operations Office, BOR
Randall Peterson, Salt Lake Office, Upper Colorado Region, BOR
California State Water Resources Control Board
US Fish and Wildlife Service
Western Area Power Administration
Regional Tribal Operations Committee

F-3

APR-30-2007 MON 12:12 PM U.S.E.P.A. FAX NO. 4159478026 P. 04

U.S. Environmental Protection Agency Rating System for Draft Environmental Impact Statements Definitions and Follow-Up Action*

__Environmental Impact of the Action__

LO – Lack of Objections

The U.S. Environmental Protection Agency (EPA) review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC – Environmental Concerns

EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce these impacts.

EO – Environmental Objections

EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU – Environmentally Unsatisfactory

EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

__Adequacy of the Impact Statement__

Category 1 – Adequate

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2 – Insufficient Information

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses or discussion should be included in the final EIS.

Category 3 – Inadequate

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the National Environmental Policy Act and or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA __Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment__. February, 1987.

F-3

APR-30-2007 MON 12:12 PM U.S.E.P.A. FAX NO. 4159478026 P. 05

EPA DETAILED DEIS COMMENTS LOWER BASIN SHORTAGE GUIDELINES AND COORDINATED MANAGEMENT STRATEGIES FOR LAKE POWELL AND LAKE MEAD UNDER LOW RESERVOIR CONDITIONS, LOWER COLORADO RIVER BASIN, CA, AZ, NV, APRIL 30, 2007

Conservation and Water Use Efficiency

The Basin States and Conservation Before Shortage alternatives include water management tools which would enhance the management flexibility of the Colorado River system. EPA strongly supports the implementation of these tools to maximize water conservation and water use efficiencies – key components of supply and demand management – if adverse effects on third parties (e.g., downstream users, in-stream beneficial uses) are minor. Innovative and aggressive supply and demand management is essential in assuring a long-term, sustainable balance between available water supplies, demand, and ecosystem and public health. Efforts to improve system flexibility, conservation, and water use efficiencies are even more urgent given the projected growth in the Lower Colorado River Basin, the adverse effects of the multi-year drought, and the potential adverse effects of climate change on scarce water supplies.

Recommendations:

We urge the Bureau of Reclamation (Reclamation) to include a detailed tool kit of supply and demand management measures in an appendix in the Final Environmental Impact Statement (FEIS). This appendix could serve as an extension of any of the action alternatives; further enhancing Colorado River system flexibility and the benefits of the proposed management approach. The list of tools could also serve as a resource for Colorado River water providers (e.g., water districts, irrigation districts) who wish to maximize the effective use of their water supplies. The appendix should describe the full range of tools available to users to improve water quality and reuse, maximize water use efficiencies, balance supply and demand, and avoid and minimize adverse effects to third parties. The description of these tools should include a report of each tool's potential adverse third party effects, its ability to enhance water management flexibility, mitigation opportunities, and the most appropriate entities to use the tool. 11

As recommended by the Water Science and Technology Board (National Academy of Sciences)[1], we urge Reclamation to work with Colorado River users to conduct a comprehensive, action-oriented study of Colorado River region urban and agricultural water practices and changing patterns of demand. If integrated with the proposed shortage guidelines, this study could provide a more systematic basis for water resources planning across the region. We recommend the FEIS address the need for this study and how and when the study could be conducted. 12

[1] Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability (2007), p. 9. Water Science and Technology Board, National Academy of Sciences, 500 Fifth St. N.W., Washington, D.C. 20001.

1

F-3

APR-30-2007 MON 12:13 PM U.S.E.P.A. FAX NO. 4159478026 P. 06

Efficient water use can be influenced by development, infrastructure, and drinking water policies. We recommend the FEIS explore the linkages between these different factors and describe potential mechanisms to align them in order to better protect water resources. We recommend the FEIS provide a short discussion of who could best implement the identified mechanisms. The following reports may be of assistance as a starting point for your evaluation:

- Growing Toward More Efficient Water Use: Linking Development, Infrastructure, and Drinking Water Policies. EPA Publication 230-R-06-001, EPA National Service Center for Environmental Publications, (800) 490-9198 or nscep@bps-lmit.com.
- Protecting Water Resources with Higher-Density Development. EPA publication 231-R-06-001. EPA National Service Center for Environmental Publications, (800) 490-9198 or nscep@bps-lmit.com.

We recommend the Affected Environment chapter of the FEIS describe the current efforts to increase conservation, water use efficiencies, water supplies, and management flexibility for the Colorado River system. For instance, provide a summary of Arizona's Drought Management Plan, efforts by California to ensure adequate water supplies for southern California, and the conservation and use measures being taken by the Southern Nevada Water Authority (SNWA). 13

Storage and Delivery of Conserved Water (Water Banking in Lake Mead)
The DEIS analysis clearly demonstrates the benefits of the storage and delivery of conserved water (water banking). These benefits include the reduced probability of shortages, increased Colorado River management flexibility, and increased probability for flows below Morelos Diversion Dam, under some alternatives, that could benefit the complex riparian ecosystem of the Limitrophe Reach (Northern International Boundary to the Southern International Boundary) (p. ES-14, p. 4-76) and Colorado River Delta.

Recommendations:
The Basin States alternative limits the use of water banking in Lake Mead to the Lower Basin States while the Conservation Before Shortage alternative allows other entities, including Mexico, to utilize this water bank. The allowable total amount of stored conserved water also varies between alternatives. In order to fully realize management flexibility through water banking, EPA recommends the selected alternative maximize the use of water banking by allowing a broad range of users and ample storage capacity for conserved water. 14

The Conservation Before Shortage alternative includes the concept of compensated voluntary water reductions, triggered by specific Lake Mead elevations and financed through a compensation program. Under this concept willing Lower Basin users, including Mexico, would be paid to voluntarily and temporarily reduce their water use (p. 4-82). To facilitate regional efforts to optimize water use, we recommend the FEIS provide additional information on 15

2

F-3

APR-30-2007 MON 12:13 PM U.S.E.P.A. FAX NO. 4159478026 P. 07

Lake Mead elevation triggers, funding mechanisms, and management of the compensated voluntary water reduction program. 15

We recommend the FEIS include a detailed description of the accounting procedures and conserved water validation process for the storage and delivery of conserved water in Lake Mead. 16

Monitoring and Adaptive Management Plan

The DEIS analysis depends heavily on probabilistic models based upon a number of assumptions regarding precipitation, climate, water supply depletion rates, water supply policy and trends, and conservation programs. We recommend that existing conditions be monitored and model assumptions validated.

Recommendation:

Given the assumptions and uncertainties surrounding probabilistic models, we recommend Reclamation develop and commit to a detailed monitoring and adaptive management plan as part of the FEIS. We recommend the plan include details on what, who, and when to monitor; the process used to ensure monitoring results feed into the management decision process, and how monitoring can be used to help verify model assumptions. 17

The ability to monitor the hydrology of the Colorado River is provided by the U.S. Geological Survey's Colorado River Streamflow Gaging Network. As stated by the Water Science and Technology Board,[2] financial support for these stream gaging stations has been inconsistent and limited in recent years. The loss of stations with long periods of record (greater than 30 years) is of concern because they provide key data for understanding Colorado River hydrology and water quality (e.g., downstream perchlorate contamination, temperatures, sedimentation) and thus for Colorado River water management.

Recommendation:

We recommend the FEIS describe how Reclamation and other users of the Colorado River can ensure resources are available to maintain and expand the Colorado River Streamflow Gaging Network. 18

Climate Change

A number of studies specific to the Colorado River Basin have indicated the potential for significant environmental impacts as a result of changing temperatures and precipitation.[3] While we commend the inclusion of the hydrologic sensitivity analysis to determine model results with a wider range of hydrologic variability (Appendix N), we believe that

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[2] Water Science and Technology Board, pps 4-5.

[3] For example, Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability (2007); The Colorado River Basin and Climatic Change, Linda L. Nash & Peter H. Gleick (1993) (EPA Publication 230-R-93-009).

APR-30-2007 MON 12:14 PM U.S.E.P.A. FAX NO. 4159478026 P. 08

a more extensive discussion of climate change and its potential effects on the proposed action would better serve long-term, Basin-wide water management planning.

Recommendation:
We recommend the FEIS include a separate discussion of climate change and its
potential effects on the proposed action and the action's impacts. We recommend 19
this discussion provide a short summary of climate change studies specific to the
Colorado River Basin, including their findings on potential environmental and
water supply effects and their recommendations for addressing these effects.
Potential effects to examine include the incremental effects on shortage
allocations and land use. For example, if there is a projected 10-20% reduction in
precipitation for the Colorado River[4], we would recommend the FEIS describe the
effect on potential shortages, whether California would experience a higher
probability of shortages, and whether adverse land use effects, in addition to 20
temporary agricultural fallowing, could occur under a shortage determination.

Tribal Impacts

The DEIS provides a limited description of the Cocopah Indian Reservation (p. 3-84), the Limitrophe Reach, and potential cultural resources in this region. Twelve miles of the Limitrophe Reach lie within the Cocopah Indian Nation. This reach includes a complex riparian ecosystem that supports a wide variety of birds and wildlife. The multi-agency effort, in cooperation with the Cocopah Indian Nation, to restore 350 acres of this habitat signifies the ecological importance of the Limitrophe Reach. We also note that the Cocopah Indian Nation and their cultural interests extend down to the Colorado River Delta.

Recommendations:
We recommend the FEIS include a more detailed description of the ecological
resources of the Limitrophe Reach and of cultural resources below Imperial Dam 21
to the Southern International Boundary. Potential impacts to these resources
should be fully evaluated and described in the FEIS. We recommend the FEIS 22
include a description of the Cocopah Indian Nation, including a description of
their tribal interests and concerns down to the Colorado River Delta and potential 23
effects on these tribal interests.

Power Generation

Although the action alternatives would have minor impacts on the economic value of electrical power generation at Glen Canyon and Hoover Dams, the total loss of electrical power generation capabilities would have a substantial effect on the Basin Power Funds which rely on power revenues (pps. 4-230, 4-241). These funds provide key support for Colorado River environmental programs, the Colorado River Salinity Control Program, and projects to address Tribal water right settlements.

[4] Nash and Gleick, p. ix.

4

F-3

APR-30-2007 MON 12:14 PM U.S.E.P.A. FAX NO. 4159478026 P. 09

Recommendation:

EPA is concerned with the potential reduction of the Basin Power Funds. We 24 recommend the FEIS describe potential mitigation measures that could be included in the selected alternative to offset or replace these revenue reductions. 25

5

F-3

Reponses to Comment Letter F-3

F-3-1

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

F-3-2

Your comment is noted. No change to the Final EIS was necessary.

F-3-3 and F-3-4

Your comment is noted. The content of the Final EIS has been modified as appropriate.

F-3-5

Your comment is noted. The content of the Final EIS has been modified as appropriate.

F-3-6

Your comment is noted. The content of the Final EIS has been modified as appropriate.

F-3-7

Water supply planning and water supply management occurs at the federal, state, regional and local levels. Most states, regional agencies, local agencies, and communities already have or are in the process of preparing water resources management plans and/or drought management plans that address varying water demand and water supply management issues. The proposed guidelines are intended to, among other benefits, provide mainstream United States users of Colorado River water, particularly those in the Lower Division states, a greater degree of certainty with respect to the amount of annual water deliveries in future years, particularly under drought and low reservoir conditions and provide additional mechanisms for the storage and delivery of water supplies in Lake Mead. Additionally, the proposed water storage and delivery mechanism is expected to be used by agencies to increase their flexibility in meeting water use needs from Lake Mead. Implementation of these guidelines will be highly beneficial to water supply planners and will provide added water supply management options that can be used by agencies to develop more comprehensive plans to meet their water use needs, particularly during drought or low reservoir conditions.

F-3-8

Your comment is noted. Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that address the administration of the ICS mechanism.

F-3-9 and F-3-10

Reclamation concurs with these comments. No change to the Final EIS was necessary.

F-3-11

See response to Comment No. F-3-7.

F-3-12

Your comment is noted. No change to the Final EIS was necessary.

F-3-13

Your comment is noted. Additional information with respect to the drought response and water supply management plans of Arizona, MWD, and SNWA have been included in Section 4.14 in the Final EIS.

F-3-14

Your comment is noted. The environmental impacts of a mechanism allowing ICS of up to 4.2 maf have been analyzed for the Preferred Alternative identified in the Final EIS.

F-3-15

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment, as well as other public comments. Section H.6. of the Final EIS includes an additional assessment that considers the impacts of a compensated voluntary conservation program. Additionally as noted in Section 2.4.5 of the EIS, the Conservation Before Shortage proposal postulated several potential funding sources which the Department currently does not have the authority to implement in their entirety absent additional legislation. The viability of this funding proposal is not known at this time and therefore there is some uncertainty as to whether all of the elements of the Conservation Before Shortage proposal can be implemented.

F-3-16

See response to Comment No. F-3-8.

F-3-17

Your comment is noted. No change to the Final EIS was necessary.

F-3-18

The United States Geological Survey (USGS), in cooperation with Reclamation and other regional and local agencies, maintains a stream flow gaging system throughout the Colorado

River Basin. Reclamation also maintains additional gages in the Lower Basin. The data from these systems is used to monitor and record flows throughout the mainstream and tributaries of the Colorado River. Although Reclamation is committed to maintaining its gaging network in addition to assisting the USGS, ensuring that resources are available to expand and maintain these networks is beyond the scope of this EIS.

F-3-19 and F-3-20

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

F-3-21 and F-3-22

The information requested regarding ecological resources in the NIB to SIB reach (limitrophe) is provided in the Draft and Final EIS. Section 3.8 provides a discussion of the vegetation and wildlife species present in the study area by river reach, including the NIB to SIB reach. Additional information on the existing endangered and listed species that are found in the NIB to SIB reach can be found in the LCR MSCP EIS (Reclamation 2004). Section 4.8 describes the potential effects of the proposed action, again by river reach including the NIB to SIB reach.

As noted in Section 3.9, there is little to no data relative to the existence of historic properties within the river channel for the river reach that extends from Imperial Dam to the SIB. Nevertheless, any known or as yet undiscovered cultural resources within this reach of the River will not be affected by the No Action Alternative or action alternatives because the current river operations will continue into the future

F-3-23

Section 3.10 provides a description of Indian Trust Assets (ITA), including those of the Cocopah Indian Reservation. Potential impacts to ITAs as a result of the proposed federal action are discussed in Section 4.10.

F-3-24 and F-3-25

Section 4.11 provides a description of electrical power resources, including the Basin Funds. Potential impacts to the Basin Funds as a result of the proposed federal action are discussed in Section 4.11.

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BC00-1000
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INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

APR 27 2007

Bureau of Reclamation
Attention: BC00-1000
P.O. Box 61470
Boulder City, NV 89006-1470

Dear Bureau Staff:

Thank you for providing the opportunity to review the Draft Environmental Impact Statement, titled *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* (DEIS). The United States Section, International Boundary and Water Commission (USIBWC) is charged through various treaties and international agreements to evaluate the relationship of projects to international obligations of the United States. The following and attached review comments are for your consideration and use.

The International Boundary and Water Commission (IBWC) is responsible for applying the boundary and water treaties between the two countries and settling differences that arise in the application of the treaties. The United States Section carries out the activities in the United States resulting from obligations and rights assumed with the Government of Mexico in accordance with these treaties and related agreements. The USIBWC duties include review of projects on resources in the United States and effects potentially crossing into Mexico.

The IBWC has agreements that pertain to issues within the Colorado River watershed, the Treaty Relating to the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, and supplementary protocol, November 1, 1944 Untied States-Mexico (1944 Water Treaty), the Treaty to Resolve Pending Differences and Maintain the Rio Grande and Colorado River as the International Boundary Between the United States and Mexico, signed at Mexico November 23, 1970 (1970 Boundary Treaty), and several related agreements that merit consideration.

In accordance with the 1944 Water Treaty, the United States delivers 1.5 million acre-feet of Colorado River water annually to Mexico. The treaty also states that when there is water surplus to United States uses, an additional volume of up to 200,000 acre-feet/year may be delivered. The two Governments entrusted the IBWC to give attention to salinity control. Minute No. 242, a binding agreement of the United States and Mexican Governments, controls the salinity of Colorado River water delivered to Mexico. The Minute also provides for limits on groundwater pumping within five miles of the international boundary near San Luis, Arizona, and for consultations between the two countries prior to undertaking any new development of the surface or groundwater resources, or undertaking substantial modifications of present developments in the border area, that might adversely impact the other country. Commission Minute No. 306 provides for cooperation between the two countries in the development of studies and recommendations regarding the ecology of the Colorado River limitrophe and delta. The 1970

F-4

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Boundary Treaty includes providing for the preservation of the Colorado River as the international boundary.

These agreements are all available on the USIBWC web page at www.ibwc.state.gov.

The USIBWC is the primary federal agency responsible for promoting the identification, investigation, and resolution of transboundary and boundary water and border technical issues along the United States and Mexico boundary region. The USIBWC carries out its statutory responsibilities through binational cooperation and in partnership with other entities. The United States Government gives limited technical investigative authority to the USIBWC.

Thank you again for the opportunity to review and comment on the DEIS. If you have any questions regarding these comments, please call me at (915) 832-4702 or contact R. Steve Fox, Environmental Protection Specialist, at (915) 832-4736.

Sincerely,

Gilbert G. Anaya
Supervisory Environmental Protection Specialist
Environmental Management Division

F-4

DRAFT Review Comments, United States Section, International Boundary and Water Commission, April 2007, on the *Draft Environmental Impact Statement Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*, February 2007, Bureau of Reclamation

General Comment.

The Draft Environmental Impact Statement (Draft EIS) seems to be on water management and deliveries.

Specific Comments.

Page TOC-viii, Section 6.8. Revise to "Consultation with Government of Mexico Agencies" or "Consultation with Agencies of Mexico." 1

Page 1-3, line 34, delete "drought and" 2

Page 2-4, line 34. Revise to "In addition, the determination of shortages to Mexico does not fall under the authority of the Secretary, and therefore is not a part of the proposed federal action. 3
Such determination would be made in accordance with the 1944 Treaty" (Section 1.7). Page 2-4, 4
line 36. Specify the Subsection of the stated "(Section 1.7)," as the Section is broad.

Page 2-15. Line 22. Add a sentence or footnote to indicate that potential future Mexican participation in a storage and delivery mechanism is assumed to be included within the range for the "Unassigned" category in Table 2.6-1. 5

Page 3-3, Section 3.2. Please comment on the following. Based on the Section and Chapter 4, there could be effects to the services of MWD. MWD provides assistance to the IBWC on the "emergency transfer of a part of Mexico's Colorado River water through the Southern California aqueduct system to the emergency water connection at Otay Mesa for deliveries to Tijuana, Baja California, Mexico." Minute 310 was signed in 2003. The USIBWC FONSI notes that the agreement is for five year. 6

Page 3-46, line 1. Specify the Subsection of the stated "(Section 3.4)." Section 3.4 is referenced in line 1 of the Draft EIS in the context of salinity yet the Section is on water quantity, not quality. Recommended is stating such. 7

Page 4-8, lines 31-37 and Page 4-9, lines 1-2. This paragraph is confusing. It should be rewritten 8
for clarification. The statement "replacement of bypassed water is not assumed to occur in the
future" is particularly confusing. What does this mean in terms of modeling deliveries to Mexico 9
or why was that assumption made?

Page 4-119, lines 1-3. The sentence: "The occurrences of deliveries greater than 1.5 mafy reflect both times when additional water up to 200 kafy is made available during Flood Control conditions." After the word "available" insert the word "and." 10

F-4

3

Page 4-119, Figure 4.4-32 and others. The Figure and other charts in this Section label the y-axis as "Annual Depletions." Recommended is changing those labels to "Annual Deliveries," though they are depletions from the system. 11

Page 4-131, Section 4.5. Subsections 4.5.2.1 and 4.5.3 are on salinity. It is suggested that the Draft EIS describe the Minute 242 requirements regarding the applicable salinity differential for water deliveries to Mexico, and reference Section 3.5.1, page 3-46, on salinity. 12 It is also suggested that the Draft EIS state what the alternatives' effect would be on the salinity of waters delivered to Mexico and Minute 242 compliance. 13

Page 6-5, line 16. The Draft EIS states "IBWC and Mexico National Water Commission Meetings with representatives of Mexico…" Revise to "IBWC, the Mexico National Water Commission, and Mexico Secretariat of Foreign Relations meetings with agencies of Mexico …" 14

Page 6-8. Delete "**United Mexican States Agencies**" and insert "**Government of Mexico Agencies**." 15

Page B-32, line 2. Delete "… approximately 25 miles …" and insert "… 23.7 miles …" 16

Page B-32, line 11. Insert "The current design flood flow in the limitrophe is 140,000 cfs." 17

Page B-32, line 26. Insert after the words "The reach of" the word "the." 18

Page B-32, line 33, after "up to" insert "an additional."
With this change, it would read, "Mexico is allowed to schedule up to an additional 200 kaf pursuant to the 1944 Treaty during flood control years…." 19

Page I-1, Table I-1, U.S. Department of State. Insert after the stated "Various planning meetings" the punctuation and date "; 6/23/06." 20

Page I-2. Delete "**United Mexican States Agencies**" and insert either "**Government of Mexico Agencies**," or "**Agencies of Mexico**." 21

Page I-2, Table I-1, International Boundary and Water Commission, Mexican Section. Insert after the stated date "2/8/06," the words and punctuation "including the shortage issues and EIS,". 22 Also, insert after the stated "9/25-29/06" the words and punctuation "; including Upper Basin Tour." 23 Finally, insert, in bold in column one, another category at the end of the table, and title it "International Boundary and Water Commission (IBWC)." In column two of the same new entry, insert the words and meeting date "IBWC and Reclamation, meetings, including 6/23/06." 24

Page I-2. Table I-1. It is recommended to add additional meeting dates that occurred in February and March 2007 with the Mexican representatives. 25

Page M-8, lines 10-18. This paragraph is confusing, especially the last sentence on lines 16-18. It is suggested that this concept be clarified. If the storage credits were assumed to be generated 26

F-4

4

via extraordinary conservation within Mexico, then how could they be used by the United States to be counted toward replacement of the bypass flows to the Cienega de Santa Clara in Mexico? 26
Does this assume that U.S. entities would pay to acquire some of Mexico's water? If so, then it raises significant treaty compliance issues. 27

F-4

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Reponses to Comment Letter F-4

F-4-1

Your comment is noted. The TOC and Section 6.8 have been revised in the final EIS to reflect the suggested changes.

F-4-2

Reclamation does not concur with this comment. No change to the Final EIS was made.

F-4-3

Your comment is noted. No change to the Final EIS was necessary. The Draft EIS and the Final EIS include statements throughout clearly stating that determinations regarding water deliveries to Mexico would be made in accordance with the 1944 Treaty and are therefore not part of the proposed federal action.

F-4-4

Your comment is noted. The reference has been changed from Section 1.7 to Section 1.7.2.3.

F-4-5

Your comment is noted. No change to the Final EIS was necessary. As noted in Appendix M, at this time, it is unknown which entities might participate in a Lake Mead mechanism that allows the storage and delivery of conserved system and non-system water. However, modeling assumptions with respect to the entities that might participate and their respective level of participation were needed to enable the evaluation of the mechanism and its potential effects on environmental resources, particularly to reservoir storage and river flows below Lake Mead. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico.

F-4-6

Under the current modeling assumptions, the probability of shortages to California and MWD is zero over the interim period for the Preferred Alternative (Section 4.4.7.2 of the Final EIS).

F-4-7

Your comment is noted. The reference has been changed from Section 3.4 to Section 3.4.5 in the Final EIS.

F-4-8

Your comment is noted. Information presented in the EIS in Section 4.2.7 accurately reflects the modeling assumptions that are common to the No Action Alternative and the action alternatives. No change to the Final EIS was necessary with regard to expanding or clarifying the paragraph referenced in the comment. However, although not part of the comment, there was an omission in the first sentence of this paragraph. The first sentence in this paragraph has been revised in the Final EIS.

F-4-9

As discussed in Section 4.2.7 of the Final EIS, the bypass of return flows from the Welton-Mohawk Irrigation and Drainage District to the Cienega de Santa Clara in Mexico is assumed to be 109 kafy (the historical average for the period 1990 through 2005). This water is not counted as part of the 1944 Treaty delivery.

Except under the Conservation Before Shortage and Reservoir Storage alternatives, replacement of the bypassed water is not assumed to occur in the future. Under those alternatives, replacement of the bypass flows was assumed to be part of activities related to the storage and delivery mechanism.

The United States recognizes that it has an obligation to replace, as appropriate, the bypass flows and the assumptions made herein, for modeling purposes; do not necessarily represent the policy that Reclamation will adopt for replacement of bypass flows. The assumptions made with respect to modeling the bypass flows are intended only to provide a thorough and comprehensive accounting of the Lower Basin water supply. The United States is exploring options for replacement of the bypass flows, including options that would not require operation of the Yuma Desalting Plant. For modeling purposes only, the Yuma Desalting Plant is not assumed to operate over the modeling period.

F-4-10

Your comment is noted. No change to the Final EIS was made.

F-4-11

Your comment is noted. No change to the Final EIS was made. The term “depletions” is used throughout the EIS and is defined in the Glossary.

F-4-12 and F-4-13

Your comment is noted. Additional language has been added to Section 3.5.1 and Section 4.5.3 in the Final EIS.

F-4-14

Your comment is noted. The referenced sentence in Section 6.8 has been modified in the Final EIS.

F-4-15

Your comment is noted. The referenced entry in Table 6.9-1 has been modified in the Final EIS.

F-4-16

Your comment is noted. The referenced sentence in Section B.2.8 has been modified in the Final EIS.

F-4-17

Your comment is noted. No change to the Final EIS was necessary. The design capacity of the limitrophe reach is already noted in the second paragraph in Section B.2.8.

F-4-18

Your comment is noted. The referenced sentence in Section B.2.8 has been modified in the Final EIS.

F-4-19

Your comment is noted. The referenced sentence in Section B.2.8 has been modified in the Final EIS.

F-4-20

Your comment is noted. No change to the Final EIS was made.

F-4-21

Your comment is noted. The referenced entry in Table I-1 has been modified in the Final EIS.

F-4-22 through F-4-24

Your comment is noted. No change to the Final EIS was made.

F-4-25

Your comment is noted. The appropriate information in Table I-1 has been updated in the Final EIS.

F-4-26 and F-4-27

See response to Comment No. F-4-5.

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INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

April 30, 2007

Bureau of Reclamation
Attention: BCOO-1000
PO Box 61470
Boulder City, NV 89006-1470

Dear Bureau Staff:

The U.S. Section of the International Boundary and Water Commission provided a copy of the Draft Environmental Impact Statement on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead to the Mexican Section of the Commission and invited comment from the Mexican Section. The Mexican Section provided detailed comments by means of a letter dated April 25, 2007. By means of this letter, I wish to communicate the Mexican Section's views to the Bureau in English. 1

The Mexican Section indicates that its comments of April 25 supplement initial views presented in a letter on March 29, 2007. That initial letter expressed the following views:

The Mexican Commissioner has indicated that any proposal for basin operations that affects Mexico's allocation needs to be approved bilaterally within the framework of the IBWC, particularly any alternatives that imply an interpretation or application of the extraordinary drought clause of the 1944 Water Treaty. Any reduction in the allocation of water to Mexico shall be done in strict conformance with the terms of the Treaty. As stated in the meetings, Mexico views that the reduction applicable to Mexico in the event of extraordinary drought should be proportional to consumptive uses in all of the basin states, not just those of the lower basin. 2 3 4

He also expresses Mexico's interest in being informed about and participating in discussions about sustainable use of the basin and, as appropriate, for Mexico to be a proportional beneficiary of conservation measures that could affect water availability in the main channel of the Colorado River. 5

Moreover, he states concern that operations under the shortage criteria could affect the salinity of Colorado River water delivered to Mexico, reduce the likelihood of surplus waters being delivered to Mexico in excess of the 1.5 million acre-foot annual allotment, and reduce environmental flows to the Colorado River Delta. 6 7 8

The Mexican Section is also concerned that the Draft Environmental Impact Statement (EIS) includes aspects related to Mexico that have not been agreed upon by the IBWC, which could generate false expectations regarding application of shortage criteria in Mexico. The Commissioner expresses his strong disagreement that alternatives that include Mexico do not take into account the concept of extraordinary drought as required by the 1944 Water Treaty in order to reduce allotments to Mexico. He is concerned that a perception has been created that Mexico has accepted the reduced allotments modeled in the alternatives – alternatives that do not conform to the 1944 Water Treaty. 9 10 11

End of the Mexican Section's March 29 comments

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F-5

In the letter of April 25, 2007, the Mexican Section expresses the following:

Any proposal for basin operations that affects allotments to Mexico must be agreed upon within the IBWC.

The EIS proposes conditions under which reductions of water allotments to users in the lower basin, including Mexico, will be undertaken. It clarifies that the modeling assumptions do not constitute an interpretation of the 1944 Water Treaty nor do they establish operating policies with regard to water deliveries to Mexico and that any determination about such deliveries will be made in accordance with the 1944 Water Treaty. Nevertheless, the use of modeling assumptions in relation to Mexico generates false expectations that those assumptions will be or must be accepted by Mexico and by having been recorded, they could be used in the future as a restriction or limiting factor in negotiations with Mexico.

We are concerned that in spite of the repeated statements from Mexico, the document that was released to the public presents assumptions that were not previously accepted by Mexico (timing, conditions, and proportion of the reductions to Mexico). 12

The reduction in the allotments of water to Mexico must be under the terms of the Treaty and proportional to consumption of all states in the basin.

The policy of reductions in the lower basin of the Colorado River and Mexico is maintained throughout the document but it does not include the upper basin, which means that Mexico bears a greater percentage of reduction (16.67%) than if proportional reductions were considered for all consumptive uses in the upper and lower basin (9.1%). 13

In the modeling of the reductions, Mexico is always included with Arizona and Nevada, while California is not included until level 2 is reached, and the upper basin is never included. This generates false expectations as to the timing and conditions under which there would be reductions to Mexico as well as the implicit acceptance by Mexico of those reductions. 14

Even the No Action alternative, which should not include implementation of any actions, contains strategies of cuts for Mexico.

After applying any of the four action alternatives, it reverts back to the No Action alternative, which is a de facto policy of cuts that significantly affect Mexico. 15

In this context, even the No Action alternative, as addressed in the EIS, is not acceptable to Mexico, yet the language implies that should none of the four alternatives be accepted, or once their period of application ends, Mexico would not object to the No Action alternative.

Consistent with the above, all of the alternatives show reductions to Mexico of various frequencies and quantities of water and none of them is acceptable in how issues related to Mexico are addressed. 16

The interest of Mexico in knowing about and participating in discussions of sustainable use of the basin and, as appropriate, being a proportional beneficiary of the conservation measures that could result in the modification of water availability in the main stem.

F-5

The EIS considers a conserved volume for Mexico charged to its allotment that is designated for
environmental use only and not for irrigation, its principal use in Mexico. Also, the delivery is not made 17
when Mexico needs it (situation of scarcity or normal conditions), but rather only in surplus conditions.
This type of voluntary conservation is of no use to Mexico. 18

No alternative was modeled in which Mexico could voluntarily conserve water to use it when it needs it.

Effect on the levels of salinity of the waters that Mexico receives.

In the analysis of the alternatives, only the quantity of water is evaluated, and not the quality of it. Given 19
the time to undertake these analyses with the sets of rules delivered during the current month of April, it is 20
assumed that the U.S. will comply with the salinity parameters agreed upon by the IBWC.

In the table shown on page ES18 it is observed that for three of the alternatives, increases in salinity levels
are recorded at Imperial Dam (5-20 ppm), which consequently would represent an increase in the salinity 21
of waters at Morelos Dam, since both are linked in conformance with Minute 242.

Limit on access to the surplus deliveries to Mexico.

Partial and total surpluses are allotted to U.S. users depending on reservoir storage and forecasts.
Nevertheless, these additional allotments could have as a consequence the reduction in the levels of the 22
dams that are indicators for declaring shortage. In this context, Mexico is excluded from distribution of
surpluses but included during a shortage declaration, which is unacceptable to Mexico. 23

Reduction in the occurrence of environmental flows required by the Colorado River Delta.

In Chapter 3 of the EIS (Page 3-29) it is mentioned that due to potential changes in reservoir storage that
occurs under the different action alternatives, the frequency and magnitude of flood control flows, which
are those that generate surplus deliveries to Mexico, could be affected. This represents an impact to 24
Mexico in both access to surplus deliveries as well as the occurrence of environmental flows in the Delta.

Around 16 species of fish and a list of bird species that live in the limitrophe reach are identified that
could be affected by application of the proposed federal action (Table 3.8-7). 25

As part of the cumulative impacts, it is noteworthy that the Drop 2 storage project will reduce the
volumes of over deliveries to Mexico and will have hydrologic effects in Mexican territory. 26

By allotting to the U.S. more frequent and greater quantities of surpluses, it leaves less water in Mead, so
that when Mead spills (less frequently) it is of a lesser volume and, as a result, less water arrives in 27
Mexico.

Inclusion of aspects that have not been agreed upon by IBWC that, by being made public in the U.S., generate false expectations on this issue.

During the binational meetings, Mexico questioned certain modeling assumptions related to Mexico;
nevertheless, in spite of the repeated questioning by Mexico, the document that was released to the public 28

F-5

presents assumptions that previously were not accepted by Mexico (timing and conditions of reductions to Mexico, proportion of the reductions to Mexico).

The inclusion of these assumptions will have an effect on the talks to define the term of extraordinary drought referred to in the Treaty or at the time when both governments set about to define the timing and conditions for making reductions, as well as the consultations that Mexico undertakes with its users. 28

Although the EIS is a document for domestic use in the United States, it is not acceptable that aspects related to Mexico are presented about which Mexico repeatedly expressed its disagreement and, as previously stated, any proposal for operating the basin that affects Mexico's allotments must be agreed upon within the IBWC under the terms of the 1944 Water Treaty. 29

End Mexican Section's comments of April 25

In addition to the above comments presented by the Mexican Section of the International Boundary and Water Commission, the U.S. Section has received observations from Mexico's National Water Commission (CNA). CNA's comments are as follows:

The Draft EIS presents five alternatives for operating the Colorado River basin from 2008-2026. The alternatives are presented as four federal action alternatives and one for reference, called the No Action alternative, which should lack any implementation of actions; nevertheless it contemplates strategies (reasonable ones in accordance with the draft EIS) of cutbacks to Mexico. In this sense, there is no control scenario where water would continue to be distributed as it is today. Although the EIS is for the purpose of internal analysis in the U.S., in fact it means there is already a de facto policy of cuts that significantly affects Mexico since, following the period of application of one of the four action alternatives, it reverts to the No Action alternative. This concerns the National Water Commission because, if none of the other four alternatives is accepted, it could be construed that Mexico would not object to the No Action alternative because it supposedly represents current conditions. 30 31 32

In the meeting held March 14, 2007, representatives of the U.S. Bureau of Reclamation explained to Mexican personnel from the IBWC and CNA that the draft EIS has been opened for public comment in the U.S. and to the opinion of Mexico until the end of April.

The minutes of that meeting confirm that the U.S. Bureau of Reclamation would provide to Mexico during the week of March 19 additional information requested by CNA so that CNA could provide its opinion on time. Nevertheless, it was not until April 10 that CNA received from the Mexican Section the agreed upon information, forcing us to review it under much pressure and it still has not been completely examined. 33

Upon conducting an analysis of the EIS, it is observed that at all times a policy of reduction in the lower part of the Colorado River basin and to Mexico is maintained. During the meetings it was mentioned that this was due to the fact that the states of the upper basin have natural reductions due to the fact that the flow of the river is insufficient for the required demand. It was also commented that the droughts in the upper basin are more frequent than in the lower basin. First, it must be reiterated that, according to the 1944 Water Treaty, the first step consists of declaring an extraordinary drought and, based on that, proportional reductions will be applied according to consumption in both countries, meaning the upper and lower basin together. Additionally, the term "consumption" implies that of current users and not to 34 35

F-5

APR-30-2007 MON 04:05 PM IBWC EL PASO FAX NO. 915 832 4191 P. 06/08

the volumes allotted that are still not utilized in the upper basin. From the analysis of drought undertaken 35
in the upper basin, it can be seen that its frequency and severity is not significant, and as such does not 36
constitute an argument to exclude the upper basin. It is observed in most cases that California is not 37
reduced until reaching a level 2. In any case, if the U.S. decides not to reduce California in any of the
alternatives, that is its decision. However, the reduction to Mexico should have been modeled only when
reductions were applied to the entire American basin, in conformance with the 1944 Water Treaty.
Mexico reiterates its concern that this modeling will generate false expectations and misinformation about
the timing and conditions under which there would be reductions in Mexico as well as Mexico's implicit 38
acceptance. This has great relevance when it comes time for both countries to evaluate the terms under
which cuts in allotments will have to be made, to define the term extraordinary drought, or for Mexico to
undertake consultations with its users. Until extraordinary drought is defined and declared, the U.S. must
comply with water deliveries to Mexico under the terms of the 1944 Water Treaty. What the EIS
proposes is a "goodwill" agreement.

An additional analysis performed on the Colorado River basin to verify that the upper basin is more
affected than the lower basin shows that the annual historic precipitation (1908-2006) has diminished less
than runoff. This could be due to three possible factors: 1) the basin could be dry in a year prior to a wet 39
year and part of the volume of water is lost due to seepage; 2) over pumping of groundwater reduces the
aquifer's contribution to base flow and, in extreme cases, suctions the flow from the streams; 3) rainwater
could seep into local sinkholes (natural or induced). In any event, more information is required,
especially regarding supply and demand of groundwater, in order to reach a possible conclusion. What is
certain is that the analyses show a noticeable reduction in rainfall and runoff. The fact that runoff has 40
been reduced with respect to water allotted in the Colorado River Compact, added to the presence of more
frequent droughts in the last two decades (the most recent since 2002) according to our analysis, indicates
that we must prepare ourselves for an imminent situation of periods of less runoff.

In the EIS (Appendix M) (*U.S. Section comment – we believe this is actually a reference to Appendix N*)
it appears that it is indicated that in 2026 the levels of Lake Mead will be stabilized because it will receive
a constant delivery from Lake Powell and because of that it won't fluctuate as much as during the interim
period for some of the alternatives studied. It is not clear what is meant by a stable situation for 2026
given that in the same Appendix M: 1) the graph of probability of shortages shows that they will exist
beyond 2026 and they will not have low values; 2) in 2010 there are cuts in the Reservoir Storage 41
alternative; 3) in 2017 there are lesser cuts to 1.0 maf; 4) in 2026 the majority are reductions of less than
1.0 maf but there are many at other levels; 5) in 2060 the majority of the cuts are of 500 kaf.

In conducting an analysis of the five alternatives and their effects on allotments to Mexico, the one that 42
seems to have fewer negative impacts on Mexico is Conservation Before Shortage. That is because U.S.
users would make voluntary efforts to maintain high levels in Powell. Nevertheless, the EIS refers to
voluntary conservation. In this scenario, conservation is managed as a voluntary reduction, but for
modeling purposes the U.S. Bureau of Reclamation ran suggested reductions. It must be noted that that
conserved waters are accounted for and charged to the users' allotments and the conserved volume could
be used later (discounting evaporation and a 5% charge for the benefit of the basin). In the case of
Mexico, the conserved volume at the expense of the allotment (1.5 maf) is designated for environmental 43
use only and not for irrigation (Mexico's main use). Also, the delivery is made not when it is required
(situation of scarcity or normal conditions) but rather only in a situation of abundance (modeled every
five years). Voluntary conservation in this manner is not useful for Mexico as a consumptive use.

F-5

Likewise, the EIS has a table in Appendix M with an error in that it shows that Mexico receives more water than conserved. (*U.S. Section comment – we are unclear from Mexico's comments which specific table is referenced.*) This is not possible from the physical point of view. The conserved volume is identical to the volume released in various examples on the table M4; but it should be less. 44

What is not modeled in the alternative is that Mexico would voluntarily conserve water to use when 45
needed. One aspect still pending is that, should this scenario take effect, and if it is in Mexico's best
interest, the U.S. government would need to take internal steps so that Mexico could store its conserved 46
volume. Additionally, Mexico would have to evaluate the legal impact of this measure. 47

In conclusion, this alternative only could be attractive for Mexico, in alliance with U.S. environmental organizations, if economic support from the U.S. is provided to make technical improvements to irrigation in Mexico. Otherwise, this is not considered a viable option for Mexico. 48

To better evaluate the behavior of the alternatives, analysis was done extending the interim period for 20 years before the No Action alternative entered into operation and sequences 23 and 46 were applied to this interim period, modeling the least favorable conditions that have occurred in the basin. These analyses show that for Mexico (in case it is obligated to choose from these five alternatives) the Water Supply alternative guarantees its complete allotment during the entire simulated period before the No Action alternative enters into force. Nevertheless, there exists the risk that once the No Action alternative enters into force, storage in the reservoirs would be so low that there would automatically be severe cuts 49
for Mexico. Given the recent climatic variability of the Colorado River basin, it would need to be
evaluated if this strategy of reductions after the interim period or a strategy of smaller shortages 50
distributed over the period would be beneficial to Mexico. Perhaps the decision could be supported with
U.S. funding to make technical improvements to irrigation systems in Mexico. 51

If the existing level of the reservoirs will be the indicator for making decisions, then there is no pressure on users that take water upstream of the reservoirs. This can be appreciated in the Basin States alternative where the volumes from the dams in the upper basin (including Powell) are high and the support to Mead is only produced when it reaches near the level of 1000. 52

For all the alternatives, it would be recommended that the U.S. establish a program to monitor volumes allotted, used, and returned and report on water conservation measures. 53

Finally, it must be mentioned that when comparing the results of the No Action and Water Supply alternatives, it is noted that Mexico receives less surplus water in the No Action alternative. The interpretation is that this alternative assigns surplus waters to the U.S. more frequently and in greater quantity than in the Water Supply alternative and leaves less water in Mead such that when Mead spills (less frequently) it is of a lesser volume and, as a result, less is provided to Mexico. 54

In summary, except for the considerations of the Water Supply and Conservation Before Shortage alternatives, the rest of the alternatives always show reductions to Mexico of various frequencies and quantities of water. It is evident that none of these options is appropriate for Mexico. 55

The CRSS model provided recently still has values of 10 acre-feet in some segments; this does not correspond to environmental flow. The requirement of a minimum flow of 10 acre-feet/month for each segment was used in the original model for salinity calculations. To avoid dividing by zero in calculating 56

F-5

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salinity, in case there were an upstream segment with zero flow, the original CRSS model limited flow to a minimum of 10 acre-feet/month. In the analysis of the alternatives, only the quantity of the water and not its quality is considered. Given the amount of time to undertake these analyses with the set of rules delivered in April, one is left with the assumption that the U.S. will comply with the Minutes undertaken within the terms of the 1944 Water Treaty in relation to the salinity parameters. It is also assumed that the modeling of quantity is more linked to the reality of the basin and the quality model has many more assumptions and considerations that would have to be discussed in specific meetings. Additionally, if the allotted volumes are complied with, the salinity in the lower part should not be a problem in the alternatives. 57 58 59 60

In the alternatives modeled, it is observed that in the reservoirs much care is taken to leave space for flood control; Mexico has no objection to this. 61

With the model, by running the alternatives with drier runoff scenarios (23 and 46), it is observed that the reservoirs upstream of Powell are emptied. The table of results shows negative values which physically is not possible. Perhaps the model would have to consider a minimum level (dead storage) to avoid that situation of generating erroneous results allotting water that does not exist. 62

Another observation about the model is that since it does not model groundwater, it could cause water that doesn't exist to be allotted to meet demand downstream of the sources, as well as overstated inflows to the lower dams. This is derived from the possible losses in the channels caused by overexploitation in the areas of groundwater use. 63

End CNA comments

I appreciate the opportunity the U.S. Bureau of Reclamation has afforded the International Boundary and Water Commission to share the international view of the Draft EIS. I also appreciate the Bureau's willingness to engage in meaningful technical discussions with Mexico through the Commission.

Should you have any questions, please do not hesitate to contact me at 915-832-4702.

Sincerely

Gilbert Anaya
Supervisory Environmental Protection Specialist
Environmental Management Division

F-5

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Reponses to Comment Letter F-5

Responses to Mexico's Comments:

Allotment of Colorado River water to Mexico is governed by the 1944 Treaty. The proposed federal action is a domestic action for the purpose of adopting additional operational guidelines to improve the Department's annual management and operation of key Colorado River reservoirs for an interim period through 2026. Certain modeling assumptions are used in this EIS in order to assess the potential effects to environmental resources of the proposed federal action. This assessment includes, but is not limited to, potential effects to water quantity, water quality, and fish and wildlife, particularly at the borders between the United States and Mexico. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico.

The United States has provided information to Mexico throughout the NEPA process through the United States and Mexican sections of the IBWC as detailed in Chapter 6. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

F-5-1

Comments transmitted in letters dated March 29, 2007 and April 25, 2007 have been addressed in this Final EIS.

F-5-2

Allotment of Colorado River water to Mexico is governed by the 1944 Treaty. The proposed federal action is a domestic action for the purpose of adopting additional operational guidelines to improve the Department's annual management and operation of key Colorado River reservoirs for an interim period through 2026. The proposed federal action is a domestic action. However, in order to assess the potential effects of the proposed federal action in this Final EIS, certain modeling assumptions (discussed in Section 2.2.1, Section 4.2, Appendix A, and Appendix M) are used that display projected water deliveries to Mexico. These modeling assumptions are common to all of the alternatives studied and are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

F-5-3

As noted in Section 1.7.2.3, allotment of Colorado River water to Mexico is governed by the 1944 Treaty. Determination of deliveries to Mexico would be made in accordance with the 1944 Treaty. The United States will conduct all necessary and appropriate discussions regarding the implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

F-5-4

The modeling assumption used in this EIS assumes future water delivery reductions to Mexico are proportional to future reductions to United States users in the Lower Basin. Based upon comments provided by Mexico regarding this assumption, a sensitivity analysis was conducted and included as Appendix Q, Modeling Assumptions with Regard to Future Water Deliveries to Mexico, Sensitivity Analysis, of this Final EIS. This analysis examines the sensitivity of the hydrologic resources to a different modeling assumption that assumes future water reductions to Mexico are in the same proportion as water delivery reductions to all United States users, in both the Upper and Lower Basin.

F-5-5

The governments of Mexico and the United States expressed their intention to cooperate and collaborate on issues related to the lower Colorado River in a joint statement issued on August 13, 2007. In that statement, United States and Mexican authorities stated that cooperative, innovative and holistic measures should be considered to ensure that the Colorado River is able to continue to meet environmental, agricultural and urban demands of both nations. Opportunities for water conservation, storage and supply augmentation, and more efficient Colorado River water deliveries to Mexico are among the issues expected to be addressed in discussions held under the auspices of the IBWC.

F-5-6

The Colorado River Basin Salinity Control Act of 1974 authorized implementation of desalting and salinity control projects to improve river water quality. Salinity control projects have and continue to be implemented throughout the basin including projects to control irrigation seepage and reduce transport of salt loads to the Colorado River. As shown in Section 4.5 of the Final EIS, relative changes in salinity at Imperial Dam under all alternatives are expected to be minor (approximately one to three percent).

IBWC Minute 242 (Section 3.5) was developed in 1973. Minute 242 limits the differential in annual salinity between Imperial Dam and the NIB to 115 parts per million (ppm) ± 30 ppm. The United States will continue to undertake activities to ensure compliance with the salinity provisions of Minute 242 and these activities will not be affected by the proposed federal action.

F-5-7

During flood control operations at Lake Mead, releases are made from Hoover Dam as specified by the flood control criteria established with the USACE (Section 3.3.4). Under current practice (Section 2.2.4.1), Mexico is allowed to schedule up to an additional 200 kaf pursuant to the 1944 Treaty during flood control years when water supplies exceed those required for use in the United States.

As described in Section 4.2.7, modeling assumptions common to all alternatives included deliveries to Mexico of up to 1.7 maf during flood control years. The probability of flood control surplus deliveries to the Lower Basin states for all alternatives is shown in Figure 4.4-16. Given the modeling assumption that deliveries to Mexico of up to 1.7 mafy would be made under these conditions, this figure also shows the likelihood of Mexico receiving surplus water under the 1944 Treaty. As shown in Figure 4.4-16, the likelihood of flood control releases under all alternatives is nearly the same (ranging from between zero and approximately 20 percent for all alternatives over the interim period), with the exception of the Reservoir Storage Alternative which is higher (up to a maximum of eight percent higher in 2015) over much of the interim period due to the larger volumes of shortages that are applied under that alternative which tend to keep the reservoir higher.

F-5-8

As discussed in Section 3.3.10, Mexico diverts the majority of its Colorado River water allotment at Morelos Diversion Dam resulting in limited volumes of water flowing in the NIB to SIB (limitrophe) reach and to the Colorado River Delta. The more frequent and smaller volumes of water (up to but typically less than 50,000 afy) are primarily the result of seepage from Morelos Diversion Dam, irrigation return flows and groundwater from Mexico and the United States, and water in excess of Mexico’s scheduled delivery due to cancelled orders in the United States. The proposed federal action would not affect these smaller volumes of water.

Larger, less frequent volumes of water may occur below Morelos Diversion Dam as a result of flood control releases from Hoover Dam (Section 3.3.10) that are not diverted at Morelos Diversion Dam. As shown in Figure 4.3-44 (Section 4.3.9), the probability of larger flows under all alternatives during the interim period are approximately nine to ten percent, with the exception of the Reservoir Storage Alternative which shows probabilities of about twelve percent, as well as somewhat higher magnitudes when the flows occur. The somewhat higher frequencies and larger volumes under the Reservoir Storage Alternative are primarily due to the larger volumes of shortages that are applied which tend to keep the reservoir higher.

Although the Conservation Before Shortage Alternative and Reservoir Storage Alternative assumed that conserved water would be delivered on a periodic basis to Mexico through the NIB to the SIB reach, these modeling assumptions were used only to model the alternative proponent’s recommendations and to analyze the potential impacts to resources of a larger storage and delivery mechanism. Use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, these releases could be made under current management of the Colorado River.

F-5-9

See response to Comment No. F-5-2.

F-5-10

See response to Comment No. F-5-3.

F-5-11 and F-5-12

See response to Comment No. F-5-2.

F-5-13

See response to Comment No. F-5-4.

F-5-14

See responses to Comment Nos. F-5-2 and F-5-4.

F-5-15

See response to Comment No. F-5-2.

F-5-16

See responses to Comment Nos. F-5-2 and F-5-4.

F-5-17

As discussed in Appendix M, the Conservation Before Shortage Alternative and the Reservoir Storage Alternative assumed that storage credits would be generated and used for environmental purposes. These and other modeling assumptions were utilized in the Final EIS in order to analyze the potential impacts to environmental resources of the storage and delivery mechanism, particularly with regard to reservoir elevations and river flow impacts.

The use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, these releases could be made under current administration of the river. Furthermore, notwithstanding the lack of an existing mechanism to implement such modeling assumptions, Reclamation utilized these assumptions for a number of reasons, including the following: (1) a larger volume of potential storage in Lake Mead is identified, (2) the maximum potential impacts on river flows below Hoover Dam are identified, (3) the Conservation Before Shortage Alternative proponent’s recommendations as to participating entities and levels of participation are modeled, (4) the arbitrary assignment of water conservation amounts to entities in the Lower Basin states is avoided, and (5) modeling impacts of a program of potential future cooperation between the United States and Mexico are identified.

F-5-18

The proposed federal action only involves domestic determinations and actions and does not address prospective voluntary arrangements that may be agreed upon by the United States and Mexico. The governments of Mexico and the United States expressed their intention to cooperate and collaborate on issues related to the lower Colorado River in a joint statement issued on August 13, 2007. In that statement, United States and Mexican authorities stated that cooperative, innovative and holistic measures should be considered to ensure that the Colorado River is able to continue to meet environmental, agricultural and urban demands of both nations.

Opportunities for water conservation, storage and supply augmentation, and more efficient Colorado River water deliveries to Mexico are among the issues expected to be addressed in discussions held under the auspices of the IBWC. The inclusion of the modeled information is appropriate in Reclamation's view, because, at this time, it is unknown which entities might participate in a Lake Mead mechanism that allows the storage and delivery of conserved system and non-system water and the timing and magnitude of the storage and delivery of conserved water is unknown. Certain modeling assumptions with respect to the entities that might participate and their respective level of participation were needed to enable the evaluation of the mechanism and its potential effects on environmental resources, particularly to reservoir storage and river flows below Lake Mead.

See also response to Comment F-5-17.

F-5-19 through F-5-21

See response to Comment No. F-5-6.

F-5-22

The proposed federal action builds upon the prudent water management approaches contained in the Interim Surplus Guidelines adopted by the Secretary of the Interior in 2001. These Guidelines had the effect of reducing demand on limited Colorado River water supplies through efforts to allow (and require) California to reduce its reliance on Colorado River supplies in excess of 4.4 mafy These Guidelines link availability to water supplies to the elevation of Lake Mead. The proposed federal action will adopt operational guidelines for the operation of Lake Mead for a full range of reservoir operations, including surplus, normal, and shortage conditions. This approach is integral to the prudent development of new low-reservoir operational guidelines, as the approach and management of these reservoirs at higher elevations has a direct impact on available storage, thereby affecting the likelihood and severity of potential future shortages.

F-5-23

Reclamation does not concur with Mexico's position as expressed in this comment. Under current practice (Section 3.3.4), Mexico can schedule up to an additional 200 kaf during flood control years when the water supply exceeds the needs of Colorado River water users in the United States. The modeling assumptions used in the EIS, particularly with regard to water reductions to Mexico, are common to all alternatives, are used only to display projected water deliveries to Mexico, and are not intended to constitute an interpretation or application of the 1944 Treaty.

See also response to Comments F-5-2 and F-5-7.

F-5-24

See responses to Comment Nos. F-5-7 and F-5-8.

F-5-25

Reclamation concurs with this comment. Table 3.8.7 identified 16 species of fish, primarily non-native, that may be found in NIB to SIB (limitrophe) reach. The analysis of potential impacts to vegetation and wildlife for this reach is presented in Section 4.8.3.7. It is also noted that an analysis of potential impacts to special status species for the NIB to SIB reach is also presented in Section 4.8.4.7.

F-5-26

As discussed in Section 4.2 and Section 4.16.2, the Drop 2 Storage Reservoir Project was included in the hydrologic modeling for all alternatives for Lake Mead and the Colorado River conducted for this EIS. Potential impacts are included in the analysis in Sections 4.3 and 4.4, particularly to larger flows in the NIB to SIB (limitrophe) reach resulting from flood control releases (see response to Comment No. F-5-8). The Lower Colorado River Drop 2 Storage Project Environmental Assessment analyzed the potential hydrologic impacts of the project on smaller (non-flood release) flows in the limitrophe reach.

F-5-27

The alternatives analyzed in the EIS considered a range of methodologies for determining surplus conditions in the United States. Specifically, the Basin States Alternative, the Conservation Before Shortage Alternative, and the Preferred Alternative assume that the more permissive provision of the Interim Surplus Guidelines (i.e., Partial Domestic Surplus) is eliminated in 2008. See also response to Comment No. F-5-7.

F-5-28

See responses to Comment Nos. F-5-2 and F-5-5.

F-5-29 through F-5-30

See response to Comment No. F-5-2.

F-5-31 and F-5-32

As noted in Section 2.2, a reasonable representation of future conditions under the No Action Alternative is needed for comparison to each action alternative. The modeling assumptions used for this representation are consistent with assumptions used in previous environmental compliance documents for the ISG, the Colorado River Water Delivery Agreement, and the LCR MSCP (Section 1.8). However, as noted in the response to Comment No. F-5-2, the assumptions used in the No Action Alternative are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

F-5-33

Reclamation conducted a modeling workshop to facilitate an understanding of the technical details of the modeling conducted for the Draft EIS. This workshop was held in Henderson Nevada on March 6, 2007 for all interested parties, including Mexico. One participant from Mexico attended. In the spirit of comity, Reclamation offered to repeat the workshop in Juarez Mexico on March 14, 2007 for the convenience of other interested parties in Mexico. Additional information was requested by the Mexican participants at that time and Reclamation provided, through the USIBWC, all available information in the timeliest manner possible.

F-5-34

See response to Comment No. F-5-4.

F-5-35

As discussed in Section 4.2, modeling future Colorado River conditions requires the input of a large amount of information, including the future depletion (consumption) schedules for the Basin States and for Mexico. The depletion schedules for future use in the Upper Basin were provided by the Upper Colorado River Commission (Section 3.4 and Appendix C).

F-5-36

The United States does not concur with Mexico's statement that drought in the Upper Basin has been "not significant." Provisional calculations of natural flow for the Colorado River at Lees Ferry, Arizona, show that the average flow over the past eight years (2000 through 2007 inclusive) was the lowest eight-year average in 100 years of record-keeping. United States users throughout the Upper Basin have incurred shortages throughout this period.

With respect to the inclusion of the Upper Basin in calculations of modeled water reductions, see response to Comment F-5-4.

F-5-37

The modeling assumptions used in this EIS regarding shortage-sharing between the Lower Division states are consistent with the Consolidated Decree and federal law, in particular the 1968 Colorado River Basin Project Act (the CRBPA). Specifically, the CRBPA states that satisfaction of all PPRs and California's 4.4 maf apportionment would have priority over CAP and other post-1968 water delivery contracts (contracts with approval dates after September 30, 1968). It also states that Nevada shall not be required to bear shortages in any proportion greater than would have been imposed in the absence of the CRBPA (Section 3.4.3).

F-5-38

See responses to Comment Nos. F-5-2 and F-5-4.

F-5-39

Your comment is noted. Reclamation agrees that a complete understanding of the relationships between precipitation and runoff throughout the Basin would require a large amount of data and further study.

F-5-40

Your comment is noted. In addition, the Department concurs that recent hydrologic trends indicate a strong likelihood of ongoing and imminent periods of less runoff. These concerns are highlighted by inclusion of information in the Final EIS regarding considerations of paleohydrology and possible global climate change impacts. It is precisely these concerns and realities (along with precipitously decreasing reservoir levels) that informed the decision to proceed with this NEPA process. The uncertainty in future hydrologic conditions warrant more efficient use of the available water supply throughout the basin. This process to develop additional operational guidelines for Lake Powell and Lake Mead is being undertaken to address this concern.

F-5-41

If the reference is assumed to be Appendix N (as suggested by USIBWC), it should be noted that the elevations shown for example in Figure N-3, do not represent actual traces, but rather the ranking of each year's data from the 100 traces for the conditions modeled. Future reservoir levels would fluctuate from year to year and would depend on the future variation in basin runoff conditions. As noted in Section 4.3, these presentations are best used for comparing the relative differences in the general lake level trends that result from the simulation of the different alternatives. Under the No Action Alternative, the 50th percentile or median elevations at Lake Mead remain relatively stable over time primarily due to the increasing probability of shortage.

F-5-42

Your comment is noted; however, Reclamation notes that the Conservation Before Shortage Alternative would have users make efforts to maintain high levels in Lake Mead not Lake Powell as referenced in your comment.

F-5-43

See responses to Comment F-5-17 and Comment F-5-18.

F-5-44

Although it is unclear the specific table that is being referenced, the model assumes that conserved water can only be delivered if sufficient credits exist. The credits may be created in the same year or they may be available because they were created in previous years. The model performs an accounting of the credit balance in each year as detailed in Appendix M.

F-5-45

See responses to Comment Nos. F-5-17, F-5-18, and F-5-2.

F-5-46

See responses to Comment Nos. F-5-5, F-5-18, and F-5-2.

F-5-47

Your comment is noted. See also response to Comment F-5-18.

F-5-48

Your comment is noted.

F-5-49

Reclamation fully concurs with this comment. The example presented clearly shows that there are tradeoffs between incurring more manageable yet more frequent water delivery reductions versus incurring no water delivery reductions for some period of time resulting in an increased risk of incurring much larger, severe and less manageable water delivery reductions at a later date.

F-5-50

An analyses of the trade-offs between incurring more manageable yet more frequent water delivery reductions versus incurring no water delivery reductions for some period of time resulting in an increased risk of much larger, severe and less manageable water delivery reductions at a later date has been performed through the comparison of the alternatives that have been studied in the EIS. With respect to these trade-offs for purpose of this domestic action, Reclamation's determination is manifested through its identification of the Preferred Alternative, which selects more frequent, less severe reductions in water deliveries, potentially avoiding the need for larger more severe reductions (depending on hydrology). These analyses included the potential impacts to water deliveries to Mexico (Section 4.4.6). The sensitivity of the hydrologic resources to increased hydrologic variability has been analyzed in Appendix N.

F-5-51

Your comment is noted. See response to F-5-5.

F-5-52

Reclamation does not concur with this statement and does not believe it is an accurate description of the information presented in the Draft (and Final) EIS. The Basin States and Conservation Before Shortage Alternatives and the Preferred Alternative have a common coordinated operation element whereby the annual release from Lake Powell is determined by the storage in both Lake Powell and Lake Mead (Chapter 2 and Table 2.8-2). For example, under these alternatives, if Lake Powell is below the Equalization Line and Lake Mead is below 1,075 feet msl, the Upper Level Balancing operation can result in annual releases from Lake Powell of up to 9.0 mafy.

F-5-53

The Consolidated Decree stipulates that the United States shall prepare and maintain complete, detailed, and accurate records of diversions, return flows and consumptive use throughout the Lower Basin on an annual or more frequent basis. The Lower Colorado Region has an on-going program to meet this stipulation and the annual reports are available at http://www.usbr.gov/lc/region/g4000/wtracct.html. These reports also include various supplemental information including water conservation and water transfers. Furthermore, Reclamation has expanded that program to provide, on a daily basis, estimates throughout the year of use-to-date and forecasted use through the end of the calendar year for all users throughout the Lower Basin that consume greater than 2,000 afy, totaling approximately 98 percent of all water used in the Lower Division states.

F-5-54

Reclamation does not concur with this comment. As described in the response to Comment No. F-5-7, Figure 4.4-16 presents the probability of flood control surplus conditions, and given the modeling assumption that deliveries to Mexico of up to 1.7 mafy would be made under these conditions. This figure also shows the likelihood of Mexico receiving surplus water under the 1944 Treaty. Although the likelihood of flood control releases under the all alternatives is nearly the same (with the exception of the Reservoir Storage Alternative), the probability of flood control releases under the No Action Alternative is not less than the probability under the Water Supply Alternative throughout the Interim Period.

F-5 55

Your comment is noted.

F-5-56

As discussed in the modeling workshop in Juarez Mexico held on March 14, 2007, certain Upper Basin reaches experience zero flow during simulation under the driest hydrologic sequences in the CRSS model. To prevent division by zero when performing salinity calculations, a minimum flow constraint of ten af per month is applied in each Upper Basin reach. This situation occurs infrequently.

F-5-57

Reclamation does not concur with this comment. Section 3.5 describes the water quality constituents that may be potentially affected by the proposed federal action and Section 4.5 describes those potential impacts. In particular, the potential impacts to salinity are considered in both sections (see response to Comment No. F-5-6).

F-5-58

The United States will continue to comply with the Minutes undertaken within the terms of the 1944 Water Treaty, including with regard to the salinity differential pursuant to Minute 242, described in Section 3.5 (see response to Comment No. F-5-6).

F-5-59

Your comment is noted. Reclamation welcomes the opportunity to meet with representatives from Mexico to discuss the various assumptions and considerations that are used in the CRSS salinity module.

F-5-60

See response to Comment No. F-5-58.

F-5-61

Your comment is noted.

F-5-62

Reclamation investigated this observation, but did not find negative storage or release values at any reservoir. Reclamation welcomes the opportunity to meet with representatives from Mexico to discuss modeling results from CRSS.

F-5-63

Groundwater aquifers in direct connection to the Colorado River could act as either water sources or sinks depending upon the hydraulic gradient. In many areas, the hydraulic gradients are quite variable and can change rapidly. As noted in the response to Comment No. F-5-39, the interactions between surface and groundwater are complex and require a large amount of site-specific data. The necessary data is not currently available throughout the Colorado River Basin.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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April 30, 2007

Dr. Terrance Fulp
Regional Director, Lower Colorado Region
Bureau of Reclamation
Attn: BCOO-1000
P.O. Box 61470
Boulder City, NV 89006-1470

Dear Dr. Fulp

Thank you for the opportunity to comment on the recent Draft EIS on Proposed Guidelines for Managing the Colorado River During Drought Conditions.

We are pleased to see that Reclamation is taking steps to include the effects of climate variability
in its evaluation of management strategies for low reservoir operations of Lake Mead and
Powell. We encourage Reclamation to work further to consider how climate change may impact 1
water availability and environmental conditions in the Basin.

As discussed in our scoping comments for this EIS, we recommended that management
strategies for low reservoir operations of Lake Mead and Powell should include the effects of
climate variability and long-term trends in climate. We suggested that Reclamation should
consider including information on long-term climate variability (such as paleoreconstructions of 2
flows from tree rings), potential climate change impacts the potential of ENSO-based seasonal
forecasts and intraseasonal forecasts to contribute to reservoir management. Reclamation has
made some effort to incorporate our scoping comments (e.g. Appendix N), but we believe more
could be done.

Since the Scoping process, several studies have been released which can provide information to
assist in incorporating the potential impacts of climate change in the evaluation of alternatives.
These include the Summaries for Policymakers of the Intergovernmental Panel on Climate
Change (IPCC 2007a,b), the IPCC Regional Climate Projections (Christensen et al., 2007) a 3
National Academy of Sciences report, *Colorado River Basin water management: Evaluating and
adjusting to hydroclimatic variability* (NAS, 2007), and several journal articles including, *Global
pattern of trends in streamflow and water availability in a changing climate* (Milly et al., 2005),
*Model projections of an imminent transition to a more arid climate in Southwestern North
America: A multimodel ensemble approach to assessment of climate change impacts on the*

F-6

hydrology and water resources of the Colorado River basin (Christensen and Lettenmaier, 2007), and a special issue of Southwest Hydrology including an article by Hoerling and Eischeid (2007), *Past peak water in the southwest?*.

Some of the key findings are summarized below.

The IPCC international panel of experts finds observed changes in climate including:

- An increase in the rate of global average temperature rise to 0.74°C (1.3°F) [range 0.56 - 0.92°C, 1.08 - 1.6°F] for 1906-2005.
- Discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns. 4
- Widespread changes in extreme temperatures have been observed, including less frequent cold days, cold nights and frost, and more frequent hot days, hot nights, and heat waves.

Future impacts relevant to the Western U.S. and the Colorado River Basin include:

- Over North America, annual mean warming is likely to exceed the global average. Over western North America, median temperatures are projected to increase by 3.5°C, 4°C, and 5°C by 2100 under the B1, A1B, and the A2 emissions scenarios, respectively.
- In the southwestern U.S., warming is likely to be the largest in summer
- Warmer and fewer cold days and nights are virtually certain as are warmer/more frequent hot days and nights over most land areas 5
- Warm spells and heat waves are very likely to increase over most land areas
- There is very high confidence that high elevation warming is projected to cause decreased snowpack, more winter flooding, and reduced summer flows
- Annual mean precipitation is likely to decrease in the southwestern U.S.
- The area affected by drought is likely to increase, with more widespread water stress and water shortages and reduced hydropower generation potential
- The global models likely underestimate the warming at high altitudes due to the snow-albedo feedback.
- Snow season length and snow depth are very likely to decrease over most of North America.

The NAS report notes that temperature records and climate model projections both suggest that temperatures across the Western U.S. will continue to rise in the foreseeable future. The NAS report, Hoerling and Eischeid (2007), and Christensen and Lettenmaier (2007) all point to the negative impacts of higher temperatures on water supply in the West. The IPCC 2007 findings also point to the impacts of rising temperature on water supplies in already arid areas, and note that areas like the U.S. West are particularly vulnerable because its economies are closely linked with climate-sensitive resources, its rising population, urbanization, and dependence on already highly utilized water resources.

It is noteworthy that the IPCC 2007 model runs consistently show a reduction in water supplies in the American Southwest even when precipitation stays approximately the same. This is due to temperature increases and the resultant widespread drying. The results in Milly et al (2005), 6

Hoerling and Eischeid (2006), Christensen and Lettenmaier (2007), and Seager and et al. (2007) 7
all indicate a reduction in water supplies, albeit with some significant differences in magnitude.
Models used in the IPCC Third Assessment Report in 2001 (IPCC 2001) and the National
Assessment of the Potential Consequences of Climate Variability and Change in (USGCRP, 8
2000) showed no such consistency with some models indicating more precipitation and some
less.

These and other recent studies are showing that the use of historical hydrology for the Colorado 9
River cannot adequately capture the likely future variability of water supply. We strongly
encourage Reclamation to consider ways to generate hydrology representative of likely future 10
conditions and to continue to utilize the paleo record to investigate climate variability outside
that of the historical period.

We have been pleased to participate in a panel of experts convened to consult with Reclamation and assist in addressing these questions. The NOAA and the NOAA-University of Colorado Western Water Assessment are happy to continue to work with Reclamation, to assess the potential effects of climate variability and change, as well as the opportunities for the use of seasonal climate forecasts, in studying how best to operate Lakes Powell and Mead during low reservoir conditions

Sincerely,

Andrea J. Ray, Ph.D.
NOAA Earth Systems Research Laboratory and
NOAA-University of Colorado Western Water Assessment

Brad Udall
University of Colorado and
NOAA-University of Colorado Western Water Assessment

3 F-6

References:

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U.S. Global Change Research Program, National Assessment Synthesis Team, 2000. Climate change impacts on the United States: The potential consequences of climate variability and change, Overview. National Assessment Synthesis Team. Available at: http://www.usgcrp.gov/usgcrp/Library/nationalassessment/

Reponses to Comment Letter F-6

F-6-1 through F-6-10

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

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Comments Submitted By Individuals

This section contains comment letters submitted by the following individuals:

I-1	Mike (3Sononta73@Cox.net)
I-2	Brianne Emery
I-3	Sherry Celine
I-4	Raymond Trancynger
I-5	Jerry and Annette Prioste
I-6	Mikki and Dorothy Niemi
I-7	Brenda Samide
I-8	David Whipkey
I-9	Suzanne Kruger
I-10	Bonnie Haymon
I-11	Earl Zarbin
I-12	Richard Spotts
I-13	Julia Burwell
I-14	Mark W. Belles
I-15	Orion Inskip
I-16	Lana Jones
I-17	Cliff Hurley
I-18	Mark Bird
I-19	Tim Barnett
I-20	Stacey Hamburg
I-21	Melanie Florence
I-22	Crista Worthy
I-23	Rebecca McCartt

From: 3sonora73 [3sonora73@cox.net]
Sent: Friday, March 02, 2007 1:40 PM
To: strategies@lc.usbr.gov
Subject: Comment on Colorado River drought plan

Dear Sir or Madam,
I have not had time to read the plan but I did want to comment on it.
I live in the Phoenix area. The future water shortage situation has been talked about for years here but nothing has been done about it. Arizona and Nevada are two of the biggest growth areas in the nation. Arizona has the added burden of illegal aliens pouring in along with the people from other parts of the U.S.. This crazy growth has to stop or at least slow down. We are going to have enough problems sharing the water with the existing population.
I realize this is a state issue, not a federal issue, but nobody from the governor on down wants to talk about it I guess because growth means money to the various state and local governments and their buddies. The builders are just going nuts out here and absolutely nobody wants to slow them down. The Phoenix area could someday be the biggest ghost town in the world. The repercussions would be devastating. Is there any way to talk some sense into these representatives from Arizona to start looking into growth control? 1

Thanks for letting me rant,
Totally Frustrated Mike

I-1

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Reponses to Comment Letter I-1

I-1-1

Your comment is noted. No change to the Final EIS was necessary. As noted in Section 3.4 and Section 4.4, water supply planning and water supply management occurs at the federal, state, regional and local levels. Most states, regional agencies, local agencies, and communities have already or are in the process of preparing water resources management plans and or drought management plans that address varying water demand and water supply management issues.

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From: Brianne Emery [brianne.emery@gmail.com]
Sent: Wednesday, March 07, 2007 7:53 PM
To: strategies@lc.usbr.gov
Subject: CO River Interim Guidelines DEIS
Mr. Fulp,

I am writing to express my support of the "Conservation Before Shortage" Alternative for the draft EIS of the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead. 1

I feel that this alternative would meet the purpose and need of the project without limiting the recreational opportunities of these lakes and without being economically detrimental. 2 While I understand new legislation would have to be passed to provide funding to implement this project, I feel that the Basin States would be willing to support such an action. 3

I do however, feel that such an action should be considered for the long term viability of operations and not merely used as "interim guidelines". 4 With the increasing growth in Basin states, it is important that the Bureau of Reclamation plan for not only the near future but for the long term productivity of the Colorado River. 5

Thank you,

Brianne Emery

I-2

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Reponses to Comment Letter I-2

I-2-1

Your comment is noted. No change to the Final EIS was necessary.

I-2-2 and I-2-3

Your comment is noted. See also response to Comment No. G-1-4.

I-2-4 and I-2-5

Reclamation does not concur with this comment. The interim nature of the guidelines is intended to provide an opportunity to evaluate how the guidelines work. In addition, opportunities for review of the effectiveness of the guidelines are anticipated to be available both throughout the proposed interim period and at intervals during the interim period. Such reviews would provide a basis for possible further federal actions and decisions at the end of the interim period. Reclamation anticipates that a review of the guidelines will be conducted at a time prior to the end of the interim that would allow the Department, and the public, to assess the effectiveness of the guidelines and to determine the most appropriate course of action for the post-interim period.

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From: sherry celine [sceline53@yahoo.com]
Sent: Wednesday, March 07, 2007 12:44 PM
To: strategies@lc.usbr.gov
Subject: drought imput

Re Colorado Drought Plan: My proposal is to limit building permits, protect the water we have by implementing substantial fines for polluters, start a conservation plan similar to Tucson & Flagstaff . Thanks for the opportunity to imput, Sherry Celine 1,2,3

I-3

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Reponses to Comment Letter I-3

I-3-1

See response to Comment No. I-1-1.

I-3-2

Your comment is noted. No change to the Final EIS was necessary.

I-3-3

Your comment is noted. See also response to Comment No. I-1-1.

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MARCH 01, 2007

DEAR SIRS/MADAM

MANDANTORY DESERT LANDSCAPE ON ALL NEW HOMES & OFFICE BUILDINGS. OR OTHER NOT REQUIRING WATER USE, IN PHOENIX. 1

I UNDERSTAND THAT "TUCSON" HAS THIS IN PLACE

THANK YOU,

Raymond

Raymond Trancynger
4430 E Le Marche Ave
Phoenix AZ 85032-4278

Raymond Trancynger
4430 E Le Marche Ave.
Phoenix, AZ 85032

PHOENIX AZ 850
02 MAR 07 PM 3 T

REGIONAL DIRECTOR
LOWER COLORADO REGION
BUREAU OF RECLAMATION
ATT. BC00-1000
P.O BOX 61470
BOULDER CITY, NV 89006-1470

89006+1470

I-4

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Reponses to Comment Letter I-4

I-4-1

See response to Comment No. I-1-1.

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From: Jerry & Annette Prioste [japrioste@cox.net]
Sent: Tuesday, March 13, 2007 11:39 AM
To: strategies@lc.usbr.gov
Subject: Colorado River drought plan

The Scottsdale, Arizona, City Government continues its profligate disregard for water resources by ignoring poorly designed, inappropriate, and mismanaged landscaping, which allows water to pour into our streets. I can only imagine the amount of water that has been wasted over the years and how so many other countries and people could be maintained with just our irresponsibly wasted water. 1

I fear for our lowered, beautiful, Colorado River systems.

Thank you for your environmental effort.

Annette Prioste
Scottsdale, Arizona 85254
Japrioste@cox.net

I-5

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Reponses to Comment Letter I-5

I-5-1

See response to Comment No. I-1-1.

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From: Mikki & Dorothy Niemi [niemicat@hotmail.com]
Sent: Friday, March 16, 2007 7:43 AM
To: rwalsh@lc.usbr.gov
Subject: Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Oper
CITIZEN INPUT on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

In Stage I:

It appears that the math used to arrive at the shortage assignments differs from case to case, no doubt the result of the 60s agreement that optimistically took responsibility for all shortages on the river unto Arizona. 1

I now ask what the incentive for all those water users in California to conserve might be? I believe this antiquated agreement that penalizes Arizona water users unduly while cutting no allocations for others leads to profligate development and wastage of water. 2

As a native Arizonan, I deplore this unfair distribution of water shortage 'allocations'. This ill-conceived agreement should be renegotiated.

Another problem is the cutting off of agriculture in favor of bedroom communities and ever continuing development is strategically foolish. Agriculture recharges the water table, provides human food and fodder for livestock and is a viable business in Arizona. I know the assumption is that food can be shipped in with less cost than the value of the water used in agriculture, but making sure that the population of Arizona is totally dependent on supplies brought in using fossil fuels is poor future planning. Fossil fuel is not going to ever be cheaper and this policy insures that the people of Arizona will be paying inflated food prices on all foodstuffs. I have a problem with this kind of shortsighted planning. Of course, the developers promote this destructive plan since they can then sop up the last of the Arizona allocation in more homes. As of now, Tucson has over 9,000 housing units for sale at inflated prices. 3

I do believe that prohibiting further water hookups, cutting water to golf courses and other water saving measures should be required of all communities using Colorado River water before this shortage allocation plan be implemented. 4

The economic problems generated by a cessation of raw development are real and can be predicted in terms of construction related unemployment. All of the communities using Colorado River water must aim for sustainability in water resources, which will force a lifestyle change among the water users. 5

I know that the present allocations were assigned during flood times on the Colorado, as corroborated by data from 1500-2000 AD. The 'new' average river flow will not sustain the current populations at their level of water use. 6

I-6

I suggest that mandatory conservation and cessation of new water hookups be required of all communities using Colorado River water. A refusal to conserve water and a refusal to deny new water hookups should result in immediate cuts of Colorado River water deliveries. All communities should share in the results of drought conditions. 7

Opinions and Facts!

http://tucsonpoly.blogspot.com

D.P. Niemi

I-6

Reponses to Comment Letter I-6

I-6-1

This comment fails to accurately reflect the information published by Reclamation in the Draft EIS. As noted in Chapter 2, the different alternatives considered alternative criteria for determining when and by how much water deliveries to the Lower Division states may be reduced during drought and low reservoir conditions. The purpose for considering the different criteria was to evaluate, among other things, the trade-offs between water deliveries and retaining water in storage for future use.

I-6-2

See responses to Comment Nos. L-17-17 through L-17-19.

I-6-3

Your comment is noted. No change to the Final EIS was necessary. Please note that the shortages within individual states are assumed to be distributed in the order of priorities within in each respective state and distributed proportionally between the water users with the same priority right. The modeling assumption that distributes water delivery reductions among the equal priorities within individual states does not necessarily distinguish between water user type.

I-6-4 and I-6-5

See response to Comment No. I-1-1.

I-6-6

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-6-7

See response to Comment No. I-1-1.

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From: Brenda Samide [hi_from_brenda@hotmail.com]
Sent: Friday, April 06, 2007 12:05 PM
To: strategies@lc.usbr.gov
Subject: Comments for Operations at Lake Powell & Lake Mead under Low Reservoir Conditions

Dear Mr. Johnson and Mr. Gold:
Lake Powell and Lake Mead lose 17 percent of the water that flows into them through
evaporation. Vacant space in underground aquifers near existing Colorado River water
recharge facilities could store more water than these two reservoirs combined. Upwards 1
of 810,000 acre-feet of water annually could be saved by eliminating Lake Powell and
operating Lake Mead principally for distribution to groundwater recharge facilities.

After more than 40 years of operation, it was not until the fall of 2004 that Lake Powell's
water storage actually augmented downstream water use. And with the impacts of climate
change and rising water consumption, it is unlikely that there will be sufficient surplus 2
water to fill Lake Powell again. Even should surplus water accumulate, Lake Mead alone
could provide sufficient storage.

Between Lake Powell and Lake Mead lies Grand Canyon National Park. The operation of
both these reservoirs has impacted the Canyon, but Glen Canyon Dam at Lake Powell has 3
been far more devastating. Since the dam's completion four of eight native fish have 4
gone extinct and the dam has trapped the sediment necessary to maintain habitat and 5
beaches for wildlife and recreation, as well as the stabilization of archeological sites.

Sediment is a major unresolved problem threatening the long-term operations of Lake
Powell and Lake Mead. Ultimately, sediment must be removed to ensure public safety. 6
Removing sediment from Lake Mead downstream, rather than Lake Powell upstream is
the most technically feasible, least costly and environmentally advantageous approach.

The Colorado River Compact of 1922, which largely governs the operations of Lake
Powell for Lake Mead, cannot meet its intended purpose of equitably sharing Colorado
River water between the Upper and Lower Basin states. With River flows expected to 7
decline 18 percent by 2040, this inequity will worsen, furthering the need for Compact
amendments while highlighting the benefits of eliminating Lake Powell to fulfill the
Compact's primary objective.

Brenda Samide
160-55 99th Street
Howard Beach, NY 11414

I-7

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Reponses to Comment Letter I-7

I-7-1

See response to Comment No. G-8-33.

I-7-2

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-7-3 through I-7-5

Your comment is noted. No change to the Final EIS was required.

I-7-6

See response to Comment No. G-6-31.

I-7-7

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

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From: David Whipkey [chorse36@msn.com]
Sent: Thursday, April 05, 2007 8:59 AM
To: strategies@lc.usbr.gov
Subject: Comments for Operations at Lake Powell & Lake Mead under Low Reservoir Conditions

Dear Mr. Johnson and Mr. Gold:
Lake Powell and Lake Mead lose 17 percent of the water that flows into them through
evaporation. Vacant space in underground aquifers near existing Colorado River water
recharge facilities could store more water than these two reservoirs combined. Upwards 1
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Powell for Lake Mead, cannot meet its intended purpose of equitably sharing Colorado
River water between the Upper and Lower Basin states. With River flows expected to 7
decline 18 percent by 2040, this inequity will worsen, furthering the need for Compact
amendments while highlighting the benefits of eliminating Lake Powell to fulfill the
Compact's primary objective.

David Whipkey
132 Rebecca Dr.
Winchester, VA 22602

I-8

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Reponses to Comment Letter I-8

I-8-1

See response to Comment No. G-8-33.

I-8-2

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-8-3 through I-8-5

Your comment is noted. No change to the Final EIS was necessary.

I-8-6

See response to Comment No. G-6-31.

I-8-7

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

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From: Suzanne Kruger [soozikruger@webtv.net]
Sent: Friday, April 06, 2007 1:15 PM
To: strategies@lc.usbr.gov
Subject: Comments for Operations at Lake Powell & Lake Mead under Low Reservoir Conditions

Dear Mr. Johnson and Mr. Gold:
Lake Powell and Lake Mead lose 17 percent of the water that flows into them through
evaporation. Vacant space in underground aquifers near existing Colorado River water
recharge facilities could store more water than these two reservoirs combined. Upwards 1
of 810,000 acre-feet of water annually could be saved by eliminating Lake Powell and
operating Lake Mead principally for distribution to groundwater recharge facilities.

After more than 40 years of operation, it was not until the fall of 2004 that Lake Powell's
water storage actually augmented downstream water use. And with the impacts of climate
change and rising water consumption, it is unlikely that there will be sufficient surplus 2
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Powell for Lake Mead, cannot meet its intended purpose of equitably sharing Colorado
River water between the Upper and Lower Basin states. With River flows expected to 7
decline 18 percent by 2040, this inequity will worsen, furthering the need for Compact
amendments while highlighting the benefits of eliminating Lake Powell to fulfill the
Compact's primary objective.

Suzanne Kruger
rt.2, box 1008
Harpers Ferry, WV 25425

I-9

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Reponses to Comment Letter I-9

I-9-1

See response to Comment No. G-8-33.

I-9-2

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-9-3 through I-9-5

Your comment is noted. No change to the Final EIS was necessary.

I-9-6

See response to Comment No. G-6-31.

I-9-7

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

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From: BONNIE HAYMON [rfc333@msn.com]
Sent: Sunday, April 08, 2007 6:32 AM
To: strategies@lc.usbr.gov
Subject: Comments for Operations at Lake Powell & Lake Mead under Low Reservoir Conditions

Dear Mr. Johnson and Mr. Gold:
Lake Powell and Lake Mead lose 17 percent of the water that flows into them through
evaporation. Vacant space in underground aquifers near existing Colorado River water
recharge facilities could store more water than these two reservoirs combined. Upwards 1
of 810,000 acre-feet of water annually could be saved by eliminating Lake Powell and
operating Lake Mead principally for distribution to groundwater recharge facilities.

After more than 40 years of operation, it was not until the fall of 2004 that Lake Powell's
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change and rising water consumption, it is unlikely that there will be sufficient surplus 2
water to fill Lake Powell again. Even should surplus water accumulate, Lake Mead alone
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Powell and Lake Mead. Ultimately, sediment must be removed to ensure public safety.
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the most technically feasible, least costly and environmentally advantageous approach.

The Colorado River Compact of 1922, which largely governs the operations of Lake
Powell for Lake Mead, cannot meet its intended purpose of equitably sharing Colorado
River water between the Upper and Lower Basin states. With River flows expected to 7
decline 18 percent by 2040, this inequity will worsen, furthering the need for Compact
amendments while highlighting the benefits of eliminating Lake Powell to fulfill the
Compact's primary objective.

BONNIE HAYMON
71 PERRY ST
BROCKPORT, NY 14420

I-10

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Reponses to Comment Letter I-10

I-10-1

See response to Comment No. G-8-33.

I-10-2

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-10-3 through I-10-5

Your comment is noted. No change to the Final EIS was necessary.

I-10-6

See response to Comment No. G-6-31.

I-10-7

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

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From: Earl Zarbin at 602-437-2665
To: Regional Director, USBofR at 17022938156

04-05-:7 08:46 am
002 of 002

BC00-1000 - page 2 of 2
ENV-6.00

Powers of the Authority should include:

1) Use of eminent domain to reallocate water from farmers or others, both on and off Indian reservations, for urban purposes. There should be one-time compensation to anyone giving up water. (Reservation Indians are citizens of the U.S. and should be treated as all other citizens, i.e., the special privileges awarded reservation Indians by the U.S. Congress at the expense of other citizens should end.)

2) Own and operate the river dams.

3) Construct additional dams and diversion works.

4) Augment the river supply.

Other considerations:

The Authority should urge the U.S. Congress to:

1) Repeal the U.S. Supreme Court's "practicably irrigable acreage" (PIA) ruling as the measure of water for Indian reservations (PIA ignores reality, from climate to location, and awards excessive quantities of water to some tribes. See footnote for two such tribes in Arizona).[2]

2) Repeal language in Section 5, Boulder Canyon Project Act, which the U.S. Supreme Court purposefully misinterpreted to give the U.S. secretary of the Interior power to distribute water to Arizona, California and Nevada, and to users within these states.

3) Repeal all laws based upon PIA.

4) Repeal all laws that conflict with powers given the Colorado River Basin Authority.

5) End the reservation system for Indians and assure "the equal protection of the laws" for all citizens as provided in the 14th Amendment to the U.S. Constitution.

Correction: "The Gila River Reservation," according to Chapter 3, 3-88, lines 38-39, Draft EIS, "Reclamation, Managing Water in the West," "*was established by executive order* in 1859..." (emphasis supplied). Not so. The reservation was created February 28, 1859, **by an act of the U.S. Congress**. 3

---

[2] With implementation of the Arizona Water Settlements Act of 2004, two Arizona Indian reservations, with less than one-half of 1% of Arizona's 5,130,632 people in 2000, are supposed to have yearly almost 1 million acre-feet of Arizona's Colorado River water entitlement. These two are the Gila River Indian Community (GRIC), 328,800 acre-feet (including 17,000 acre-feet from ASARCO, Inc., that remains unsettled), and the Colorado River Indian Tribes, 662,402 acre-feet. With fewer than 19,000 residents, these two reservations will have 991,202 acre-feet (including the 17,000 acre-feet). Add in the Gila River tribe's other water, and the two reservations yearly will have 1,315,902 acre-feet. Not morally, ethically, or historically are these tribes entitled to that much water. These tribes no doubt will be founding members of the Organization of Water Exporting Tribes (OWET).

I-11

From: Earl Zarbin at 602-437-2665
To: Regional Director, USBofR at 17022938156

04-05-:7 08:46 am
001 of 002

April 05, 2007 page 1 of 2

To: Regional Director, Lower Colorado Region, Bureau of Reclamation, Attention: BCOO-1000, Box 61470, Boulder City, Nevada 89006-1470
From: Earl Zarbin, 3803 E. St. Catherine Ave., Phoenix, AZ 85042-5013 - (no home Internet or fax reception)
Re: BCOO-1000 - Response to Draft EIS - Colorado River Interim ENV-6.00 Guidelines for Lower Basin Shortages, etc.

Best alternative: Given Arizona's growing population, the U.S. secretary of the Interior should adopt as a guideline for Lower (Colorado River) Basin Shortages the alternative calculated to do the least harm to the sufficiency of the Central Arizona Project water supply. 1

Preferred action: Because it is preposterous and illogical to lock into perpetuity a system of water distribution that ignores population shifts and other Colorado River Basin changes, and,

Because the present system unjustly enriches or enables some people at the expense of others, and,

Because there exists a need to restore reason, common sense, and sanity to management of the Colorado River,

The areas of the seven Basin States and the Republic of Mexico within the Colorado River Basin should seek to create a new entity administratively independent of their federal and state governments and other special interests. To accomplish this, the seven Basin States: 2

Should create, using **Section 19** of the Boulder Canyon Project Act, a Colorado River Basin Authority or other entity independent of the U.S. secretary of the Interior, and invite Mexican water users to cooperate.[1]

(Should the Basin States meet to create a Colorado River Basin Authority, Section 19 permits the U.S. president to name a representative to "participate" and to "report to Congress of the proceedings and of any compact or agreements entered into." The States and the Congress have to approve any agreement, but the Interior secretary has no role unless named by the president. The Interior secretary should not be named.)

[1] Ideally, as noted by John Wesley Powell, river basins should be operated as a unit. For the Colorado River Basin, options include: 1) The U.S. should acquire the portion of Mexico receiving Colorado River water; 2) Mexico should acquire areas of the seven states within the basin; 3) the Colorado River Basin, including the area in the U.S. and Mexico, should create an independent Colorado River Basin Republic. None of these are likely to occur, which means the present messy management of the river will continue unless the seven Basin States unite and act to change the system.

I-11

Reponses to Comment Letter I-11

I-11-1

Your comment is noted. No change to the Final EIS was necessary.

I-11-2

Your comment is noted. No change to the Final EIS was necessary. The creation of a new entity that is administratively independent of federal/state governments and special interests groups to manage river and water and reallocate water is outside the scope of the subject EIS.

I-11-3

Information presented in the Draft EIS has been modified in the Final EIS (see Section 3.10.2.2) pursuant to this specific comment, as well as other public comments. Section 3.10.2.2 of the Final EIS has been revised to reflect this comment. This revision does not significantly change the impact analysis or results presented in the Draft EIS.

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From: Richard Spotts [spotts@infowest.com]
Sent: Monday, April 30, 2007 6:43 PM
To: strategies@lc.usbr.gov
Subject: My comments on Colorado River DEIS

April 30, 2007

Dear Bureau of Reclamation officials:

Please accept this letter with my comments on the Colorado River water allocations DEIS.

I strongly support and urge you to adopt and implement the "Conservation Before 1
Shortage Alternative". I believe that this alternative best reflects the changes that are 2
needed to address exponential human growth combined with declining water supplies.
Communities in the arid Southwest must learn to be much more aggressive and effective
in achieving water conservation and reclamation. Groundwater recharge is also 3
preferable to reservoir storage because of the latter's excessive evaporation losses. Water
pricing must reflect true market demands and delivery costs, without any subsidies. 4
Greater use of tiered water pricing can reward conservation and punish wasteful
practices.

With global warming and the prospects for more severe droughts, the continuation of status quo management of the Colorado River would be irresponsible and dangerous. Strong reforms are needed now, in anticipation of the more serious shortages to come. We need only to look at Australia this year to see what the future may hold for us.

Please have the foresight and courage to implement these necessary reforms in the public interest.

Thank you very much for your consideration.

Sincerely,

Richard Spotts
1125 W. Emerald Drive
St. George UT 84770-6026
spotts@infowest.com

I-12

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Reponses to Comment Letter I-12

I-12-1

Your comment is noted. No change to the Final EIS was necessary

I-12-2

See response to Comment No. I-1-1.

I-12-3

See response to Comment No. G-8-33.

I-12-4

Your comment is noted. No change to the Final EIS was necessary.

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>>> Julia Burwell <jules0342@msn.com> 04/17/07 12:39AM >>>
Dear Mr. Johnson and Mr. Gold:
Lake Powell and Lake Mead lose 17 percent of the water that flows into them through evaporation. Vacant space in underground aquifers near existing Colorado River water recharge facilities could store more water than these two reservoirs combined. Upwards of 810,000 acre-feet of water annually could be saved by eliminating Lake Powell and operating Lake Mead principally for distribution to groundwater recharge facilities. 1

After more than 40 years of operation, it was not until the fall of 2004 that Lake Powell's water storage actually augmented downstream water use. And with the impacts of climate change and rising water consumption, it is unlikely that there will be sufficient surplus water to fill Lake Powell again. Even should surplus water accumulate, Lake Mead alone could provide sufficient storage. 2

Between Lake Powell and Lake Mead lies Grand Canyon National Park. The operation of both these reservoirs has impacted the Canyon, but Glen Canyon Dam at Lake Powell has been far more devastating. 3 Since the dam's completion four of eight native fish have gone extinct 4 and the dam has trapped the sediment necessary to maintain habitat and beaches for wildlife and recreation, as well as the stabilization of archeological sites. 5

Sediment is a major unresolved problem threatening the long-term operations of Lake Powell and Lake Mead. Ultimately, sediment must be removed to ensure public safety. Removing sediment from Lake Mead downstream, rather than Lake Powell upstream is the most technically feasible, least costly and environmentally advantageous approach. 6

The Colorado River Compact of 1922, which largely governs the operations of Lake Powell for Lake Mead, cannot meet its intended purpose of equitably sharing Colorado River water between the Upper and Lower Basin states. With River flows expected to decline 18 percent by 2040, this inequity will worsen, furthering the need for Compact amendments while highlighting the benefits of eliminating Lake Powell to fulfill the Compact's primary objective. 7

Julia Burwell
31 Crescent Key
Bellevue, WA 98006

I-13

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Reponses to Comment Letter I-13

I-13-1

See response to Comment No. G-8-33.

I-13-2

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-13-3 through I-13-5

Your comment is noted. No change to the Final EIS is necessary.

I-13-6

See response to Comment No. G-6-31.

I-13-7

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

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Mark W. Belles
9318 Willard Street
Rowlett, Texas 75088
glen.canyon@verizon.net

4/13/07

Regional Director
Bureau of Reclamation, Lower Colorado Region
Attn: BCOO-1000
P.O. Box 61470
Boulder City, Nevada 89006-1470

09 April 2007

Dear Director,

Thank you for the review copy of the Draft Environmental Impact Statement (DEIS) – Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead. Please retain my name on the mailing list.

Specific Comments to the text of the DEIS

1. Page 4.16

   I don't understand why Lake Powell Traces 1, 21, and 48 presented in Figure 4.3-1 were based on hydrologic sequences beginning in years 1906, 1926, and 1953 respectively when Lake Powell didn't even exist then. What do these data mean? 1

2. General Comment

   I see no assessment of the potential for reduced seepage and evaporation at Lake Powell if storage is concentrated at Lake Mead. Studies should be done to determine if system-wide seepage and evaporation losses could be reduced in this manner. This could improve the benefits of the Water Supply Alternative. 2

I-14

Page 1 of 2

Recommended Alternative

1. The primary purpose of the Colorado River Storage Project is to deliver water to the holders of water rights. The Water Supply alternative is the only alternative that focuses 3 on this purpose. To protect the SNWA the alternative should be amended to protect the 1,000 feet MSL level consistent with the proposed SNWA Lake Mead Intake No. 3 4 Project noted on page 5-8. With this change the Water Supply Alternative best meets the 5 primary purpose of the system.

Thank you for the opportunity to participate in this process,

I-14

Reponses to Comment Letter I-14

I-14-1

The information requested is provided in the Draft EIS. As noted in Section 4.3.2 of the Draft EIS, these traces represent the results of three of the 100 model runs. These distinct traces were provided only to illustrate what was actually simulated under the various traces and respective hydrologic sequences and to highlight that the 90^{th}, 50^{th}, and 10^{th} percentile lines do not represent actual traces, but rather the ranking of each year's data from the 100 traces for the conditions modeled. The traces also illustrate the variability among the different traces and that the reservoir levels could temporarily decline below the 10^{th} percentile line.

I-14-2

See response to Comment No. G-8-32.

I-14-3

Your comment is noted. No change to the Final EIS was necessary.

I-14-4 and I-14-5

Your support for the Water Supply Alternative is noted. No change to the Final EIS was necessary. As noted in Chapter 2, the No Action Alternative and the Conservation Before Shortage Alternative were the only two alternatives that considered absolute protection of Lake Mead water surface elevation 1,000 feet msl. The other action alternatives assumed that SNWA deliveries would be zero at Lake Water surface elevation below 1,000 feet msl. As noted in the response to Comment No. I-14-3, the other action alternatives were formulated to permit an evaluation of a wide range of operating conditions and to permit an evaluation of the trade-offs between water deliveries and retaining water in storage for future use. These other action alternatives, amongst other things, facilitated an evaluation with regard to how often and by how much SNWA may receive water deliveries below their annual entitlement due to Lake Mead water levels dropping below elevation 1,000 feet msl.

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April 15, 2007

TO: Regional Director, Lower Colorado Region,
Bureau of Reclamation, Attention: BCOO-1000,
P.O. Box 61470, Boulder City, Nevada 89006-1470;
FAX (702) 293-8156; e-mail strategies@lc.usbr.gov

FROM : Orion Inskip, Class of 2008
Seattle University, School of Law, Sullivan Hall
901 12th Avenue, P.O. Box 222000
Seattle, WA 98122-1090
inskipo@seattleu.edu

RE:

DRAFT EIS: Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

This comment is regarding the Draft Environmental Impact Statement (DEIS) prepared by the Bureau of Reclamation (Reclamation) for the Secretary of the United States Department of the Interior (Secretary) in support of a proposal to adopt specific interim guidelines for the Colorado River Lower Basin (Lower Basin) shortages and coordinated operations for Lake Powell and Lake Mead, particularly under drought and low reservoir conditions. The bulk of these comments are related to how the Interim Shortage Guidelines (ISG) will affect the Navajo Nation.

SUMMARY of COMMENTS

In general the DEIS fails

(1) to include the Upper Basin usage or Management into the any of the plans; the Final Environmental Impact Statement should be a programmatic EIS that includes the shortage plan for the entire basin so that the shortage can be equally shared across all stakeholders; 1

(2) to address the issue of Federal Indian Reserve Water Rights particularly the lack of adequate culinary water available to members of the Navajo Nation; 2

(3) to address the storage capabilities of CAP, the MWD Aquaduct, and the alternatives of using aquifers for storage to reduce the evaporative loss in the reservoirs; and 3

(4) to include contingencies to react to actual global warming projections. 4

I-15

1

Background of the Navajo Nation

The Navajo Nation includes the largest geographic area of any reservation in the United States.[1] The reservation is approximately 27,000 square miles.[2] As of the year 2000 census there are currently 298,215 members of the Navajo Nation, of which an estimated 173,987 currently live within the Navajo Nation reservation.[3] The majority of the Navajo Nation is geographically located in the Lower Basin state of Arizona. However, there are portions of the Navajo Nation in New Mexico and Utah. As of the 2000 census 63,500 members of the Navajo Nation were without domestic culinary water in their homes and had to haul water from community wells. [4] Additionally, the Navajo Nation will likely continue a transition from livestock herding to an agricultural based economy. In order to meet the future demands of the Navajo Nation a substantial quantity of water will be required.

The Supreme Court recently decreed in the Consolidated Decree that the Colorado River Indian Reservation, located in Arizona and California, had a prior perfected right to 662,402 acre feet (af) of Lower Basin.[5] This allocation is based on water that can be diverted and put to a consumptive use on the reservation.[6] However, the Decree does not actually restrict the use to which that water can be applied, so long as it is a beneficial use under the meaning in the decree.[7] Additionally, under the Consolidated Decree allocations to the tribes are charged to the state within which the consumptive use is made.[8] Although, there are members of the Navajo Nation homesteading on the Colorado River Indian Reservation, the bulk of the Nation's

[1] http://www.census.gov/population/www/cen2000/phc-t18.html [last checked 15 April 2007]
[2] *Id.*
[3] *Id.*
[4] http://www.freenewmexican.com/news/57909.html [last checked 15 April 2007]
[5] *AZ v. CA*, 547 U.S. 150, 126 S.Ct. 1543 (2006)
[6] *Id.*
[7] *Id.*
[8] *Id.*

I-15

2

members remain within the Navajo Nation reservation. Unfortunately, the Consolidated Decree does not identify an apportionment from the Lower Basin's apportionment to the Navajo Nation.

Approximately one third of the Navajo Nation reservation is in the state of New Mexico. The fact that the Navajo Nation is split between states and between the Upper and Lower Basins has severely complicated any claims by the Navajo Nation for water. Although Congress granted the Navajo Nation 508,000 af of Upper Basin water in the Navajo Indian irrigation project, the Navajo Nation has never realized that amount.[9] Instead, after decades of litigation and controversy, the Navajo Nation has agreed to settle with the State of New Mexico for 56% of New Mexico's entire allocation and with priority dates starting in 1868.[10] However, that settlement is still pending congressional approval. Furthermore, only one third of the Navajo Nation will be serviced from the water in the settlement if it is approved.

The balance of the Navajo Nation is in Arizona, 18,119.2 square miles, and Utah. The Navajo Nation has the right to demand sufficient water to put the all of the irrigable land on the reservation to a beneficial use. Unfortunately, the amount of irrigable land is still heavily contested. There are 11,601,856 acres of Navajo Nation Land within Arizona, under the precedent in the Consolidated Decree the Navajo Nation could claim an average of 6 af per irrigable acre on the reservation.[11] Under the Law of the River the water would be charged against Arizona's allocation. Furthermore, the Consolidated Decree has determined that anywhere between thirty and seventy percent of a tribe's reservation may be irrigable.[12] However, Public Law (87-483) designated 110,630 acres of the Navajo Nation reservation

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[9] Navajo Indian Irrigation Project, Public Law 87-483, (1962).
[10] *New Mexico v. U.S.*, CIV. 75-418. See THE SAN JUAN RIVER BASIN IN NEW MEXICO NAVAJO NATION WATER RIGHTS SETTLEMENT, April 19, 2005.

[11] *AZ v. CA*, 547 U.S. 150, 126 S.Ct. 1543
[12] *Id.*

I-15

3

located in New Mexico as irrigable, or roughly, two percent, a more realistic number when looking at the Navajo Nation.[13] Therefore, if the Navajo Nation can prove that 232,037 of the total reservation in Arizona is irrigable then the Navajo Nation could claim as much as 1.4 maf, or approximately one half of Arizona's total apportionment under the BCPA.[14]

COMMENTS

FACT SHEET

1. The Fact Sheet states that four action alternatives and a no-action alternative are included in the DEIS. Additionally, the Fact Sheet states that two of the four action alternatives were developed based on comments from parties outside the Bureau of Reclamations. Please identify the cooperating agencies, stakeholders, and other interested parties that are mentioned as providing input for the two action alternatives. Other stakeholders and interested parties would be more likely to provide meaningful input into the DEIS if it was clear who had already participated in the drafting process. 5

2. The Fact Sheet also states that the purposes of the proposed federal actions are to: (1) improve Reclamation's management of the Colorado River by considering the tradeoffs between the frequency and magnitude of reductions of water deliveries, and considering the effects on water storage in Lake Powell and Lake Mead, water supply, power production, recreation, and other environmental resources; 2) provide mainstream U.S. users of Colorado River water, particularly those in the Lower Division states, a greater degree of predictability with respect to the amount of annual water deliveries in future years, particularly under drought and low reservoir conditions; and, 3) provide additional mechanisms for the storage and delivery of water supplies in Lake Mead. With the increase in demand on water use projected in the Upper Basin

[13] Navajo Indian Irrigation Project, Public Law 87-483, (1962).
[14] Boulder Canyon Project Act of 1928

I-15

4

states and pending determinations of Tribal reserve water rights, the purpose should include identification and resolution of those issues to avoid future conflicts during times of drought. 6

CHAPTER 1: PURPOSE AND NEED

1. Section 1.3 Purpose of and Need for Action. The DEIS statements for the need for action fail to mention anything about the known effects of climate change on the future supply of water for the Colorado River Basin. The harms associated with global climate change were recently recognized in by the Supreme Court in *Massachusetts v. EPA*.[15] Among the known harms that will directly affect any shortage plan in the Colorado River Basins is a significant reduction in winter snowpack in the Rocky Mountains.[16] 7

2. Additionally, Section 1.3 fails to account for the recent 9th Circuit decision that vacated an injunction against lining the All American Canal to reduce seepage into Mexico.[17] Under the *Mexicali* decision the seepage water that currently enters Mexico from the canal will be reclaimed for use in the Imperial Valley Irrigation District. This will further reduce the amount of water that enters Mexico to meet treaty obligations.[18] Although it was assumed that this seepage water was not part of the treaty allocation it has become relied upon by Mexico and will have to be replaced from another source in the Lower Basin. Additionally, where the seepage has replaced the in-stream flows into Mexico it may have the original priority date set by the treaty of 1944.[19] 8

3. Section 1.5.1 Affected Region and Interests: limits the scope of the DEIS to the Lower Basin. It is well documented that there is a hydrological nexus between the Upper and Lower

[15] *Massachusetts v. EPA.* 2007 WL957332 (U.S.)
[16] *Id.* at 12-17
[17] *Consejo de Desarrallo Economico de Mexicali, A.C. v. U.S.* 2007 WL1054271 (9th Cir(Nev.)).
[18] *Id.*
[19] *See* Treaty Between the United States of America & Mexico Respecting Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande ["1944 Treaty"], 59 Stat. 1219, T.S. No. 994, Section III, Art. 10 (Nov. 8, 1945).

I-15

5

Basin States.[20] If the interim guidelines for Lower Basin shortage operations are based on the 9
assumption that a minimum of 8.23 maf of water will be available for release annually from Glen
Canyon Dam then the affected region includes all of the Upper Basin states. Under current and
future projected precipitation the total per annum flow through the basin is, and will continue to
be, less than 15 maf.[21]

CHAPTER 2: DESCRIPTION OF ALTERNATIVES

1. Section 2.1 Development of Alternatives: Although there is discussion of encouraging
conservation under one of the four action alternatives, there is no inter-basin strategy to reduce 10
demand for water resources through an increased emphasis on conservation. With a growing
demand and diminishing supply the Conservation Before Shortage Alternative is the only
alternative that realistically attempts to address the larger problem. However, without an inter-
basin coordinated management alternative any savings realized in the Lower Basin will be lost to 11
the ever decreasing supply available from the Upper Basin. Furthermore, all published
alternatives require an unrealistic minimum annual inter-basin transfer of 8.23 maf through Lee's 12
Ferry and follow the same Shortage priority

2. Section 2.2.1 Shortage Guidelines: The DEIS discusses the Secretary's current options under the Law of the River as placing California's claims ahead of Arizona. In effect, under this interpretation, California would not incur a shortage until all Arizona post 1968 contracts were
reduced completely, including the Central Arizona Project. However, there is no discussion of
allocation to the tribes and specifically the Navajo Nation during a shortage. The Navajo Nation 13

[20] *See generally,* Pontius, Dale, Colorado River Basin Study: Report to the Western Water Policy Review Advisory Commission, http://hdl.handle.net/1928/2782 (1997)

[21] *See* Niklas S. Christensen, *The Effects of Climate Change on the Hydrology and Water Resources of the Colorado River Basin,* Climatic Change 62: 337-363 (Kluwer Academic Publishing, Netherlands, 2004).

I-15

6

has a water right as of September 9, 1850.[22] Under the *Winters' Doctrine* the Supreme Court
recognized the water rights of the tribes as the time that the reservation was created under the
treaty.[23] Additionally, the Supreme Court quantified the right as an amount sufficient to make
use of the reserved land in the manner for which they are reserved.[24] However, the actual acre
feet reserved to the Navajo Nation has yet to be determined. Any interim or long term shortage 14
strategy must include an accurate accounting of the water available to the Upper and Lower
Basin states after the prior perfected rights are quantified and apportioned. Finally, in 1922 the
Colorado River Compact solidified that the Indian reserve water rights were not to be affected by 15
the Compact or later statutes or decisions.[25]

CHAPTER 3: AFFECTED ENVIRONMENT

1. Section 3.4.1 Apportionments to Upper Basin States: explains the apportionment to the
Upper Basin states by percentage. Appendix C includes a depletion schedule projected through
2060 based on current and projected uses. Section 3.2.1.1 identifies that the Navajo Nation is
riparian to a portion of Reach 1 defined as Gypsum Canyon to Glen Canyon Dam. Section 3.3.2
Lake Powell and Glen Canyon Dam: states that the Navajo Generating Station takes water
directly from the Lake Powell for use as cooling water. The depletion schedule in Appendix C
limits use within Arizona to 50 kaf. The amount currently used by the Navajo Generating
Station is 34,100 af. The balance of the 50 kaf is already allocated to beneficial uses within the 16
portion of the Navajo Nation in the Upper Basin. The Navajo Nation has agreed not to make
demands additional demands against Arizona's Upper Basin apportionment greater than 50 kaf

[22] 9 Stat. 974.
[23] *Winters v. United States*, 207 U.S. 564 (1908)
[24] *Arizona v. California*, 373 U.S. 546, 600 (1963).
[25] *See* article 4(a), Colorado River Compact (St. Cal. 1929, p. 4).

I-15
7

before 2018.[26] However, this amount does not account for the total prior perfected right of the 16
Navajo Nation in the Upper or Lower Basin.

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

1. Section 4.15 Environmental Justice: explains the methodology and consequences of the ISG on the 9 identified Environmental Justice counties within the Lower Basin states. Because the alternatives all follow the same priority for reductions in deliveries to the respective water users there is no significant difference to the environmental justice communities under any alternative. However, Executive Order 12898 directs agencies to identify and address, as appropriate, disproportionately high and adverse human health and environmental impacts of their programs, policies, and activities on minority and low-income populations.[27] The tribes have historically been left out of the discussions regarding allocations of water throughout the basin. Any plan that does not take into account the Indian reserve water rights, and specifically the reserve water rights of the Navajo Nation, will ultimately have a disproportionately high and 17
adverse impact on the low-income populations on the reservations. By failing to identify and secure the water rights of the Navajo Nation now the agency is effectively maintaining the 18
status-quo by allowing junior water-rights holders to continue to appropriate water ahead of their priority date. Additionally, the longer the agency waits to rule on the quantity due to the Navajo Nation the more severe the impact and the greater the estoppel argument against the prior perfected rights of the Navajo Nation. 19
Without a final decision the junior appropriators are far more likely to continue to litigate the matter as long as they can and are allowed to use the water during litigation. The ISG should take into account the amount of water that the Navajo Nation can put to a beneficial use on the existing reservations.

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[26] *See* Navajo Nation Council Resolution CD-108-68.
[27] Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations, **59 FR 7629(1994).**

CONCLUSION

None of the proposed alternatives have significant differences to environmental impacts or on environmental justice issues. There are no alternatives relating to the actual significant government action that is affecting the human environment, specifically the Interim Shortage Guidelines and the priority of imposing shortages is the substantially the same in each alternative. Essentially, all of the current alternatives follow the same shortage sharing modeling assumptions. The ISG then imposes shortages in the same priority without any regard for the actual quantity of available water after consideration of the Federal Reserve Indian Water rights of the Navajo Nation. 20 Finally, the Scope of the Environmental Impact Statement needs to be reevaluated to adequately address the effects of the ISG on minority and low-income populations that stand to be affected by the Federal Action in accordance with EO 12898. 21

Respectfully yours,

Orion Inskip
Seattle University – School of Law
Class of 2008

I-15
9

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Reponses to Comment Letter I-15

I-15-1

As noted in Section 3.2 reservoirs located upstream of Lake Powell and operate independently of Lake Powell would not be affected by changes in the operations of Lake Powell and Lake Mead or consequently the proposed federal action.

I-15-2

Your comment is noted. To the extent that additional Tribal water rights are developed, established or quantified during the interim period of the proposed federal action, the United States will manage Colorado River facilities to deliver water consistent with such additional water rights, if any, pursuant to federal law. Thus, modifications to system operation, in accordance with pertinent legal requirements, will be considered as Tribal water rights and will be exercised in accordance with applicable law.

I-15-3

See response to Comment No. G-8-33.

I-15-4

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-15-5

The information requested is provided in the Draft and Final EIS. Please refer to Section 1.4 for a listing of the cooperating agencies and Chapter 2 for details on the involvement of other stakeholders in the development of the alternatives.

I-15-6

See response to Comment No. IT-15-2.

I-15-7

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-15-8

The All-American Canal Lining Project is not a part of this proposed federal action but is considered an interrelated project. A description of this project has been added to Chapter 5 (Other Considerations and Cumulative Impacts) in the Final EIS.

I-15-9

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability. See also response to Comment No. G-5-44.

I-15-10 through I-15-12

As noted in Section 3.2 reservoirs located upstream of Lake Powell and operate independently of Lake Powell would not be affected by changes in the operations of Lake Powell and Lake Mead or consequently the proposed Federal Action. Your comment is also addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-15-13 through I-15-15

See response to Comment No. I-15-2.

I-15-16

Your comment is noted. See response to Comment No. I-15-2.

I-15-17 through I-15-20

Reclamation recognized federal reserved water rights of tribes on pages 3-81 to 3-89 and on 4-213 of the Draft EIS. Given that no effect is anticipated to Indian water rights, there would be no resulting environmental justice impacts. See also response to Comment No. I-15-2.

I-15-21

The information requested is provided in the Draft EIS. Please refer Section 4.14, Section 4.15, and Appendix H in the Draft and Final EIS for information on the potential impacts on minority and low-income populations which includes Indian tribes.

>>> Lana Jones <lana.jones@arizona.edu> 04/23/07 03:07PM >>>
Dear Bureau of Reclamation:

I'm writing to comment on the Draft EIS Interim Guidelines for Lower Basin Shortages.

In Chapter 4, page 4-265, lines 35-37 the range for reduced consumptive use of
4.2 to 6.9 af per acre is attributed to Colby et. al. 2006 but there is no entry for Colby in the References Cited, 1

page Ref-4.

In Colby B., K. Pittenger and L. Jones. "Voluntary Irrigation Forbearance to Mitigate Drought Impacts: Economic

Considerations" water application rates range from 3.5 to 5.8 af/acre. These rates comes from "Estimated Quantity of

2

Water Applied and Method of Distribution by Selected Crops Harvested:
2003 and
1998." 2003 Farm and Ranch Irrigation Survey Census of Agriculture,
2002 Census
of Agriculture,
http://www.nass.usda.gov/census/census02/fris/tables/fris03_28.pdf.

In brief, the range of consumptive use reduction in the dEIS seems high compared to the application rates found in the 3

irrigation survey.

Best regards,
Lana Jones
Graduate Research Assistant
Agricultural & Resource Economics
University of Arizona

I-16

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Reponses to Comment Letter I-16

I-16-1 and I-16-2

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment, as well as other public comments. The appropriate citation has been added to the References Cited (bibliography). This revision does not significantly change the impact analysis or results presented in the DEIS.

I-16-3

Your comment is noted. No change to the Final EIS was necessary. The range of consumptive use reductions considered in the Draft EIS are attributed to the references cited. Although these rates may vary by region and more specifically by the local soils type, crops grown, and irrigation methods, amongst other factors; the methodology in the Draft EIS addressed this issue in an appropriate fashion since the information was used consistently between alternatives and appropriately lent itself in the relative comparison of the alternatives.

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4-17-07

Bureau of Reclamation

Re: Comments on Shortage Guideline Matters

1. I request that your use of the term "extraordinary conservation" be changed to **extraordinary measures** which includes:
   a. **Extraordinary conservation** based on doing something using less water and thereby generating **conserved wet water.** 1
   b. **Fallowing and crop rotation** based on "not farming for a period of a year or more" or "not farming for a period which is less than a year" and generating **saved wet water.**

   Making this distinction is important for:
   (1) **Conservation** has a positive socioeconomic impact
   (2) **Not farming** has a negative socioeconomic impact

2. I support Reclamation directly managing the ICS program based on: 2
   a. The Lower Basin States submitting their ideas
   b. Reclamation proposing and establishing policies and procedures
   c. Reclamation managing the ICS program in accordance with its policies and procedures

Because the Seven Basin State and lower Basin State meetings and the Technical Committee meetings are closed to the public, I request that Reclamation will be available to discuss the management of the ICS program further upon request. 3

Cliff Hurley

Cliff Hurley **1108 W. Evan Hewes Hwy, El Centro, CA 92243** **Phone/fax 760.352.6496**

I-17

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Reponses to Comment Letter I-17

I-17-1

Your comment is noted. No change to the Final EIS was necessary.

I-17-2

Your comment is noted. No change to the Final EIS was necessary.

I-17-3

Your comment is noted. No change to the Final EIS was necessary. See also response to Comment No. L-3-7.

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From: Bird, Mark [mark.bird@ccsn.edu]
Sent: Thursday, April 26, 2007 1:51 PM
To: strategies@lc.usbr.gov
Cc: Bird, Mark
Subject: river DEIS

Hi:

I am responding the DEIS for the Colorado River. I believe options to be considered should include:

1. The Secretary of the Interior reducing water to all river states by 5 percent. 1
2. Converting farm water to city water. 2
3. Increasing by a factor of three the amount of money for desalting research and development. 3
4. U.S. efforts at reducing global warming gases at a national and international level. 4

These options are further discussed in the following newspaper article relating to the Colorado River. Please include a copy of this article as a part of my reply. Also, can you tell me whether or not you can include the following article? 5

Thanks,

Mark Bird

I-18

Is California headed toward economic collapse?

By Mark Bird
March 9, 2007

California has been using over 100 percent of its allocation of the Colorado River and over 100 percent of its annual renewable groundwater. Nearly 100 percent of the water used in metro San Diego and metro Los Angeles flows from hundreds of miles away.

There is a virtual 100 percent probability global warming is occurring and will intensify. Solutions will be thwarted by a near 100 percent certainty of litigation.

The Colorado River is the most critical water source for Southern California, Arizona and Nevada. In the next 30 years, the population of these two latter states will increase by 100 percent. Wyoming, Colorado, Utah and New Mexico will all also be using more Colorado River water in the next decade.

Lake Mead, on the Colorado River, is the largest reservoir in North America. Relative to its designed storage capacity, Lake Mead is now 15 percent silt, 37 percent water and 48 percent empty. A California economic collapse would commence if Lake Mead loses as little as another 20 percent of its storage capacity.

Additional hydrological factors include the absence of any large lake or river that is entirely within Southern California, the urban heat island effect, the tree-ring record suggesting the 20th century was a wet century, aging water infrastructure and an absence of regulations addressing shortage conditions on the Colorado River.

Additional sociological factors include water speculators buying water rights, bureaucratic inertia, an anti-science disposition relative to present trends, unfriendly relations with other states, and the complexity of approximately a thousand water districts and water-regulating entities in California. These factors are certain to intensify water scarcity in the near future.

But global warming is probably the most significant factor. In about 150 years of measurement, the 10 warmest years have all occurred after 1989. Statistically, one would not expect this pattern in over a million samples of picking 10 random years from a box.

For metro Los Angeles, 86 percent of its water derives from aqueducts supplying water from the Colorado River or the Sierra Nevada mountains in Northern California. Global warming is likely to continue to mean less snow being created, upstream soil absorbing more water, more evaporation from all reservoirs, less water entering the over 2,000 miles of concrete canals in California and more evaporation from these canals. At the same time, due to the warming, all farms will need more water to grow the same quantity of food.

It would be difficult to quantify, but perhaps the 43 non-Colorado River states and about 200 nations in the world are now annually "using," in terms of global warming evaporation, an amount of California water equal to the annual water usage of San Diego.

Over a few years, the contours of a collapse may feature a 50 percent increase in water bills, a 50 percent increase in power bills from electricity from Colorado River dams, and a 50 percent increase in the cost of food grown in Southern California. Such a scenario would send ripples of unemployment, crime and civil

I-18

unrest throughout the Golden State.

Given these trends, what are four key solutions?

Perhaps the most immediate solution is for the federal government to promptly reduce water deliveries by 5 percent for all seven Colorado River states. This could be in effect until the water level of Lake Mead reaches, say, 75 percent of capacity.

Likewise, California should institute water-based financial rewards and penalties for all farms and cities.

As there are three theoretical techniques that may each reduce desalting costs by 75 percent, the federal government should triple funds for desalting research and development, with a focus on desalting powered by solar, wind, tidal or other sources.

To further prepare for certain lean water years, the federal government should assume a far more energetic leadership role in reducing global warming gases.

Without major water policy shifts, an economic collapse of California could start as early as 2008. Otherwise, as California has eight times as many people as Louisiana in 2004, an economic collapse could be more financially devastating than Hurricane Katrina.

▪ Bird, a professor at the Community College of Southern Nevada, is an author of over 30 water-related articles. He can be reached via e-mail at **mark_bird@ccsn.edu**.

»Next Story»

Find this article at:
http://www.signonsandiego.com/uniontrib/20070309/news_lz1e9bird.html

☐ Check the box to include the list of links referenced in the article.

I-18

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Reponses to Comment Letter I-18

I-18-1

Your comment is noted. No change to the Final EIS was necessary. The Secretary is vested with the responsibility to manage the mainstream waters of the Lower Basin pursuant to applicable federal law. The responsibility is carried out consistent with a body of documents referred to as the Law of the River. The Law of the River comprises numerous operating criteria, regulations, and administrative decisions included in federal and state statutes, interstate compacts, court decisions and decrees, an international treaty, and contracts with the Secretary. This body of documents also sets forth the quantity and priority of water rights from the Colorado River. The Secretary has the responsibility to observe the priority of water rights and cannot arbitrarily implement delivery reductions that do not comport to the established rights, and the elements of the legal framework for allocation and delivery of Colorado River water, including the Supreme Court Consolidated Decree.

I-18-2

Your comment is noted. No change to the Final EIS was necessary.

I-18-3

Your comment is noted. No change to the Final EIS was necessary.

I-18-4

Your comment is noted. No change to the Final EIS was necessary. Please note that the identification and evaluation of the methods to reduce warming gasses is outside the scope of this EIS.

I-18-5

Your comment is noted.

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From: Tim Barnett [tbarnett-ul@ucsd.edu]
Sent: Friday, April 27, 2007 10:13 AM
To: strategies@lc.usbr.gov
Cc: tbarnett-ul@ucsd.edu
Subject: Objections: Colorado EIS

Importance: High

4/13/2007
TWIMC....
I was
>reviewing the USBR EIS* on operating rules for the Colorado in times of
>water shortage. The results of that EIS are
practically useless and, if implemented, will put the public interest at risk. My reasons 1
for this statement are as follows:

>Essentially, they use a river/reservoir model forced by 50 years chunks
>of actual Colorado River flow. These runs under different river flow
>scenarios are used to estimate the likely range of future levels of
>Lake Mead (say); the probability the Lake will be full or empty. In
>fact, their simulations show a disturbingly large range of
>possibilities from full pool to a level near dead pool. Just how the
>Lake is operated depends on these probabilistic estimates of future
>elevation.
>
> But the analysis done by USBR to date and the one on which the
>EIS is omits one huge factor. Essentially, their analysis to date
>assumes the past climatic variations in rainfall, snow levels,
>evaporation, etc are good estimates of what the future will be 2
>like··past river flows are good estimates of future river flows. In
>their case, this is a fatal error that, in my view, negates the basis
>of the EIS.
>Numerous studies over the last 10 years have shown the climate of the
>Colorado drainage will change markedly in the next few decades (it is
>already!). There will be less rain, snow pack will disappear earlier, 3
>increase temperatures will increase evaporation, etc. In short, the
>EIS is defined for the past, not the future. As such it is largely
>unreliable for decision makers.
>
> I believe the model forcing changes could be estimated from
>existing information. They could be added to the existing simulations
>and the whole probability structure of future possibilities be made
>available to decision makers·.at least then we would be taking a fairly 4
>realistic look at the future of the Colorado system under the climate
>change scenario. Given that the system is uncomfortably close to
>failure now, we need the best look at what to expect.

I-19

>
>   One other item along the same lines:
>while USBR talks about inflow, outflow, etc in the EIS, they never
>factor in increasing population. The 20 million more folks expected to
>rely on Colorado water by 2030 will need something like 3 maf MORE than 5
>is required today. This is order 20-30% the typical inflow to Lake
>Powell today. And as we have seen, numerous studies all show that
>inflow will decrease in a greenhouse world. So where does that extra
>water come from?

Thank you for your consideration. Dr. Tim Barnett, Climate research Div, Scripps Inst Oceanography, La Jolla, CA
>
>
>
>* Draft EIS Feb, 2007. Colorado River Interim Guidelines for lower
>Basin shortages and coordinated operations for Lakes Mead and Powell.
>--

I-19

Reponses to Comment Letter I-19

I-19-1

Your comment is noted. No change to the Final EIS was necessary.

I-19-2 through I-19-4

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-19-5

The information requested is provided in the Draft EIS. Please refer to Section 3.4 (Water Deliveries) for details on the water depletion schedules that were used in the modeling of the alternatives. As noted in this section, the Upper Basin depletion schedules have factored the projected increased water demands that are associated with increased use of domestic water supplies to meet the projected population growth in the Upper Division states. In the Lower Basin, all of the Lower Division states are currently using the full amount of their entitlement of Colorado River water and therefore, their respective entitlements limit their use of water from the Colorado River. Managing future population growth within the constraints of available water supply is primarily a local responsibility.

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>>> "Stacey Hamburg" <shambu@myway.com> 04/27/07 11:15AM >>>

Mr. Rick Gold
Regional Director, Bureau of Reclamation Upper Colorado Region
Attn: UC-402
125 South state St
Salt Lake City, Utah 84138-1147

Dear Mr. Gold,

I applaud the Bureau's acknowledgment of the critical water problems for the people of the southwest in the face of continuing long-term drought as well as the efforts to devise a strategy to deal with the problem.

Of the four alternatives listed in the DEIS, Conservation before Shortage provides the best solution for providing for the water and electricity needs of the southwest cities while also protecting the Colorado's riverine ecosystem. 1

A particularly attractive feature of Conservation Before Shortage that is not included in the Basin States Alternative is that users who give up water in response to a conservation trigger are compensated. 2 The Basin States alternative does not provide such compensation but strictly follows first in time, first in right western water law. This feature of Conservation Before Shortage is attractive for its obvious fairness and is particularly meaningful in that it alters the traditional way of dealing with water shortage in the West.

There are significant potential advantages to the use of voluntary, market-based conservation as an alternative to and as a means of mitigating against involuntary shortages. 3

In addition, in the Conservation Before Shortage Alternative, Mexico is allowed to participate in the ICS. That is Mexico can create surplus and bank it in Mead. This feature has many beneficial possibilities for the Delta. Initial indications are that all the potential players, including the powers in Mexico, find the potential attractive. 4

- Based on extensive modeling performed for the Lower Basin states, reductions of 400,000, 500,000 and 600,000 acre-feet at Lake Mead elevations 1075 feet, 1050 feet and 1025 feet, respectively, appear to provide optimal results in preventing larger involuntary shortages that perform better than the 200,000, 400,000, and 600,000 acre-foot reductions proposed in the original CBS proposal. 5

- It is desirable to protect the elevation of Lake Mead at no less than 1000 feet under any condition to protect Southern Nevada Water Authority's lower intake structures, as well as the new minimum power pool if proposed low-pressure turbines are installed at Hoover Dam. 6

I-20

- It is preferable for Lower Basin water users to voluntarily engage in predictable, small-scale reductions in use – and receive compensation for those reductions – rather than face large-scale, involuntary and uncompensated disruptions in water deliveries that could cut into municipal and agricultural water supplies and create unmitigated economic impacts. 7

- There is a large volume of Colorado River water which could be temporarily conserved through voluntary, market-based mechanisms such as part-year fallowing or forbearance agreements, dry year options, or other similar arrangements to reduce Lower Basin consumptive use on an occasional, temporary basis as an alternative to involuntary shortages to low-priority users.

- Users of Colorado River water in Mexico may wish to participate in short-term, voluntary and compensated conservation agreements, to reduce the probability of larger, uncompensated future reductions due to a declaration of shortage under the 1944 Treaty with Mexico. 8

For the reasons listed above, I urge the Bureau to adopt the Conservation before Shortage Alternative as the preferred alternative.

Thank you.

Stacey Hamburg
1550 N Fort Valley #19
Flagstaff, AZ 86001

I-20

Reponses to Comment Letter I-20

I-20-1

Your comment is noted. No change to the Final EIS was necessary.

I-20-2

Your comment is noted. No change to the Final EIS was necessary.

I-20-3

Information presented in the Draft EIS has been modified in the Final EIS (see Appendix H) pursuant to this specific comment, as well as other public comments. According we have added an analysis that considers the positive and negative effects of a voluntary conservation program. The results of this analysis are summarized in Appendix H, Section H.6.

I-20-4

Your comment is noted. No change to the Final EIS was necessary.

I-20-5

Your comment is noted. No change to the Final EIS was necessary.

I-20-6

Your comment is noted. No change to the Final EIS was necessary.

I-20-7

See response to Comment No. I-20-3.

I-20-8

See response to Comment No. F-5-2.

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>>> Melanie Florence <smskflor@yahoo.com> 04/27/07 12:42PM >>>
Dear Bureau of Reclamation,

I live in St. George, Utah, a place that will be affected by future water policies on the Colorado River. I have read the four alternatives and feel like the best one is the conservation before shortage initiative. 1

St. George right now uses a lot of water--about 300 gallons per person per day--and is pursuing building a Lake Powell to get even more. Most of the water is used on house lawns and golf courses--even during the summer when the snowbirds have left for cooler temperatures. Sprinklers all over town go off during the hot times of the day, in strong winds, and many areas overwatered. Even the city does not appear to be curbing water conservation in parks, school grounds, etc. Although St. George and Washington County in general has a desert climate, very few homes and businesses are xeriscaped in the front yards.

I feel like the only way to force the city and county to look toward future water shortages and encourage water conservation practices now is by imposing it from the outside somehow. I hope the conservation before shortage alternative will do that. 2

Sincerely,
Melanie Florence

I-21

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Reponses to Comment Letter I-21

I-21-1

Your comment is noted. No change to the Final EIS was necessary

I-21-2

Your comment is noted. No change to the Final EIS was necessary.

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>>> "Crista Worthy" <cristaworthy@hotmail.com> 03/01/07 10:47 AM >>>

Thank you for the opportunity to comment:Due to climate change, which has already
begun, it seems inevitable that those who depend on the Colorado River for their water 1
supply will receive less and less in the future. This makes it all the more ridiculous to
continue the existence of "Lake" Powell. Although I am one of those who has enjoyed
boating on this reservoir, I also know that it wastes an obscene quantity of water each 2
year, through evaporation and seepage--enough to supply the entire state of Nevada! The
Glen Canyon Dam, just upstream from the Grand Canyon, not only prevents sediment
from entering that National Park, but drastically lowers the water temperature, causing 3
the extinction of a number of fish, and near-extinction of others, contrary to Federal Law.

Lake Powell should be drained, the dam decommissioned, and the West will instantly
have enormously more water, which can be taken directly from the river or stored, if 4
necessary, in the Lake Mead reservoir. The small amount of electricity generated at the
Glen Canyon Dam can be replaced by building wind and solar generators nearby. The
Grand Canyon river ecosystem, unique in all the world, will be saved. The muck and 5
scum of "Lake" Powell that now fills the main channel of the Colorado River through
Glen Canyon will clean itself out within a decade or so through natural forces, and Glen 6
Canyon will once again be what it was: the true heart of the Southwest, an oasis with
more wildlife than all the thousands of square miles of desert surrounding it put together.

Crista Worthy
16664 Calle Brittany
Pacific Palisades, CA 90272
(310) 454-4329
(310) 560-7324

I-22

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Reponses to Comment Letter I-22

I-22-1

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-22-2 and I-22-3

See responses to Comment Nos. G-6-31 and G-8-32.

I-22-4 and I-22-5

See response to Comment No. G-6-18.

I-22-6

Your comment is noted. No change to the Final EIS was required.

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From: Rebecca McCartt [ramccartt@hotmail.com]
Sent: Wednesday, May 09, 2007 7:11 PM
To: strategies@lc.usbr.gov
Subject: Comments for Operations at Lake Powell & Lake Mead under Low Reservoir Conditions

Dear Mr. Johnson and Mr. Gold:
Lake Powell and Lake Mead lose 17 percent of the water that flows into them through
evaporation. Vacant space in underground aquifers near existing Colorado River water
recharge facilities could store more water than these two reservoirs combined. Upwards 1
of 810,000 acre-feet of water annually could be saved by eliminating Lake Powell and
operating Lake Mead principally for distribution to groundwater recharge facilities.

After more than 40 years of operation, it was not until the fall of 2004 that Lake Powell's
water storage actually augmented downstream water use. And with the impacts of climate
change and rising water consumption, it is unlikely that there will be sufficient surplus 2
water to fill Lake Powell again. Even should surplus water accumulate, Lake Mead alone
could provide sufficient storage.

Between Lake Powell and Lake Mead lies Grand Canyon National Park. The operation of
both these reservoirs has impacted the Canyon, but Glen Canyon Dam at Lake Powell has 3
been far more devastating. Since the dam's completion four of eight native fish have 4
gone extinct and the dam has trapped the sediment necessary to maintain habitat and 5
beaches for wildlife and recreation, as well as the stabilization of archeological sites.

Sediment is a major unresolved problem threatening the long-term operations of Lake
Powell and Lake Mead. Ultimately, sediment must be removed to ensure public safety. 6
Removing sediment from Lake Mead downstream, rather than Lake Powell upstream is
the most technically feasible, least costly and environmentally advantageous approach.

The Colorado River Compact of 1922, which largely governs the operations of Lake
Powell for Lake Mead, cannot meet its intended purpose of equitably sharing Colorado
River water between the Upper and Lower Basin states. With River flows expected to 7
decline 18 percent by 2040, this inequity will worsen, furthering the need for Compact
amendments while highlighting the benefits of eliminating Lake Powell to fulfill the
Compact's primary objective.

Rebecca McCartt
1360 Franklin st NW
salem, OR 97304

I-23

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Reponses to Comment Letter I-23

I-23-1

See response to Comment No. G-8-33.

I-23-2

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

I-23-3 through I-23-5

Your comment is noted. No change to the Final EIS was necessary.

I-23-6

See response to Comment No. G-6-31.

I-23-7

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

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Comments Submitted By Local Agencies

This section contains comment letters submitted by the following local agencies:

L-1 Mohave County Water Authority
L-2 City of Phoenix, Arizona
L-3 City of Scottsdale, Arizona
L-4 Metropolitan Water District of Southern California
L-5 Salt River Project
L-6 City or Peoria, Arizona
L-7 City of Chandler, Arizona
L-8 Colorado River Water Conservation District
L-9 City of Bullhead City, Arizona
L-10 City of Tempe, Arizona
L-11 Lake Havasu City, Arizona
L-12 City of Glendale, Arizona
L-13 Town of Gilbert, Arizona
L-14 City of Mesa, Arizona
L-15 San Diego County Water Authority
L-16 Arizona Power Authority
L-17 Central Arizona Project
L-18 City of Tuscon, Arizona
L-19 Imperial Irrigation District

Phone: (928) 505-7785
Law Offices of Maureen Rose George, P.C.
2000 McCulloch Boulevard N., Suite D
Lake Havasu City, AZ 86403
E-mail: mrglaw@npgcable.com
Fax: (928) 505-7786

April 30, 2007

Bureau of Reclamation
Attn: BCCO-1000
PO Box 61479
Boulder City, NV 89006-1470
Fax: 702-293-8156
Phone: 702-293-8500
Email: strategies@lc.usbr.gov

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To Whom It May Concern:

INTRODUCTION

The Mohave County Water Authority (MCWA) submits the following comments to the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement (February 2007). MCWA is comprised of members representing Bullhead City (BHC), Lake Havasu City (LHC), Mohave Water Conservation District (MWCD), Mohave Valley Irrigation and Drainage District (MVIDD), Golden Shores Water Conservation District (GSWCD), City of Kingman and Mohave County. BHC, LHC, MWCD, MVIDD and GSWCD represent the first (and probably only) municipal / industrial users in the State of Arizona to be significantly and immediately impacted by projected shortages during the interim period. Because of our unique position in the State of Arizona, we renew our previously denied request for consultation on this matter as the draft EIS makes it abundantly clear that no one with whom Reclamation consulted was adequately representing the interests of Arizona's 4th priority on river users.

THE SEVEN BASIN STATES ALTERNATIVE

MCWA recognizes Arizona worked diligently with the other Basin states to achieve agreement on the Basin States' Preliminary Proposal recommended to the Secretary of Interior on February 3, 2006 following the publication of the Draft EIS, and that Arizona has continued to work closely with the other states to refine and improve the Basin States' Preliminary Proposal and to develop one set of comments to the Draft EIS on behalf of all of the states ("Basin States Comments"). We understand the Basin States will be submitting the Basin States' Comments, together with the Basin States'

1

"As you drink the water, remember the spring."
– Chinese proverb –

L-1

Proposal, which will include the Basin States' Agreement, Proposed Interim Guidelines for Colorado River Operations, draft Forebearance Agreement and Arizona-Nevada Shortage Sharing Agreement (Basin States Proposal). While MCWA has some significant reservations regarding the Basin States Alternative we join in Arizona's letter submitted this date recommending the Secretary choose the Basin States alternative as the preferred alternative in the FEIS and adopt an ROD with the guidelines and criteria necessary to implement the Basin States Alternative in substantial conformance with the carefully negotiated Basin States Proposal provided such ROD adopts Arizona Department of Water Resources' Director's Shortage Sharing Workshop Recommendations, October 24, 2006 (Revised) Final attached hereto as Exhibit 1. 1

COMMENTS TO ADDRESS CONCERNS SPECIFIC TO MCWA

1. <u>No Action Alternative</u>:
   This alternative would provide no guidance to the on river 4th priority users in planning for shortages. Our members could suffer 30% shortages in both M&I and agricultural supplies as early as 2011. It gives no guidance as to how and when shortages would be imposed. It also assumes (a) the existing 602(a) interpretation would stand (see Arizona's letter for further discussion) and (b) the CRBPA requires on river agricultural and municipal/industrial users to be shorted immediately when CAWCD suffers shortages. This conclusion is not compelled by either the language in our contracts nor the CRBPA. This alternative leaves too many unanswered questions both among the Basin States and within Arizona to be acceptable to MCWA. 2

2. <u>Water Supply Alternative</u>
   The DEIS indicates that there would likely be no shortages in Arizona during the interim period under this alternative. In the short term this is clearly the best alternative for us, but we recognize the potential long term adverse consequences of this alternative and the likely conflicts it would cause among the Basin States. The compromises encompassed within the Basin States Proposal benefit the entire system and its long term benefits are reasons we support the Basin States Alternative versus the Water Supply Alternative. 3

3. <u>Reservoir Storage Alternative</u>
   The modeling provided in the DEIS shows that this alternative would have a significant negative impact on the river communities in Mohave County. 4 While the Reservoir Storage Alternative proposes to offset some of its impact with increased intentionally created surplus (ICS) the Arizona cities most immediately and severely impacted by this proposal, i.e., Lake Havasu City and Bullhead City, would be unlikely to benefit from an ICS program without a legal battle within Arizona. 5

   MCWA for the above reasons, as well as the reasons set forth in Arizona's letter, strongly objects to the Reservoir Storage Alternative. 6

2

L-1

4. <u>CBS Alternative</u>
MCWA believes the concept of voluntary fallowing, as well as the opportunity for
participation by all parties (including Arizona's on river 4th priority users and
Mexico) in the ICS program are laudable goals and request the FEIS adopt the 7
Basin States Alternative as the preferred alternative but discuss further the steps
which could be taken, within the Law of the River, to get the benefits likely to
result from a voluntary fallowing program (which would put fallowing contracts in
place NOW for future shortages) and to broaden participation in the ICS
program. Representing the communities in which Arizona will take the first, and
most significant, reductions in times of shortage we consider it incumbent upon
the Secretary to take all reasonable steps to mitigate the impacts of shortage by 8
supplementing the mitigation efforts we already have in place.

5. <u>Additional Comments on the DEIS</u>
   A. <u>ICS</u>
   Reclamation should, in the Final EIS, accurately describe ICS as a
   category of surplus, include a description of the forebearance necessary
   for the delivery of ICS to the entity that created the Surplus, and, in the 9
   record of Decision, adopt guidelines for the creation and delivery of ICS as
   set forth in the Proposed Interim Guidelines contained in the Basin States'
   Proposal. Reclamation should also take reasonable steps to provide that
   the benefits of ICS are available to all users particularly those immediately 10
   and significantly impacted by projected shortages, i.e., our members.

   B. <u>On River 4th Priority Agricultural Users</u>
   The draft EIS includes the following statement: "Key to the impact analysis
   is the assumption that the most conservative way to estimate impacts is to
   assume that, if a shortage occurs, farmers would react by fallowing
   irrigated lands." (p.4-263) This is an adequate approach for analyzing
   shortage reductions expected to last for a single year. However, we 11
   disagree with the assumption that this approach captures the expected
   impact for multiple consecutive-year storage reductions. Since fourth
   priority agricultural water users in Mohave County, Arizona have no
   reasonably available replacement water supply, a long term shortage will 12
   likely result in the permanent loss of production for some lands.

   The DEIS also fails to adequately address the impact on the economies of
   the impacted communities of this loss of agriculture by comparing the
   impact to the State and County overall (see, e.g., p.4-261 which totally 13
   ignores on river agricultural impacts in Arizona). This serves to very much
   dilute the direct and immediate impact on the on river 4th priority user
   communities.

   C. <u>On River 4th Priority Municipal and Industrial Users</u>

3

L-1

- As with on river agricultural users, the DEIS fails in any manner to
  address the direct and immediate impact of the projected shortages 14
  and cumulative shortages on municipal users of 4th priority on river
  users (see, e.g., p.3-129) and, again, lumps the communities
  together by County which significantly dilutes the local impact.

- The DEIS depletion schedules (Appendix D) underestimate by 25-
  35% on river M&I water use (as compared, e.g., to Reclamation's
  own 2006 water use report) which again, serves to underestimate
  the extent and effect of shortages and makes it difficult to determine 15
  the actual shortage amounts we would be expected to suffer based
  on the DEIS hydrologic modeling.

- The DEIS fails to address the significant costs borne by our
  members to date, and the even higher costs to be borne in the
  future, of the mitigation efforts taken to date (primarily participation 16
  in the Arizona Water Banking Authority (AWBA) program which
  costs include water, delivery, storage, recovery and replacement of
  any water used in times of shortage). The significant economic
  hardship of using AWBA water in times of shortage, particularly in
  multiple year shortage occurrences, is totally ignored by the DEIS. 17
  The DEIS also ignores the hundreds of millions of dollars our
  communities have spent/are spending to convert from septic to
  wastewater treatment systems in order to generate effluent to offset
  the impacts of shortage.

- Future estimated shortage reductions to mainstream users,
  including Lake Havasu City and Bullhead City, run as high as 30%
  of entitlement over a number of consecutive years. Despite the
  conclusion in the DEIS that no permanent changes in land use are
  expected (p.4-270) it is highly unlikely that such significant cutbacks 18
  in supply, and as early as 2011, would not alter land use patterns in
  the affected communities.

- The DEIS goes to great lengths to address impacts in Nevada
  (ostensibly in support of the extreme measures be proposed to
  solve both its long term and shortage supply needs) and the
  Central Arizona Project area while totally ignoring that Arizona's on
  river 4th priority users are in a far worse position than either of these 19
  areas for a number of reasons including:

(1) Neither our agricultural nor M&I users have a readily available alternative source of water to offset shortage reductions; e.g., no adjacent tributaries, no non Colorado River related surface water flows,

4

L-1

nor (based on Reclamation's current interpretation of Article V accounting under the Consolidated Decree in *Arizona and California*) is there any locally available, non-Colorado River groundwater..

(2) The small (relative, e.g., to the SNWA and CAP service areas) population in the area, and the large geographic distances separating the on river P4 users, make financing of any water importation project unlikely at best.

(3) Fallowing agreements, e.g. with farmers or tribes, as are available to Central Arizona Project communities are not available to on river P4 users for a variety of reasons including the trading of our priority for the CAP (which did not benefit, and arguably harmed, on river users), on river tribes in Mohave and LaPaz settling their claims before our communities existed and thus such settlements make no provision for leasing to adjacent municipalities, and the apparent position of Arizona and CAP that ICS in any form is not available to us without forebearance by Arizona and CAP.

(4) Limited, if any (investigation is ongoing) adjacent basins unconnected to the River in which recharge, and recovery, could occur (i.e., our own banking program).

- The ROD needs to include the Arizona/Nevada shortage sharing agreement as submitted with the Basin States Proposal and a provision that the proceeds of that agreement are to first be used to hold the on river P4 M&I users, the first impacted by this "deal", harmless (i.e., as to water and money) from the impact of this sharing agreement. Arizona has verbally indicated to MCWA that this is the intent but due to the immediate and detrimental impact of the Arizona/Nevada agreement MCWA takes the position this commitment should be recognized in the ROD. 20

D. Additional Comments

- An agreement with Mexico is a critical component of the Basin States Proposal and MCWA's support of same. The impacts of a failure to reach such an agreement are not modeled in the DEIS but would no doubt have a significant impact on our members 21
- MCWA, its members, and Arizona as a whole appear to be penalized in the DEIS for its active planning for drought for decades (p.4-282). 22 The DEIS dismisses the significant economic impact of the investments made to date, and projected into the future, by coming to the erroneous conclusion that due to Arizona's drought planning, there is no real impact on its M&I users. 23

5

L-1

- The projected depletion schedules and shortage impact tables in the DEIS do not accurately portray the various contracts and contract amounts held by MCWA and its various subcontractors. This should be corrected in the FEIS. 24

- Because a shortage has not been declared to date on the River, and because our M&I users take the most immediate and significant and disproportionate reductions, the FEIS should include a program for monitoring the economic, land use and public policy impacts of any declared shortage during the proposed interim period. 25

- Operation of the YDP at full capacity should commence as soon as possible in order to stop the loss of water now occurring as a result of the bypass flows to the Cienega de Santa Clara. 26

- Reclamation should immediately undertake programs and projects to augment system flows. 27

- Final shortage guidelines should be flexible in order to allow the appropriate response to changing conditions including, but not limited to, improved hydrologic conditions during the year(s) in which a shortage is declared and catastrophic conditions requiring cuts in excess of 600,00 a/f. 28

CONCLUSION

Subject to Arizona's comments as submitted by ADWR, and our comments as noted above, the Mohave County Water Authority strongly recommends that the Secretary choose the Basin States Alternative as the preferred alternative in the FEIS and adopt a ROD with the guidelines and criteria necessary to implement the Basin States Alternative in substantial conformance with the carefully negotiated Basin States' Proposal. 29

Sincerely,

Maureen R. George
General Counsel
Mohave County Water Authority

Attachment: Exhibit 1; Director's Shortage Sharing Workgroup Recommendation, October 24, 2006 (Revised) Final

6

L-1

Cc: Herbert R. Guenther, Director, Arizona Department of Water Resources (email)
Board Members, Mohave County Water Authority
Les Byram, Mayor, City of Kingman – (email)
Diane Vick, Mayor, Bullhead City – (email)
Tom Sockwell, Supervisor, Mohave County – (email)
Tom Griffin, Mohave Water Conservation District – (email)
Paul Maxwell, Golden Shores Water Conservation District
Doyle Wilson, Lake Havasu City – (email)

7

L-1

Director's Shortage Sharing
Workgroup
Recommendation

October 24, 2006
(Revised)
Final

In 2005, the Director established the Arizona Shortage Sharing Stakeholder Workgroup (Workgroup). The Workgroup had two specific goals:

1. Develop a recommendation to the Director regarding the appropriate volume and implementation strategy for implementing future Colorado River shortages in the lower basin.
2. Develop a recommendation to the Director for allocating shortages between the Central Arizona Project (CAP) and equivalent priority mainstream Colorado River water users.

The Workgroup effort supports a larger Bureau of Reclamation (Reclamation) Environmental Impact Analysis process to develop lower basin shortage criteria and conjunctive management strategies for the operation of Lakes Powell and Mead. Reclamation currently plans to issue a Record of Decision in December 2007.

Shortage Volume and Implementation Strategy

The Workgroup developed the following recommendation for implementing lower basin shortages:

1. At or below Lake Mead elevation 1075 feet, 400,000 acre-feet shortage
2. Below elevation 1050 feet, 500,000 acre-feet shortage
3. Below elevation 1025 to 1000 feet, 600,000 acre-feet shortage
4. Below elevation 1000 feet, reconsultation with Reclamation and the states

The recommendation assumes that the first step will be to reduce water deliveries to Mexico and the next step will be to calculate shortage sharing with Nevada. Hydrologic conditions that necessitate reductions in excess of 600,000 acre-feet will trigger a Secretarial consultation process to determine how to implement additional reductions in the least damaging and most equitable manner possible. That consultation process has not been defined, but should be developed with input from the basin states.

The Director forwarded this recommendation to the other Colorado River basin states, and it has been incorporated into the *Seven Basin States' Preliminary Proposal Regarding Colorado River Interim Operations, February 3, 2006,* with one modification, that reconsultation would be triggered at elevation 1025.

Shortage Allocation Between CAP and Fourth Priority Mainstream Entitlements

The Workgroup analyzed methods for allocating shortage reductions between CAP and fourth priority mainstream water users. The CAP has an established priority system for implementing shortage reductions. Excess water supplies are reduced first. If additional reductions are needed, non-Indian agricultural priority water supplies are reduced until gone, and finally municipal/industrial/Indian uses are reduced according to the formula in the Gila River Indian Community Water Rights Settlement L-1

Agreement. There is no equivalent shortage implementation system for fourth priority mainstream water users. Fourth priority mainstream uses (agricultural and municipal) will be reduced proportionately as soon as Arizona Colorado River shortage reductions are implemented. Future estimated shortage reductions to mainstream users including Lake Havasu and Bullhead City run as high as 30 percent. Under Reclamation's current interpretation for Article V accounting, there is no locally available, non-Colorado River water supply to offset these shortage reductions.

The Director requested that a small technical subgroup of Workgroup stakeholders begin working with the Department to develop a shortage allocation recommendation. The technical group established principals to guide a shortage allocation strategy:

1. Define a method for the Secretary to utilize when allocating shortages to Arizona users
2. Beneficiaries bear the costs of shortage protections
3. Shortages must be allocated in a reasonable manner based on existing contracts and agreements
4. To the extent possible, treat similar users groups equitably

The Mohave County Water Authority (MCWA) presented a recommendation for proportional shortage reductions to fourth priority mainstream water supplies based on entitlement. Shortage reductions to mainstream domestic water supplies could be mitigated by the Arizona Water Banking Authority. The Department completed additional technical analysis of the proposal, which was endorsed by the technical group. The technical group recommends that Arizona fourth priority shortages be allocated as follows:

1. Determine shortage amount and allocation to Mexico. Allocate the remaining shortage amount first to Nevada, and the remainder to Arizona. The enclosed spreadsheet first allocates 16.7% of the shortage to Mexico. The remaining shortage amount is then allocated 7.4% to Nevada and the remainder to Arizona.
2. Determine the estimated priority 1-3 consumptive use amount based on the last non-shortage year use. Determine the **Total Water Supply Available for Fourth Priority Diversion**. Subtract the priority 1-3 consumptive use amount from the Arizona Colorado River water allocation of 2,800,000 acre-feet.
3. Determine the **Fourth Priority Mainstream Shortage Percentage**. Divide the fourth priority mainstream diversion entitlement, 164,652 acre-feet, by the Total Water Supply Available for Fourth Priority Diversion (#2).
4. Determine the total water supply **Available for Fourth Priority Diversion after Shortage Reduction**. Subtract the Arizona portion of lower basin shortage from Total Water Supply Available for Fourth Priority Diversion amount (#2).
5. Determine the **Fourth Priority Mainstream Shortage Reduced Water Supply**. Multiply the Available for Fourth Priority Diversion after Shortage Reduction (#4) water supply by the Fourth Priority Mainstream Shortage Percentage (#3).
6. Determine the remaining, CAP water supply. The Total Water Supply Available for Fourth Priority Diversion amount is based on estimated priority 1-3 water use. Actual use may be higher than estimated, and could result in an inadvertent CAP overrun. The CAP has agreed to be responsible for payback, under the Inadvertent Overrun and Payback Policy, up to the amount of the water user's entitlement. Actual use may be lower than estimated, resulting in an increased water supply for CAP.

L-1

Director's Shortage Sharing Workgroup Recommendation
October 24, 2006
(Revised)
Final

Since there is a fixed maximum diversion entitlement for fourth priority mainstream water users, as noted in the *Contract Between the United States and the Central Arizona Water Conservation District for Delivery of Water and Repayment of Costs of the Central Arizona Project, December 1, 1988*, the mainstream fourth priority water supply has been calculated based on that entitlement. After determining the mainstream fourth priority water supply, the remaining water supply is available for diversion by the CAP, including any available return flow from mainstream water uses.

The shortage allocation recommendation includes the opportunity for mainstream municipal water users to firm 100 percent of their individual municipal/industrial entitlements. Based on updated population projections (2003) the AWBA would need between 450,000 and 525,000 acre-feet of credits for fourth priority mainstream municipal and industrial water users. As AWBA credits are used and replaced, the new credits will be earmarked in the name of the entity that replaced the credits, thereby creating a revolving fund. The AWBA has not foreclosed the opportunity for any fourth priority mainstream entitlement holder to contract with the AWBA for firming.

L-1

3

Shortage Sharing Scenarios - Pro Rata Reductions Based On Priority 4 Entitlements

(Values in Acre-feet)

Year	Priority 1-3 Mainstream Projected Consumptive Use[1]	Available for Priority 4 Diversions - Normal Supply [2]	Priority 4 Mainstream Total Entitlement	Priority 4 Mainstream Shortage Sharing Percentage	Arizona Portion of Lower Basin Shortage[3]	Available for Priority 4 Diversion - Reduced Supply	Priority 4 Mainstream Diversion - Reduced Supply	Projected Priority 4 Mainstream Diversion [1]	Priority 4 Mainstream Diversion - Net Reduction
400,000 Acre-Feet Shortage									
2010	1,171,867	1,556,133	164,652	10.58%	308,588	1,247,545	132,001	155,880	23,879
2016	1,177,135	1,550,865	164,652	10.62%	308,588	1,242,277	131,890	158,961	27,071
2025	1,185,597	1,542,403	164,652	10.68%	308,588	1,233,815	131,710	162,362	30,652
2031	1,191,580	1,536,420	164,652	10.72%	308,588	1,227,832	131,582	163,799	32,217
500,000 Acre-Feet Shortage									
2010	1,171,867	1,556,133	164,652	10.58%	385,735	1,170,398	123,838	155,880	32,042
2016	1,177,135	1,550,865	164,652	10.62%	385,735	1,165,130	123,699	158,961	35,261
2025	1,185,597	1,542,403	164,652	10.68%	385,735	1,156,668	123,475	162,362	38,887
2031	1,191,580	1,536,420	164,652	10.72%	385,735	1,150,685	123,314	163,799	40,485
600,000 Acre-Feet Shortage									
2010	1,171,867	1,556,133	164,652	10.58%	462,881	1,093,251	115,675	155,880	40,204
2016	1,177,135	1,550,865	164,652	10.62%	462,881	1,087,983	115,509	158,961	43,452
2025	1,185,597	1,542,403	164,652	10.68%	462,881	1,079,521	115,239	162,362	47,122
2031	1,191,580	1,536,420	164,652	10.72%	462,881	1,073,538	115,047	163,799	48,752

ENDNOTES

1 Source: Arizona Department of Water Resources 2003 mainstem Colorado River water use projections.

2 An amount of 72,000 acre-feet has also been deducted to account for higher priority Ak-Chin and Salt River Pima-Maricopa Indian settlement water.

3 This amount is determined by first deducting Mexico's share (16.7%) of the total Lower Basin shortage. The remaining shortage volume is apportioned first to Nevada (7.4%) and the remainder to Arizona.

L-1

2006 REVISED FINAL RECOMMENDATION Oct 2006.xls /
P4Shortages-NormalSupplyRev#1

Page 1 of 1

As of October 18, 2006

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Reponses to Comment Letter L-1

L-1-1

Your comment is noted. No change to the Final EIS was necessary.

L-1-2

Your comment is noted. No change to the Final EIS was necessary.

L-1-3

Your comment is noted. No change to the Final EIS was necessary.

L-1-4 through L-1-6

Your comment is noted. No change to the Final EIS was necessary.

L-1-7 and L-1-8

Your comment is noted. See also response to Comment No. G-5-93.

L-1-9

ICS is the proposed mechanism for the storage and delivery of conserved system and non-system water in the Preferred Alternative. In addition, Draft Operational Guidelines have been included in Appendix S of the Final EIS that provide reviewers with an understanding of Reclamation's current assessment of the likely proposed format and content of the proposed interim guidelines which includes ICS administration.

L-1-10

See responses to Comment Nos. G-5-93 and L-1-9.

L-1-11 and L-1-12

Your comment is noted. The content of the Final EIS has been modified to reflect this public input. A discussion of the probabilities and socioeconomic effects of multi-year shortages has been added to Section 4.4 and 4.14 of the Final EIS. The effect of such a multi-year shortage on land use would depend on how these shortages were allocated among individual farmers within the water agency service area, or which lands within a single farming operation were fallowed. Given these unknowns, Reclamation did not conclude that the same acres would be fallowed each year, and did not identify socioeconomic impacts from permanent land use changes.

L-1-13

As indicated in the EIS, losses in employment, income, and tax revenues that may be experienced during a shortage represent a small percentage of employment, income, and tax revenues within Arizona and the counties that may be directly affected. Reclamation's assessment of the relative effects of shortages occurring at the county-level determined that no individual county in Arizona would see losses in employment, income, or tax revenues greater than one percent of the total generated within that county. The analysis for impacts to the agricultural economy did include the counties along the river where agriculture would be affected, including Mohave County.

L-1-14

The Draft EIS did address socioeconomic impacts to the agricultural sector at the County level, including impacts along the Colorado River mainstream, including Mohave County. Reclamation concurs that fourth priority municipal contractors such as Lake Havasu City and Bullhead City will be affected by shortages, and additional information has been added to the Final EIS to acknowledge this. The specific reductions distributed to affected Arizona M&I users under specific shortage determinations is included in Appendix G. See also response to Comment No. L-1-13.

L-1-15

Reclamation concurs with this comment. In the Draft EIS, the depletion schedules for three entities, Bullhead City, Lake Havasu City and Mohave Water Conservation District, consisted of the portion of water related to their water delivery contract with the Secretary; but did not include subcontracted water from the Mohave County Water Authority (MCWA). Instead the schedules were related to the MCWA water delivery contract with the Secretary. For the Final EIS, the schedules for these three entities were increased to include subcontracted water with MCWA. Therefore the depletion schedules and modeling for the Final EIS now correctly reflects the water supply conditions of these three entities.

L-1-16 and L-1-17

See response to Comment No. G-1-25.

L-1-18

See responses to Comment Nos. L-1-11 and L-1-13.

L-1-19

See response to Comment No. L-1-14.

L-1-20

The content of the Final EIS has been modified to reflect this public input. The modeling assumptions in Section 4.2.7.1 of the Final EIS and resulting analyses are consistent with the Arizona and Nevada Shortage Sharing Agreement. The use of the proceeds of the shortage sharing agreement are beyond the scope of this EIS.

L-1-21

Your comment is noted. No change to the Final EIS was necessary.

L-1-22 and L-1-23

See response to Comment No. G-1-25.

L-1-24

See response to Comment No. L-1-15.

L-1-25

Reclamation does not concur with this comment. The interim nature of the guidelines is intended to provide an opportunity to evaluate how the guidelines work. In addition, opportunities for review of the effectiveness of the guidelines are anticipated to be available both throughout the proposed interim period and at intervals during the interim period. Such reviews would provide a basis for possible further federal actions and decisions at the end of the interim period. Reclamation anticipates that a review of the guidelines will be conducted at a time prior to the end of the interim that would allow the Department, and the public, to assess the effectiveness of the guidelines and to determine the most appropriate course of action for the post-interim period..

L-1-26

Your comment is noted. See also the response to Comment No. F-4-9.

L-1-27

Your comment is noted. See also response to Comment No. L-1-9.

L-1-28

See response to Comment No. G-8-37.

L-1-29

Your comment is noted. No change to the Final EIS was necessary.

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City of Phoenix
OFFICE OF THE CITY MANAGER

April 30, 2007

Regional Director
Lower Colorado Region
Bureau of Reclamation, Attention BCOO-1000
P.O. Box 61470
Boulder City, NV 89006-1470

Re: Notice of Availability and Notice of Public Hearings for the Draft Environmental Impact ("EIS") Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.

Dear Director,

The City of Phoenix ("City") submits its comments to the Draft EIS for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (72 Fed. Reg. 9026 dated February 28, 2007). The City is keenly interested in the outcome of the shortage criteria and coordinated operations for Lake Powell and Lake Mead. The City has previously commented during the scoping process pursuant to the Notice of Intent to prepare the EIS. Likewise, the City has directly participated in the negotiations between the Seven Colorado River Basin States culminating in the Seven Basin States proposal to the Secretary of the Interior dated February 3, 2006 and in stakeholder meetings within the State of Arizona resulting in shortage criteria proposed to Reclamation by the Arizona Department of Water Resources and agreed upon by all the Basin States. Phoenix' commitment to these processes is a necessary outgrowth of its reliance upon Colorado River water, delivered through the Central Arizona Project ("CAP"). The City serves over 1.4 million people and Colorado River water currently supplies over 35% of its total water demand. The City's CAP water supplies include sources with a variety of priorities, and its exposure to shortages varies accordingly. The City holds subcontracts for Municipal and Industrial priority water and leases for Indian priority water. The City also holds a contract for a substantial volume of lower-priority non-Indian agricultural CAP water. As a result, the City must consider many potential drought scenarios that the majority of the municipalities relying upon CAP water do not need to be concerned with.

The City's plight is further complicated by the fact that the CAP is the major junior priority user under the Law of the River. It is imperative that the Secretary of the Interior ("Secretary") be mindful of this factor when selecting and implementing a preferred alternative. Thus, Arizona water users face the greatest risks when a shortage declaration is made and the preferred alternative must recognize and minimize impacts to those water users. 1

L-2

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Regional Director
April 30, 2007
Page 2

The City has a long-standing track record of sound water resources management including diversifying its water resources portfolio, building integrated infrastructure to allow efficient use of those resources, reusing reclaimed water, a strong water conservation program that has been in place for over two decades that has resulted in declining rates of water use and a drought management program that allows for the imposition of mandatory demand reductions. Despite all these efforts by the City, catastrophic shortages on the Colorado River could pose serious problems to the City's ability to continue to fully serve its customers.

The Proposed Alternatives

The Final EIS Should Designate the Basin States Alternative as the Preferred 2
Alternative
The Basin States Alternative provides the greatest degree of certainty for the City of 3
Phoenix because it is consistent with the agreement reached by the Basin States and
can be implemented upon approval of the Record of Decision ("ROD") without the need 4
for additional action. This alternative best meets the goals of the proposed action
discussed in the February 28, 2007 Federal Register Notice, i.e., "[T]his action is
proposed in order to provide a greater degree of certainty to U. S. Colorado River water
users and managers of the Colorado River Basin by providing detailed and objective
guidelines for the operations of Lake Powell and Lake Mead, thereby allowing water
managers and water users in the Lower Basin to know when, and by how much, water
deliveries will be reduced in drought or other low reservoir conditions." (72 Fed. Reg.
9027 dated February 28, 2007.) Moreover, certainty provided by the Basin States
Alternative goes well beyond the actual criteria and numbers. The Agreement reached 5
by the Basin States, and reflected in the Basin States Alternative, creates an increased
level of confidence that legal issues over the interpretation and implementation of the
Colorado River Compact, the Mexican Treaty, accounting under the Arizona v.
California Decree, and equalization of Lake Mead and Lake Powell will not result in
costly and divisive litigation with an uncertain outcome for water users. The value of 5
collaboration by the Basin States can not be overstated.

Another unique attribute of the Basin States Alternative is that it provides flexibility
within the system and a mechanism, that can be immediately implemented upon 6
execution of the ROD, for maximizing the efficiency of the system by allowing for the
intentional creation of surplus ("ICS") in Lake Mead by a Lower Colorado River
Mainstem contractor and release of that surplus for use within the state that created it,
with the forbearance of the other Lower Division States. The State of Arizona recently
enacted legislation that allows the State to forbear ICS water if the Secretary "adopts 7
substantially the same concepts as contained in the proposal of the seven basin states
for shortage guidelines and conjunctive management of lakes Mead and Powell,"
clearing the way, at least from Arizona's perspective, for ICS to be implemented if that
alternative is memorialized in the ROD.

L-2

Regional Director
April 30, 2007
Page 3

Certainty for water users and the ability of the Basin States Alternative to be
immediately implemented is also enhanced by the fact that the Lower Colorado River
Multi-Species Conservation Plan ("MSCP") provides compliance with the Endangered
Species Act ("ESA") given the reductions of flow proposed in the Basin States
alternative and the reductions analyzed in the MSCP. Additional ESA consultation that 8
may be required under other alternatives raises uncertainties regarding the
implementation schedule for those alternatives.

The Basin States Alternative is the only alternative that allows for the extension and 9
modification of the existing Interim Surplus Guidelines ("ISG") without the need for
further action. The package submitted to the Secretary by the Seven Basin States on
February 3, 2006 includes provisions to amend the ISG by agreement of all the States.
The Basin States Alternative adopts those amendments.

Finally, the Basin States Alternative is the only alternative that meets all the criteria 10
discussed in Section 1.1 of the Draft EIS that states, "[T]he Secretary intends to
consider, adopt and implement the proposed federal action consistent with applicable
federal law and judicial decisions, and, further, in a manner that will not require any
additional statutory authorization." (DEIS at p. 1-1).

<u>The No Action and Water Supply Alternatives</u>
The No Action and Water Supply Alternatives analyze a broad range of environmental 11
impacts but fall short of meeting the goals of the proposed action by failing to provide
certainty for the timing and extent of shortages in the Lower Basin and by failing to
propose viable criteria for the coordinated management of Lake Powell and Lake Mead.
These two alternatives do not allow for the creation or use of ICS thus limiting flexibility 12
in the operation of the system and creating greater risk and uncertainty regarding
shortages for water users in the Lower Basin.

<u>The Reservoir Storage Alternative</u>
The Reservoir Storage Alternative ("RSA") proposes levels of shortages starting at
600,000 AF and increasing to 1,200,000 AF and the magnitude of the average shortage
volumes during the interim period are the highest under this alternative. (DEIS at p. ES-
10). Shortage levels beyond 600,000 AF (including 17% for Mexico or 500,000 AF just 13
for the Lower Basin) are draconian in nature for Arizona water users on their face, and
their adoption can not be justified when compared to reductions of 400,000 AF, 500,000
AF and 600,000 AF (including 17% for Mexico or 300,000 AF, 400,000 AF and 500,000
AF just for the Lower Basin) proposed under the Basin States Alternative. The Basin
States recognized the harsh nature of shortages greater than 600,000 AF (including 14
17% for Mexico or 500,000 AF just for the Lower Basin) and have agreed to consult with
the Secretary if shortages are projected to exceed this volume (Seven Basin States
Letter to Secretary Norton, February 3, 2006, Attachment A., at p.6). The RSA does not 15
meet the goal stated in the Federal Register Notice, i.e., "to (1) Improve Reclamation's
management of the Colorado River by considering the trade-offs between the *frequency*

L-2

Regional Director
April 30, 2007
Page 4

and magnitude of reductions of water deliveries…" (72 Fed. Reg. 9027 dated February 28, 2007. emphasis added). Furthermore, this alternative would require changes to the Law of the River prior to its implementation. 16

The Conservation Before Shortage Alternative

The Conservation Before Shortage Alternative ("CBS") also falls short of meeting the certainty provisions of the proposed action as evidenced in Table ES-1, Matrix of Alternatives. 17 Column one of that table states that for the CBS alternative, "shortages are implemented in any given year to keep Lake Mead above SNWA's lower intake at elevation 1000' (absolute protect of elevation 1,000)." Water users in the Lower Basin will be left to the whims of the Annual Operating Plan for determining when and how much of a shortage will be declared under this alternative. This greatly reduces certainty for water users like Phoenix. 18

This alternative is also dependent upon the creation and use of ICS but reliance upon ICS would require changes to the Law of the River prior to this part of the alternative being implemented. 19 In addition to this inherent fatal flaw, the City also points out that this alternative essentially would allow 4.2 million AF to be stored in Lake Mead compared to a maximum storage of 2.1 million AF under the Basin States Alternative. Creating ICS of this magnitude could create too much risk for losing expensive ICS water to spills in wet years and earmark too much Lake Mead water for a particular water use, rather than for the system. 20

Two additional drawbacks of the CBS alternative are: (1) no funding mechanism for creation of ICS currently exists; 21 and (2) including ICS by the Republic of Mexico may necessitate amending the 1944 Treaty to allow for the creation and delivery of ICS water to Mexico. 22 Reclamation recognizes the limitations of the CBS alternative by stating, "[T]he viability of the Conservation Before Shortage program funding proposal is not known at this time. Reclamation currently does not have authority to implement all facets of this proposal and additional legislation would be necessary to gain such authority." (Draft EIS at p. 2). 23

Summary

When weighing the proposed alternatives against one another it is evident that the Basin States Proposal is superior to any of the other alternatives because it provides the greatest degree of certainty to water users, avoids potential litigation, creates shortage criteria that are reasonable in magnitude and are readily predictable based upon elevations at Lake Mead, and present a package that can be implemented without the need for further legislation or ESA compliance. 24

Furthermore, the Basin States Alternative best meets all the aspects of the purpose and need for the action and has the support of the Basin States which will enhance the Secretary's ability to manage the Colorado River system in a collaborative manner. The City of Phoenix urges the Secretary to adopt the Basin States Proposal as the preferred alternative in the Final EIS.

L-2

Regional Director
April 30, 2007
Page 5

Conjunctive Operation of Lake Mead and Lake Powell

The Basin States Alternative creates the ability to more effectively balance the contents of Lake Mead and Lake Powell in a way that dampens the large fluctuations in reservoir elevations during extended periods of low inflow into the system. 25 That alternative also removes potential issues over the methodology for equalizing the contents of Lake Mead and Lake Powell under other proposed alternatives.

Currently equalization is largely governed by the Interim 602(a) Storage Guideline for Management of the Colorado River which contains a 14.85 million acre-feet storage 26 requirement. That guideline artificially limits equalization and has a detrimental effect on storage in Lake Mead and thus on the City of Phoenix. While the current guideline was also part of a package agreed to by the Seven Basin States as part of the ISG process, it essentially provides for greater protection for power production at Lake Powell than is otherwise authorized under the Law of the River. 27 The Basin States Alternative replaces this equalization requirement in favor of a strategy that is not as onerous for the City.

As stated in the City's scoping comments dated November 30, 2005, water supply has a higher priority than hydro-generation and water users in Phoenix should not be subject 28 to shortages for the benefit of hydropower production. Absent the adoption of the Basin States Alternative (and after the expiration of the ISG in 2016) the City believes the Secretary must adhere to the following: (1) the 602(a) storage algorithm must be reviewed and revamped so that it accurately reflects the requirements of Section 602(a) of the Colorado River Basin Project Act of 1968; (2) the algorithm should be changed so that the current storage in Lake Powell of an additional amount over 5 million acre-feet to protect hydropower production is no longer included in the operating criteria; (3) 29 actual Upper Basin depletions and a measurable realistic projection of new depletions to calculate the 602(a) storage requirement must be incorporated into the algorithm. The use of overstated depletion schedules results in significant increases in Lake Powell storage before equalization occurs; and (4) review the methodology that determines available storage in reservoirs authorized by the Colorado River Storage Project Act to determine whether forecasted active storage in the Upper Basin is greater than the Section 602(a) storage requirement under subarticle II(3) of the Coordinated Long-Range Operation of Colorado River System Reservoirs to insure that active storage in the Upper Basin is being properly calculated.

If the Basin States Alternative is adopted and implemented in the guidelines set out in the ROD, at the end of the interim period in 2026 or if the guidelines are changed, whichever comes first, Reclamation can not revert to its current interpretation of the 30 602a requirements. In that case, Reclamation must consult on the modification of the guidelines to make them consistent with the legal priorities established by the Law of the River.

For these reasons and because the coordinated operations of Lake Powell and Lake Mead are essential components to shortage criteria, the Secretary should adopt the Basin States Alternative.

L-2

Regional Director
April 30, 2007
Page 6

The Record of Decision and Implementation of the Preferred Alternative

The City supports the Basin States Alternative as the preferred alternative and
recommends that it be incorporated into the Record of Decision ("ROD") in a way that
parallels the Interim Surplus Guidelines ROD. The City believes that the Secretary
should work with the Basin States to create specific implementation criteria and
guidelines consistent with the adoption of the Basin States Alternative as the preferred
alternative. That document will serve as a road map that the City can then rely upon to
better manage its water supplies and to better prepare for shortages. To effectuate
those guidelines and criteria so that the certainty outlined in the proposed action is
achieved, the City urges the Secretary to include a statement in the ROD that "during
the effective period of the guidelines the Secretary shall utilize the established process 31
for development of the Annual Operating Plan for the Colorado River System
Reservoirs (AOP) and shall use those guidelines to make determinations regarding
normal, surplus and shortage conditions for the operation of Lake Mead and for the
coordinated management of Lake Mead and Lake Powell."

Cumulative Impacts of Shortages in Arizona

The DEIS has only attempted to analyze the socio-economic impacts for shortages in a
single year. Analysis by the State of Arizona indicates a high probability that multi-year
shortages will occur. The socio-economic impacts of multi-year shortages should be 32
analyzed and incorporated into the Final EIS for all of the alternatives.

Socioeconomic Impacts to Municipal Water Users in Arizona

The DEIS does not adequately analyze and describe the impacts to municipal water 33
users in Arizona or to the City of Phoenix in particular. The DEIS states, "Implementing
statewide and local demand-side and supply-side strategies are expected to minimize
adverse socioeconomic effects occurring during the maximum M&I shortage." This
statement accurately reflects the strategies that Phoenix has historically used, and
continues to use for determining its long-term need for water supplies, including
supplies to help offset shortages. Likewise demand restrictions are also part of the
City's plan for dealing with actual shortages. Phoenix' goal is to minimize the impacts
on its citizens and on its economy. However, neither demand-side nor supply-side
strategies and actions come without a substantial price. The DEIS does not analyze
quantitatively, or even qualitatively, the costs associated with shortages. This is a 34
glaring omission in the DEIS.

Arizona municipal water providers and the City of Phoenix have already expended
substantial sums of money in anticipation of shortages on the Colorado River.
Municipal water users in Arizona, including the City of Phoenix, will rely in part on
recovery of water stored underground by the Arizona Water Banking Authority to make
up for shortfalls due to Colorado River shortages. Through calendar year 2006, the 35
Arizona Water Banking Authority ("Bank") has stored about 2,243,000 AF of water at a
cost of about $101 million. More appropriately for the City, about 1,158,000 AF of water
at a cost of about $63 million dollars has been stored in the Phoenix Active
Management Area. Funding for the Bank comes primarily from a property tax in
Maricopa, Pinal and Pima Counties, from a pump tax paid by groundwater users in

L-2

Regional Director
April 30, 2007
Page 7

those counties and some appropriations by the Arizona Legislature. To prepare for the onset of Colorado River shortages through supply-side protection, significant sums have already been expended. Additional sums will be need to be expended to store additional water underground to meet the goals of the Bank, to replace the banked water when it is used, or for access to other supplies to make up shortfalls.

Because the City's municipal priority CAP water may not be fully replaced by the Bank and because the City uses non-agricultural priority CAP water and Indian lease water not eligible to receive water from the Bank during shortages, the City is pursuing the acquisition and use of drought back up water supplies and the infrastructure necessary to use those supplies. To date the City has stored 171,600 acre-feet at a cost of about $7 million (excluding the capital costs of the facilities to store or treat water). Additionally, the City has embarked on a two year planning study to identify other options for supply enhancement for shortages. The cost of that study is estimated at about $1.8 million and the implementation costs, once options are chosen, is expected to be in the range of $50-100 million for both drought supplies and new supplies to meet normal demands. 35

Through the City's water resources planning function, a water resources plan is completed and published about every five years. The latest plan, the Water Resources Plan, 2005 Update, concludes that in extreme drought supply enhancement will not be sufficient to deal with shortages. During moderate and extreme drought conditions the City will also implement its Drought Management Plan, first promulgated in 1993. That Plan, and the City ordinances implementing it, allow for mandatory reductions in deliveries to customers and thus require cut backs in water use. There is an additional cost, over the $1.5 million the City is spending annually on its water conservation efforts, associated with implementing mandatory water user restrictions. In 2003 and 2004, in the midst of water allocations reductions by the Salt River Project, the City explored the costs associated with implementing Stage II of its Drought Management Plan which contains relatively benign mandatory water use restrictions. The estimated cost of implementing that program, at that time, was about $1.5 million per year. Implementing Stage III and Stage IV restrictions would necessitate incurring even higher costs.

As the prior discussion clearly illustrates socioeconomic impacts on municipal water users in Arizona and on the City of Phoenix due to Colorado River shortages are significant and should be documented in the Final EIS.

<u>Comments to Specific Portions of the EIS</u>

The City offers the following comments to specific language included in the DEIS:

1. Section 2.3.1, line 28: The Seven Basin States proposal dated February 3, 2006 goes beyond "suggesting" that consultation occur when shortages greater than 600,000 AF are projected to occur. Because of the impacts on Arizona water users that will likely occur, that provision is an integral part of that proposed package. 36
2. P. 3-39, Section 3.4.6.1,

L-2

Regional Director
April 30, 2007
Page 8

a. Lines 11-16: It should be noted that the AWBA also provides for banked water to be use by municipal water users of Colorado River water both within and outside of the CAP service area. 37

b. Lines 28-30: The Final EIS should incorporate the recommendation submitted to the Bureau of Reclamation on October 24, 2006 that presents shortage sharing criteria between on-river P4 water users in Arizona and CAP water users. 38

3. P. 3-40, Lines 3-5: The DEIS does not provide enough detail to address Arizona water users' efforts to prepare for drought. Individual water users adopted drought Plans over a decade before the statewide drought plan was created. The Arizona Groundwater Management Act, the Arizona Water Banking Authority and other state-wide and local government actions all contribute to Arizona's drought preparedness. 39
4. P. 3-42, Lines 1-6: The Final EIS should incorporate the terms of the Arizona-Nevada Shortage Sharing Agreement. 40
5. P. 3-87, Line 37: The City's lease for CAP water with the Salt River Pima-Maricopa Indian Community is for a term of 99 years, not 100 years. 41
6. P. 3-89, Lines 5-17: The Final EIS should clarify that the EIS assumed that the Gila River Community Indian Water Rights Settlement is in effect. The statement that "CAP water has already been leased to Phoenix area cities" is only correct if that assumption is made clear since the leases can not be consummated until the enforceability date of the Settlement. 42
7. P. 4-8, Lines 7-9: The Final EIS should recognize that the Southern Nevada Water Authority has plans to complete new intakes at Lake Mead to elevation 856' by 2011 and thus the "limitations" on SNWA's ability to pump from Lake Mead, or form the Colorado River, at that point in time will not be 1000'. 43
8. P. 4-8, Lines 31-36: The discussion of the bypass flows is confusing regarding the extent of the "obligation" to replace those flows. If a legal obligation to replace those flows exists, the Final EIS should cite to the controlling law, contracts, treaties or other legal instruments evidencing the obligation. 44
9. P. 4-9, Lines 3-4: The City continues to support the operation of the Yuma Desalting Plant at its full capacity to maximize the efficiency of Lower Colorado River operations. 45
10. P. 4-238, Lines 21-24: Any "benefits" of increased power revenues on the const of CAP water would likely be more than offset by increased delivery charges ("OM&R") to CAP water users when CAP deliveries are reduced because of shortages. The delivery rate paid by CAP water users will greatly increase because fixed OM&R, the numerator in the rate equation will remain the same, while water deliveries, the denominator in the rate equation, will be less. While the CAP Board of Director's may chose to artificially hold rates down to minimize "rate shock", there is still a negative economic consequence because the funds to hold down the rates will likely come from the tax payers or rate payers within the CAP. 46
11. P. 4-264, Lines 17-19: The Final EIS should recognize that the cost of water used in this analysis, the "price of excess water pools" for agricultural use is a subsidized water rate. The tax payers of Maricopa, Pinal and Pima counties pay 47

L-2

Regional Director
April 30, 2007
Page 9

an ad valorem property tax set by the CAP Board of Director's. One of the uses for that tax is to lower the cost of water for the agricultural pool.

12. P. 6-3, Lines 3-9. The Final EIS should expand its discussion of Section 8 of the ESA so that it is clear that consultation through the Secretary of State is a voluntary and not a mandatory function. 48

Conclusion

The City of Phoenix reiterates that the Basin States Alternative is the only alternative that meets all the criteria defined in the proposed action for the EIS. The City urges that the Final EIS adopt the Basin States Alternative as the preferred alternative and that a Record of Decision be signed incorporating the terms of the Basin States Alternative.

Sincerely

Tom Buschatzke
Water Advisor

L-2

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Reponses to Comment Letter L-2

L-2-1

Your comment is noted. The Preferred Alternative is formulated to provide more frequent yet lower magnitude shortages that are more manageable as compared to less frequent but higher magnitude shortages.

L-2-2 through L-2-4

Your comments are noted. No change to the Final EIS was necessary.

L-2-5

Your comment is noted. No change to the Final EIS was necessary.

L-2-6 and L-2-7

Your comments are noted. No change to the Final EIS was necessary.

L-2-8

Your comment is noted. Reclamation has prepared a Biological Assessment (Appendix R of the Final EIS) in compliance with Section 7 of the Endangered Species Act. As part of this assessment, Reclamation evaluated whether the Preferred Alternative would exceed the flow reductions analyzed and covered by the LCR MSCP. It was determined that the effects of the Preferred Alternative are within the range of effects analyzed in the MSCP, and no additional consultation under Section 7 is needed for the areas of effect within the LCR MSCP geographic area.

L-2-9

Your comment is noted.

L-2-10

Your comment is noted. No change to the Final EIS was necessary.

L-2-11 and L-2-12

Your comments are noted. No change to the Final EIS was necessary.

L-2-13 through L-2-16

Your comments are noted. No change to the Final EIS was necessary.

L-2-17 through L-2-23

Your comments are noted. No change to the Final EIS was necessary.

L-2-24

Your comment is noted. No change to the Final EIS was necessary.

L-2-25

Your comment is noted.

L-2-26

Your comment is noted.

L-2-27

Your comment is noted. As discussed in Section 2.3.2.1, the Basin States Alternative and the Preferred Alternative use an elevation schedule (a specified elevation for each year through 2026) to determine when equalization releases would be made from Lake Powell.

L-2-28

Your comment is noted.

L-2-29

Your comment is noted.

L-2-30

Your comment is noted. No change to the Final EIS was necessary.

L-2-31

The information requested is provided in Appendix S of the Final EIS. Reclamation has developed draft operational guidelines that are included in Appendix S of the Final EIS. The guidelines are anticipated to be finalized and adopted through the Record of Decision for this action. Following publication of this Final EIS, additional and updated information regarding the content and development of guidelines is anticipated to be provided to the public through the dedicated project website, (http://www.usbr.gov/lc/region/programs/strategies.html).

L-2-32

See response to Comment No. L-1-11

L-2-33 through L-2-35

See response to Comment No. G-1-25.

L-2-36

See response to Comment No. G-1-13.

L-2-37

Reclamation concurs with this comment. The requested change has been made in Section 3.4.6.

L-2-38

See response to Comment No. G-1-15.

L-2-39

See response to Comment No. G-1-25.

L-2-40

See response to Comment No. G-1-14.

L-2-41

Reclamation concurs with this comment and the requested correction has been made in the Final EIS.

L-2-42

Your comment is noted. The suggested clarification has been added to Section 3.10.2.2 of the Final EIS

L-2-43

See response to Comment No. G-1-31.

L-2-44

See response to Comment F-4-9.

L-2-45

Your comment is noted. No change to the Final EIS was necessary.

L-2-46

Your comment is noted. Rate setting decisions by the CAP Board of Directors are outside the scope of this EIS.

L-2-47

The quantitative evaluation of the socioeconomic effects (employment, income, and tax revenues) as a result of losses in agricultural production in Arizona was based on changes in the value of crop production measured at the farm gate. These estimates were made through application of Reclamation's shortage allocation model and spreadsheet model that estimates the acreage and crop types that would be affected. IMPLAN, the tool used to quantify these effects, does not take into account water subsidies. Taxpayers in Maricopa, Pinal, and Pima residents may benefit as a result of not paying these subsidies. However, this increase would be expected to be small when spread among all taxpayers within the three counties.

L-2-48

Your comment is noted. Sections 5.1.19, 6.3.2 and 6.8 of the Final EIS have been updated in the Final EIS.

APR-30-2007 16:26 COS WATER RESOURCES 4803125615 P.01

CITY OF SCOTTSDALE ARIZONA

WATER RESOURCES
9388 E. SAN SALVADOR
SCOTTSDALE, AZ 85258
PHONE: (480) 312-5685 / FAX: (480) 312-5615

Date: 4/30/07

To: US Bureau of Reclamation

Fax Number: 702-293-8156

From: David Mansfield

Phone Number: 480-312-5685

Number of Pages including Cover: 5

Comments:

If you experience any difficulty receiving this fax, please call (480) 312-5685.

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L-3

APR-30-2007 16:26 COS WATER RESOURCES 4803125615 P.02

• "Most Livable City" U.S. Conference of Mayors •

27 April 2007

Via Facsimile 702-293-8156
Copy to Follow via US Mail

Regional Director
Lower Colorado Region
US Bureau of Reclamation
Attn: BCOO-1000
PO Box 61470
Boulder City, NV 89006

RE: City of Scottsdale, Arizona Comments Regarding the *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement*

Dear Sir or Madam:

The City of Scottsdale, Arizona ("Scottsdale") hereby submits its comments regarding the "Draft Environmental Impact Statement for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead" (DEIS). Additionally, Scottsdale understands that the Arizona Department of Water Resources and the Arizona Municipal Water Users' Association ("AMWUA") will be also be providing comments on this issue. Scottsdale supports those comments.

More than 240,000 people rely on the City of Scottsdale to provide safe, reliable drinking water supplies and Central Arizona Project ("CAP") water is a key component of the City's long-term water resources strategy. Nearly two-thirds of Scottsdale's water supply needs are currently met with varying types of CAP water. Scottsdale has subcontracts for M&I priority water, non-Indian agricultural water, and excess CAP water. We also lease CAP water from three Native American communities. Because of our high reliance on CAP to meet our water needs, the preferred alternative that is selected for implementation by the Bureau is of critical interest to the City of Scottsdale.

Scottsdale Supports the Basin States Alternative as the Preferred Alternative

Scottsdale supports selection of the Basin States Alternative as the preferred alternative in the final environmental impact statement and supports implementation of the Basin States Alternative through the final record of decision. This alternative is a compromise alternative acceptable to each of the seven Colorado River Basin States. In selecting the pre- 1

L-3

City Of Scottsdale • Water Resources • 9388 E. San Salvador Dr. • Scottsdale, Arizona 85258
Phone (480) 312-5685 • Fax (480) 312-5615

ferred alternative and finalizing the record of decision, the Secretary of the Interior (Secretary) should recognize the value of this unique compromise. 2

Furthermore, the Basin States Alternative does not require any additional statutory authorization and is the only alternative that can be implemented immediately after the Secretary issues the final record of decision. 3 Implementation of the other alternatives, particularly the Conservation Before Shortage and the Reservoir Storage Alternatives, would require substantive changes to the Law of the River. 4

Water Management Considerations

For decades Scottsdale has been actively planning and preparing to address water shortages. The City has taken proactive steps toward achieving long-term water supply sustainability, including the following:

- implementation of enhanced water conservation programs;
- reclaimed effluent reuse by the golf courses in north Scottsdale;
- recharging the groundwater table using highly treated effluent; and
- groundwater recharge of potable CAP water using dual purpose aquifer storage and recovery ("ASR") wells.

Adoption of the Basin States Alternative as the preferred alternative in the final environmental impact statement will provide the certainty necessary for Scottsdale to continue the responsible planning necessary to address the adverse impacts that could occur during Colorado River shortages. 5

Scottsdale has developed an extensive water conservation customer outreach program. Our five full-time staff positions are supplemented by a group of active volunteers. The City is an active participant in the "Water - Use It Wisely" program, which is a regional water conservation public information campaign. The water conservation staff also participates in regional public exhibits, fairs, and festivals. In addition, the City provides a number of financial incentives for conservation, including for example offering rebates to encourage turf removal.

Golf courses are a large water user in Scottsdale. Therefore, Scottsdale has developed strategies to minimize the impact they have on our potable water supplies. Scottsdale reclaims wastewater at our Water Campus facility, treating the water for use for golf course irrigation. This water is delivered through Scottsdale's Reclaimed Water Delivery System (RWDS), which is the largest reclaimed water reuse system in the Valley. The RWDS delivers reclaimed water to twenty three golf courses in north Scottsdale. In addition, the City's Council-adopted golf course policy requires that any future golf courses must provide their own renewable surface water supply in order to locate in Scottsdale.

Scottsdale is also a leader in the Phoenix area in increasing the long term sustainability of our groundwater through artificial groundwater recharge. The City is replenishing our groundwater supply by +recharging reclaimed water at our Water Campus facility in North Scottsdale. In 2005, this groundwater recharge added over 2-1/4 billion gallons of water to our underground aquifers. Water stored in these aquifers is an important part of Scottsdale's overall water supply management strategy.

Scottsdale is also implementing groundwater recharge/recovery throughout the City by injecting treated CAP water directly into the aquifer through specially designed wells. These wells are used to recharge during the winter low water use demand periods, and supplement the water supply during the high demand summer months.

Record of Decision Guidelines

Scottsdale expects and needs the final record of decision to clearly and unambiguously set forth the guidelines that the Secretary will use to declare a shortage in the lower basin. The record of decision should identify and adopt guidelines consistent with implementation of the Basin States Alternative that the Secretary must follow in formulating each of the annual operating plans through 2026. 6

The Basin States Alternative requires that the record of decision acknowledge that the lower basin States must agree to the terms and conditions for forbearing, if necessary, their rights to delivery of Colorado River water in order to allow for the development, storage and delivery of any Intentionally Created Surplus (ICS) as defined by the DEIS. 7 Scottsdale would object if the Secretary issued a unilateral authorization that allowed for the creation of ICS without this agreement by the States. 8

Finally, the record of decision should state that the Secretary will consult with the seven basin States if the Secretary is considering declaring a shortage to the lower basin States exceeding 500,000 acre-feet. The goal of this consultation should be to minimize the impacts on the lower basin States in general, and on Arizona and the CAP in particular. 9

Lower Basin Shortage Sharing

As contemplated by the Basin States Alternative, Arizona and Nevada have finalized and executed a Shortage Sharing Agreement dated February 9, 2007. The preferred alternative and the record of decision must be consistent with this Shortage Sharing Agreement. 10

Additionally, ADWR established an intrastate process involving all interested parties to develop a method to distribute Arizona's shortage reductions between the CAP and equivalent priority Arizona mainstem water users. This method is described in the "Director's Shortage Sharing Workgroup Recommendation, October 24, 2006, (Revised) Final". Scottsdale understands that this Recommendation has been transmitted to the Bureau by ADWR. The preferred alternative and the record of decision must also be consistent with this Recommendation. 11

Economic Impacts

The DEIS inadequately addresses the economic impacts that would result from changes in deliveries of Colorado River water to municipal water users in Arizona, including 12

L-3

Scottsdale. The DEIS minimizes these potentially significant impacts by concluding that "implementing statewide and local demand-side and supply-side strategies are expected to minimize adverse socioeconomic effects occurring during the maximum M&I shortage." (DEIS at p. 4-283) 12

As pointed out earlier, Scottsdale has already taken steps to develop sustainable water supplies for its customers. Since enactment of the 1980 Groundwater Management Act, Scottsdale has implemented extensive water conservation programs that include ordinances governing landscaping, plumbing retrofit rebate programs, leak detection and control programs, and implementation of conservation oriented water rate structures. Consequently, the opportunity to make up for shortages in deliveries of CAP water through additional conservation programs is very limited. Scottsdale has also implemented comprehensive effluent reuse programs, adopted development impact fees, and established extensive recharge programs. All of these programs come at considerable expense. 13

It is therefore inappropriate to assume that the socioeconomic impacts on Scottsdale from changes in deliveries of CAP water can be minimized in any material way by implementing basic demand management and supply augmentation strategies. As mentioned above, existing demand management and supply augmentation programs are designed to insure supply sustainability in normal water supply years. Any programs developed as drought response will have additional impacts that have not been addressed in the DEIS. 14

Scottsdale strongly urges the Secretary to choose the Basin States Alternative as the preferred alternative in the Final EIS. We also urge the Secretary to adopt a ROD that includes the guidelines and criteria necessary to implement the Basin States Alternative in a manner consistent with the carefully negotiated compromise agreements developed among the seven basin states.

We appreciate the opportunity to comment on the DEIS.

Sincerely,

David M. Mansfield
General Manager

cc: Arizona Department of Water Resources
Arizona Municipal Water Users Association

L-3

TOTAL P.05

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Reponses to Comment Letter L-3

L-3-1 and L-3-2

Your comment is noted. No change to the Final EIS was necessary.

L-3-3 and L-3-4

Your comment is noted. See also response to Comment No. G-1-4.

L-3-5

Your comment is noted. No change to the Final EIS was necessary.

L-3-6

Draft Guidelines are included in the Final EIS as Appendix S.

L-3-7 and L-3-8

The information requested is provided in Appendix S of the Final EIS. Reclamation has developed draft operational guidelines that are included in Appendix S of the Final EIS. The guidelines are anticipated to be finalized and adopted through the Record of Decision for this action. Following publication of this Final EIS, additional and updated information regarding the content and development of guidelines is anticipated to be provided to the public through the dedicated project website, (http://www.usbr.gov/lc/region/programs/strategies.html).

L-3-9

See response to Comment No. G-1-13.

L-3-10

See response to Comment No. G-1-14.

L-3-11

See response to Comment No. G-1-15.

L-3-12 through L-3-14

See response to Comment No. G-1-25.

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MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Executive Office

April 30, 2007

VIA E-MAIL
& U.S. MAIL

Ms. Jayne Harkins
Acting Regional Director, Lower Colorado Region
U.S. Department of the Interior
Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City, NV 89006-1470

Comments on Bureau of Reclamation Draft Environmental
Impact Statement, Colorado River Interim Guidelines for Lower Basin
Shortages and Coordinated Operations for Lake Powell and Lake Mead

The Metropolitan Water District of Southern California commends the Department of the Interior and the Bureau of Reclamation for their comprehensive analysis of alternatives in the Draft Environmental Impact Statement; Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead ("DEIS").

Water from the Colorado River accounts for a significant share of supplies within Metropolitan's service area in the coastal region of Southern California. After years of negotiation under the leadership of the Department of the Interior, California entities reached a historic pact to allow California to live within its basic apportionment of 4.4 million acre-feet annually when surplus water and unused apportionment is unavailable. The 2003 Colorado River Water Delivery Agreement ("CRWDA") provides a number of benefits to Metropolitan, including interim access to available surpluses and greater flexibility for managing diversions into our Colorado River Aqueduct.

The Basin States' Alternative analyzed in the DEIS would establish guidelines to operate Lake Mead and Lake Powell more efficiently and flexibly for the benefit of all seven states in the Lower and Upper Colorado River Basins. Of greatest importance to Metropolitan, the Alternative would facilitate improved water management by permitting contractors to reduce water use via extraordinary conservation and recover most of that water in later years. This 1
management technique would allow Metropolitan to reduce the likelihood of regional shortages in years when California's State Water Project experiences reduced delivery capability. 2
Furthermore, the Alternative's provision for extending Metropolitan's access to surplus water would increase the likelihood of Metropolitan being able to operate the Colorado River Aqueduct at or near capacity (a key objective of Metropolitan's Integrated Resource Plan). 3

L-4

700 N. Alameda Street, Los Angeles, California 90012 • Mailing Address: Box 54153, Los Angeles, California 90054-0153 • Telephone (213) 217-6000

The Metropolitan Water District of Southern California

Ms. Jayne Harkins
Acting Regional Director, Lower Colorado Region
Page 2
April 30, 2007

Metropolitan concurs with the April 30, 2007 comments on the DEIS submitted by the States of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming Governors' Representatives on Colorado River Operations, and those of the Colorado River Board of California. 4

Like execution of the CRWDA and the Quantification Settlement Agreement, submittal of the Basin States' Proposal described in the comments of the Governors' Representatives represents a seminal moment in the history of the Colorado River. We urge Reclamation to build upon this progress by selecting the Basin States' Proposal as the preferred alternative in the Final Environmental Impact Statement and adopting the Proposal in the Record of Decision for this matter. 5

We thank the Department of the Interior and Reclamation for their responsiveness and leadership during this process.

Very truly yours,

Jeffrey Kightlinger
General Manager

PEV:gy

cc: Mr. Gerald R. Zimmerman
Executive Director
Colorado River Board of California
770 Fairmont Avenue, Suite 100
Glendale, CA 91203-1035

L-4

Reponses to Comment Letter L-4

L-4-1 through L-4-5

Your comments are noted.

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4/30/07

BCOO-1000

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Fax (602) 236-5444
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JOHN F. SULLIVAN
Associate General Manager
Water Group

April 27, 2007

Acting Regional Directors
US Bureau of Reclamation
Attention: BCOO-1000
Lower Colorado Region
P.O. Box 61470
Boulder City, NV 89006-1470

CY: 1000

Re: Notice of Availability of and Notice of Public Hearings for the Draft Environmental Impact Statement ("EIS") for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Dear Ms. Harkins and Mr. Walkoviak:

The Salt River Project Agricultural Improvement and Power District and the Salt River Valley Water Users' Association (collectively referred to herein as "SRP") submit their comments on the Draft EIS for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (collectively referred to herein as the "Guidelines").[1] We appreciate the opportunity to offer these comments and we hope that they will be useful to the Bureau of Reclamation ("Reclamation") in adopting Guidelines and preparing the final EIS.

Statement of Interests

SRP is a multi-purpose federal reclamation project authorized and constructed under the Reclamation Act of 1902, 43 U.S.C. § 371 *et seq.* Pursuant to various contracts with the United States, SRP operates the Project works, which include, among other things, seven reservoirs and dams on the Salt and Verde rivers in central Arizona, and East Clear Creek in Northern Arizona. Water is impounded in these reservoirs by SRP for subsequent delivery to municipal, industrial and agricultural water users in the Phoenix metropolitan area, where over half of the state's population resides. SRP holds the water rights for these reservoirs, and for the downstream uses they supply, pursuant to the state law doctrine of prior appropriation, as well as federal law.

SRP has a significant economic interest in Colorado River water supplies and the power generated at the Lower Basin dams. SRP's surface water supplies from the Salt and Verde Rivers are susceptible to drought and must be conjunctively managed by SRP with the groundwater beneath its 250,000-acre service area. Central Arizona is currently experiencing its twelfth year of drought, with several years during this period being some of the driest in more than 100 years of recorded history. Under these circumstances, the availability of Colorado

[1] 72 Fed. Reg. 9026 (February 28, 2007).

L-5

River water and power is critical to the continued economic well-being of SRP, its members and the municipalities that SRP serves in Central Arizona.

The drought of the past twelve years has made it necessary for SRP to purchase excess CAP water to supplement its diminishing Salt and Verde River water supplies, along with pumping maximum amounts of groundwater. Excess CAP water is also the principal source of supply for underground storage and groundwater savings projects in Central Arizona in which SRP has an interest. SRP contracts for and delivers agricultural priority CAP water for use on SRP agricultural lands. Additionally, through the Arizona Power Authority and Western Area Power Administration, SRP purchases large amounts of Parker-Davis and Hoover power each year and distributes the power to its customers in Central Arizona. SRP is therefore strongly interested in the outcome of this EIS process, which has the potential to markedly affect the availability of Colorado River water and power to Central Arizona during times of shortage.

SRP is also the operator of the Navajo Generating Station ("NGS"), a coal-fired power generation plant in Page, Arizona, which provides power to Reclamation for the operation of the CAP, and to power consumers throughout Arizona, Nevada and California. Water needed for the operation of NGS is supplied from Lake Powell. The dependability of this supply is essential to SRP's continued operations of NGS. SRP is therefore interested in any criteria that the Secretary may ultimately adopt for coordinated operation of Lake Powell and Lake Mead, which may affect deliveries of water supplied to NGS.

Comments on the Interim Guidelines

I. SRP Supports the Basin States Proposal as the Preferred Alternative, as it Represents the Consensus of the Major Users of Water and Power Resources in the Lower and Upper Basins.

SRP supports the adoption of the Basin States Alternative, as modified by the suggestions 1
of the Basin States in their comments on the draft EIS (Basin States' Proposal"), as the Preferred Alternative in the Final EIS. As a consensus approach developed by the Lower and Upper Basin
States, the Basin States Proposal minimizes impacts to the largest number of users of the 2
resources described in the Draft EIS. The Basin States Proposal provides a mechanism for
promoting the conservation of water in the Lower Basin, while at the same time minimizing 3
shortages in the Lower Basin and avoiding the risk of curtailment of water uses in the Upper Basin.[2] As a balanced approach to the management of Colorado River resources, which takes
into consideration and reflects the interests of and effects on various categories of resource users, 4
the Basin States Proposal is the ideal Preferred Alternative.

The Basin States Proposal likewise provides users of mainstream Colorado River water
within the United States with a greater degree of certainty regarding future amounts of annual 5
water deliveries during times of drought and under low reservoir conditions.[3] In the past, the threat of litigation has been a barrier to reaching a dependable, long-term resolution of the issues

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[2] Draft EIS, p. 2-8.

[3] A heightened degree of predictability of water supplies was a chief purpose of the proposed action, as described in the Draft EIS. *See* Draft EIS, p. 1-3.

L-5

related to the allocation of Lower Basin water supplies during shortage conditions, and the equalization of water levels in Lake Powell and Lake Mead. Because the Basin States Proposal was developed by consensus, the risk of future litigation challenging the adoption or 6
implementation of this alternative by Reclamation is greatly reduced. Moreover, the Basin States Proposal can be implemented relatively quickly following the conclusion of the NEPA process, without further action by Reclamation; consequently, its adoption would provide more immediate predictability to water and power users regarding the management of Colorado River water supplies.

II. <u>The Final EIS Should Individually and Comparatively Analyze the Impacts of Each of the Alternatives, When Added to the Cumulative Impacts of Past, Present and Reasonably Foreseeable Future Actions, With Respect to Each of the Resources Identified.</u>

To ensure a complete analysis supporting the selection of the Basin States Proposal as the preferred agency alternative, the cumulative impacts analysis should be amplified in the Final EIS to more comprehensively address: (1) the impacts of past, present and reasonably 7
foreseeable future actions with respect to each of the resources considered; (2) the impacts of each alternative when added to the impacts of other past, present and reasonably foreseeable 8
future actions; and (3) objectively quantifiable impacts or the reasons why that is infeasible.[4] 9

1. Impacts of Past, Present and Reasonably Foreseeable Future Actions

The cumulative impacts section of the Draft EIS should include an evaluation of the cumulative impacts of past, present and reasonably foreseeable future actions, not part of the proposed action, on each of the resources considered. Presently, this section does not undertake 10
a systematic analysis of these impacts. For example, it is not clear that the "closely related projects"[5] mentioned in the text include both present and reasonably foreseeable future actions. Even as to present actions, the list of "closely related projects" is not exhaustive. Other closely related actions for which cumulative effects should have been evaluated include, for example, 11
the Arizona water bank, the forbearance agreement between Arizona and Nevada, and municipal drought management plans entailing the use of CAP water. The cumulative impacts section also omits any discussion of the impacts of past actions on each of the resources considered in the Draft EIS. Finally, the cumulative impacts section does not consistently and methodically consider the impacts of each and all of the actions identified on each resource considered. The analysis of cumulative impacts in the Final EIS should be amplified to include this discussion and analysis.

2. Impacts of Each Alternative, When Added to the Cumulative Impacts of the Past, Present and Reasonably Foreseeable Future Actions Identified

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[4] The Cumulative Impacts section of the Draft EIS begins on page 5-6. It appears, however, that the section heading and possibly some portion of the preliminary text were inadvertently omitted from the document. The Final EIS 12
should remedy this error.

[5] Draft EIS, p. 5-7.

L-5

The cumulative impacts analysis in the Final EIS also should consistently address and compare the totality of the effects of each alternative, when added to the cumulative effects of past, present, and reasonably foreseeable future actions, on the environment. As presently written, the section omits any discussion of the impacts of each alternative, when added to the cumulative impacts, on each of the resources considered. The cumulative impacts section in the Final EIS should be revised to systematically provide this comparative analysis. We believe such a comparison will demonstrate that implementation of the Basin States Proposal would minimize cumulative impacts, as the States and individual resource users have already considered and attempted to minimize the effects of the Basin States Proposal when added to the impacts of their individual related actions. 13

3. Objective Quantification of Impacts or an Explanation of the Reasons Why an Objective Quantification of Impacts is Infeasible

Finally, the cumulative effects analysis should evaluate the impacts of each of the alternatives, plus cumulative effects, in objectively quantifiable terms, or provide an explanation of the reasons why this cannot be done. The draft cumulative impacts analysis does not refer to objective data in analyzing impacts. If the impacts described cannot be quantified in objective terms, the Draft EIS should affirmatively state this, and offer an explanation of the reasons why such quantification is infeasible. 14

III. <u>The Final EIS Should Clarify the Relationship Between the Existing Federal Programs and Activities on the Lower Colorado River, Particularly the Lower Colorado River Multi-Species Conservation Program, and the Alternatives Considered in the Draft EIS With Respect to Endangered Species Act ("ESA") Compliance.</u> 15

Section 1.8 of the Draft EIS describes five "related actions" that, along with other projects discussed later in Chapter 5, "may have a cumulative impact on the environment."[6] These include, among others, the Lower Colorado River Multi-Species Conservation Program ("LCR MSCP"). Regarding the LCR MSCP, Chapter 1 of the Draft EIS properly notes that this program "provides ESA compliance for specific covered federal actions and non-federal activities under ESA Sections 7 and 10," including the implementation of water shortages in the Lower Colorado River Basin.[7] The Draft EIS then states that, "[t]o the extent that the shortage strategy adopted by the Department is within the coverage provided by the LCR MSCP, it is anticipated that adoption of that element of the proposed federal action would not require further ESA compliance."[8] In seeming contrast to these statements, Chapter 5, Section 5.1.1 of the Draft EIS broadly describes the obligation of Reclamation to consult on proposed action under Section 7 of the ESA, as follows:

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[6] Draft EIS, p. 1-23.
[7] Draft EIS, p. 1-26.
[8] *Id.*

L-5

4

> Adoption of the proposed action by the Secretary is a discretionary federal action and it is, therefore, subject to compliance with the ESA. Reclamation will request a species list from the FWS and subsequently prepare a biological assessment to address the potential effects of the proposed federal action on listed species. Once a preferred alternative is identified, the BA will be finalized and formal consultation will be initiated, if appropriate. Reclamation and the FWS will consult during 2007, with the intent of completing a BO for inclusion in the Final EIS.[9]

Section 5.1.1 does not refer to the LCR MSCP or the ESA coverage already provided to certain categories of federal actions under the program, including the implementation of shortage guidelines within certain parameters. As written, Section 5.1.1 could be interpreted as acknowledging a comprehensive obligation on the part of Reclamation to consult on all aspects 16
of the proposed action, even those previously covered as part of the LCR MSCP. Section 5.1.1 should be modified in the Final EIS to clarify the more narrow focus of Reclamation's obligation to consult, and the relationship between ESA coverage already in place under the LCR MSCP and any additional coverage needed for the proposed action.[10]

Conclusion

SRP appreciates the opportunity to present these comments on the proposed Guidelines, in response to Reclamation's Federal 28, 2007 Federal Register notice. We hope that these comments will be useful to Reclamation in adopting Interim Guidelines and in selecting the preferred agency alternative and concluding the NEPA process. For the reasons urged in Part I of this letter, we strongly urge Reclamation to adopt the Basin States Proposal as the Preferred Agency Alternative. If you have any questions or need further information regarding any of the matters discussed in these comments, please do not hesitate to contact us.

Very Truly Yours,

John F. Sullivan

John F. Sullivan
Associate General Manager,
Salt River Project

[9] Draft EIS, p. 5-1.
[10] As any biological opinion drafted by FWS to discuss effects of the proposed action would be included in the Final EIS, it would be both feasible and appropriate for the EIS to more fully explain the relationship between the LCR MSCP, the proposed action and any other related actions on the river, with respect to ESA compliance.

L-5

Cc: Rick Gold, Regional Director, Upper Colorado Regional Office
Herb Guenther, Director, Arizona Department of Water Resources
Bob Johnson, Commissioner, U.S. Bureau of Reclamation

L-5

Reponses to Comment Letter L-5

L-5-1 through L-5-6

Your comments are noted. No change to the Final EIS was necessary.

L-5-7 through L-5-9

Reclamation does not concur with this comment. The information requested is provided in Chapter 5 of the Draft and Final EIS.

L-5-10 and L-5-11

Information presented in the Draft EIS has been modified in the Final EIS. Chapter 5 of the Final EIS has been revised by the inclusion of additional information, and the relocation of several project descriptions to a new Section 4.16 of the Final EIS.

L-5-12

Reclamation concurs with this comment. A Section heading was inadvertently left out of the Draft EIS. This omission has been corrected in the Final EIS.

L-5-13 and L-5-14

See responses to Comment No. L-5-7 and G-1-25.

L-5-15

The LCR MSCP description in Section 1.8.5 of the Final EIS has been expanded to more clearly describe the relationship between this and other ongoing proposed federal actions on the Lower Colorado River and the covered actions and activities under the LCR MSCP.

L-5-16

See response to Comment No. L-2-8.

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City of Peoria
Utilities Department
8401 West Monroe Street, Peoria, Arizona 85345
Phone: 623-773-7286 *Fax:* 623-773-7291

April 27, 2007

Regional Director, Lower Colorado Region
U.S. Bureau of Reclamation
ATTN: BCOO-1000
P.O. Box 61470
Boulder City, NV 89006-1470

RE: Draft Environmental Impact Statement (EIS) for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Thank you for the opportunity to review the above referenced draft EIS document and this letter contains the City's comments. Since Colorado River supplies via the Central Arizona Project make up nearly 46% of the City of Peoria's existing state certified renewable water supplies, the selection of the Basin States Alternative as the preferred alternative is an important one for our community. 1 This alternative is the one that can be immediately implemented without additional statutory authority. 2 This implementation would help to decrease the existing uncertainties related to future Lower Colorado River basin water supply shortages and their magnitude. 3

First, the City of Peoria supports the concepts and comments on the above referenced draft EIS outlined in letters by the Arizona Department of Water Resources letter on behalf 4 of the State of Arizona and the Arizona Municipal Water Users Association letter on behalf of the central Arizona urban communities

One specific comment on the draft EIS is a question and suggestion. We are interested in why the report did not assume the Yuma Desalting Plant was operational? This assumption ignores a potential valuable water source which could help to minimize future 5 supply shortages for the State of Arizona and the Central Arizona Project more specifically. We would recommend this important facility be included in this analysis.

Finally, the City of Peoria has expended significant funds to actively manage its water resources, implementing comprehensive water conservation programs and preparing for 6 drought conditions for the past decade. It would appear the City would be penalized for

L-6

www.peoriaaz.com

Page 2 of 2: City of Peoria, Arizona Comments on the Draft Environmental Impact Statement
Colorado River Interim Guidelines for Lower Basin Shortages
and Coordinated Operations for Lake Powell and Lake Mead

these efforts based on our reading of the EIS. Specifically, the City has recently spent over
$191 million on groundwater recharge facilities, groundwater supply wells, reclaimed water
facilities and additional water rights in order to diversify its water supplies and 6
infrastructure. The City adopted an ordinance to require a level of system redundancy (i.e.,
back-up water supply) and most recently adopted a Drought Contingency Plan in 2003.
The adoption of the Basin States Alternative as the preferred alternative will provide the
necessary protection and certainty to permit the City to continue planning for the adverse 7
impacts of potential Colorado River shortages. We don't believe the City of Peoria should
be penalized for these forward thinking efforts.

Again, thank you for the opportunity to provide these comments.

Sincerely,

Bradley M. Hill

Bradley M. Hill
Water Resources Manager

c: Terry Ellis, City Manager
Herb Guenther, Director - ADWR
Sid Wilson, General Manager, CAWCD

L-6

Reponses to Comment Letter L-6

L-6-1 through L-6-3

Your comment is noted. See also response to Comment No. G-1-4.

L-6-4

Your comment is noted. No change to the Final EIS was necessary.

L-6-5

See response to Comment No. F-4-9.

L-6-6

See response to Comment No. G-1-25.

L-6-7

Your comment is noted. No change to the Final EIS was necessary.

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Chandler • Arizona
Where Values Make The Difference

MR OFFICIAL OFFICE COPY RECEIVED 5/2/07
BCOO 1000

April 30, 2007

Regional Director
Lower Colorado Region
Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City NV 89006-1470

RE: Comments of the City of Chandler, Arizona Regarding the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement

Dear Regional Director:

The City of Chandler, Arizona ("Chandler") submits the following comments to the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement (February 2007). Chandler joins in the comments filed in this matter by the Arizona Department of Water Resources ("ADWR") and the Arizona Municipal Water Users Association ("AMWUA"). Chandler supports the selection of the Basin States Alternative as the preferred alternative in the final environmental impact statement and implementation of the Basin States Alternative through the final record of decision. 1

The City of Chandler has grown rapidly in the last two decades, and has a current estimated population of 250,000 people. Chandler receives Colorado River water through Central Arizona Project ("CAP") municipal and industrial and non-Indian agricultural priority water subcontracts and Indian priority water through a lease and an exchange. In addition, pursuant to the Salt River Pima-Maricopa Indian Community Water Rights Settlement Agreement, Chandler has a Colorado River water right pre-dating September 30, 1968. Chandler expects Colorado River water to provide more than one-fourth of its water requirements when the City reaches build-out in 2015. Therefore, the frequency and magnitude of Central Arizona Project water shortages are a significant concern to Chandler.

Chandler joins in the concerns identified in AMWUA's comments:

1. Chandler endorses and supports the comments of the Arizona Department of Water Resources. 2

L-7

Mailing Address
Mail Stop 404
PO Box 4008
Chandler, Arizona 85244-4008

Municipal Utilities Department
Environmental Resources/Water Conservation
Telephone (480) 782-3580
Fax (480) 782-3805
www.chandleraz.gov

Location
975 East Armstrong Way
Chandler, Arizona 85249

Printed on recycled paper

Regional Director
Lower Colorado Region
April 30, 2007
Page 2

2. Chandler supports the selection of the Basin States Alternative as the preferred
alternative. Chandler also supports mandatory guidelines as set forth in this
alternative be established that the Secretary will use to declare a shortage in the 3
lower Colorado River Basin. This alternative can be implemented immediately
and without additional statutory authority. Implementing the Basin State
alternative will decrease the existing uncertainties related to future Lower 4
Colorado River basin water supply shortages and their magnitude.

3. The preferred alternative and the Record of Decision ("ROD") should be
consistent with Arizona's position regarding intrastate shortage sharing as
described in the "Director's Shortage Sharing Workgroup Recommendation, 5
October 24, 2006 (Revised) Final".

4. The Secretary should not adopt an alternative that prioritizes power generation 6
ahead of water supply.

5. DEIS must assume the Yuma Desalting Plant is operating. 7

6. DEIS has failed to examine the socio-economic effects that municipal water users 8
in Arizona will experience during a maximum M&I shortage. It should not be
assumed socio-economic impacts from changes in deliveries of CAP water to
Chandler or other Arizona municipalities could be minimized in any material 9
way, by demand-side and supply-side strategies.

We appreciate the opportunity to comment on this Draft Environmental Impact Statement. Please contact Gregg Capps at 480-782-3585 if you have any comments or questions on this response.

Sincerely,

Karen Barfoot
Assistant Municipal Utilities Director

xc: Steve Olson, Director, AMWUA
Doug Toy

L-7

Reponses to Comment Letter L-7

L-7-1
Your comment is noted. No change to the Final EIS was necessary.

L-7-2
Your comment is noted. No change to the Final EIS was necessary.

L-7-3
Your comment is noted. See also response to Comment No. G-1-4.

L-7-4
Your comment is noted. No change to the Final EIS was necessary.

L-7-5
See response to Comment No. G-1-15.

L-7-6
Your comment is noted.

L-7-7
See response to Comment No. F-4-9.

L-7-8 and L-7-9
See response to Comment No. G-1-25.

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COLORADO RIVER WATER
CONSERVATION DISTRICT

Protecting Western Colorado Water Since 1937

April 30, 2007

Jayne Harkins, Regional Director
Lower Colorado Region, Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City, NV 89906-1470

Re: Comments on the Draft EIS for Colorado Interim Guidelines for Lower Basin Shortage and Coordinated Operations for Lake Powell and Lake Mead

Dear Director Harkins:

The Colorado River Water Conservation District (Colorado River District) is pleased to submit comments on the Draft EIS for Colorado River Interim Guidelines for Lower Basin Shortage and Coordinated Operations for Lake Powell and Lake Mead (Shortage Criteria DEIS).

The Colorado River District is one of four water conservation districts chartered by the Colorado General Assembly. The Colorado River District covers all of the Colorado River Basin within Colorado north of the San Juan Mountains.

The Colorado River District through a coalition with other Colorado River water agencies within Colorado has participated with Colorado state officials in the discussions and negotiations among the seven Colorado River Basin States. Therefore, the Colorado River District generally 1
endorses and supports the comments of the Colorado Water Conservation Board (CWCB), dated April 30, 2007 and the collective comments of the seven Basin States, dated April 30, 2007.

The Colorado River District believes that it its important that the Secretary of the Interior
select a preferred alternative and ultimately sign a record of decision that implements the major 2
elements of the seven states proposal. We do not believe the seven states proposal is a take-it-or-
leave-it proposal. Therefore, it would be appropriate for the Secretary to incorporate elements of the 3
other action alternatives into the preferred alternative, as needed.

SUITE #200 • 201 CENTENNIAL STREET
P.O. BOX 1120/GLENWOOD SPRINGS, COLORADO 81602
(970) 945-8522 • FAX (970) 945-8799 • www.crwcd.org

L-8

Jayne Harkins, Regional Director
Lower Colorado Region, Bureau of Reclamation
River District Comments on the Shortage Criteria DEIS
April 30, 2007
Page 2

Recognizing that the primary purpose of the Draft EIS is to disclose the environmental impacts of the proposed action and reasonable alternatives to the action, to the general public and decision making agencies, the Colorado River District has the following comments and suggestions that we believe could make the final EIS a more effective "disclosure" document:

1. The Draft EIS is very comprehensive with lengthy chapters and a number of appendices. Therefore, the Executive Summary is a critical document. Where possible, the DEIS Executive Summary could be made more user friendly. For example, on page ES-6, the "No Action Alternative" paragraph discusses the limitations and uncertainties of defining the no-action alternative, but the paragraph never really gives the reader an understandable description of no-action. 4

   The treatment of hydrology primarily uses probabilities. The following statement appears on page ES-7: "Due to the uncertainty with regard to future inflows into the system, multiple simulations were performed in order to quantify the uncertainties of future conditions and as such, the modeling results are typically expressed in probabilistic terms." Yet, the ES provides no assistance or guidance to the reader in how to utilize the results that are expressed with probabilities. 5

2. For the primary treatment of hydrology as displayed in the Executive Summary, chapter 3, "Existing Conditions" and chapter 4, "Environmental Consequences," the various graphs and conclusions are based on the 1906-2004 period. Reclamation needs to make it very clear to the reader that the fundamental assumption is that the key statistics that describe the hydrology, mean, standard deviation and skew will continue into the future (no change from the 1906-2004 period). 6

   Appendix N, "Analysis of Hydrologic Variability Sensitivity" is an excellent approach to introduce alternative methods for hydrology reviews. Reclamation is to be commended for taking this step. 7 However, in the Executive Summary, there is no reference to Appendix N. 8 Without getting into the complications, Reclamation, as a minimum, could describe for the reader, the information provided in Appendix N and why it might be relevant to the basin states, NGOs, federal agencies and the Secretary of the Interior in the decision making process. 9

   For example, the results of the Direct Paleo analysis in Appendix N suggest that based on a longer or different period of record than 1906-2004, the probability of shortages and the magnitude of shortages may be slightly higher than what is suggested in the Draft EIS (chapter 4).

L-8

Jayne Harkins, Regional Director
Lower Colorado Region, Bureau of Reclamation
River District Comments on the Shortage Criteria DEIS
April 30, 2007
Page 3

Because Appendix N is a rich source of information for decisions makers, the Executive Summary should contain a few paragraphs on its implications for future decisions. 10

3. The probabilistic treatment of the hydrology data fails the decision maker in one potentially important, if not critical factor. The numerous graphs throughout the Draft EIS generally show the probability of an event occurring versus time (under the different alternatives). For example, figure 4.3-25 "Lake Mead End-of-December Elevations" is a relatively important graph with considerable information of importance to decision makers. This graph compares Lake Mead levels under the different alternatives at the 10%, 50% and 90% levels. What is missing is the "temporal" factor. The hydrologic record for the Colorado River in both the 1906-2004 period and the longer paleo record shows that there are 10-40 year periods of above normal flows followed by 10-40 year periods of below normal flows. During the wet periods, reservoir levels are generally full and shortages rare (or nonexistent) for extended periods of time. In contrast, during the drier periods, except for occasional bump years, mainstem reservoir levels remain low and shortages are routine. This temporal data is best displayed by using example single traces. We have attached an example of this approach. Based on information Reclamation has provided, the attached graphs show Lake Mead and Lake Powell levels, release values, and calculated shortages for two sample traces, 37 and 43. For a decision maker, the consequences of shortages occurring randomly with a 1 in 3 probability over a 60 year period is very different than having a 20 year period with consecutive shortages within that 60 year period (with no shortages in the other 40 years!). 11

4. Within the Draft EIS there is no real discussion of the potential impacts of climate change. As Reclamation is aware, the National Research Council of the National Academies of Science recently published a report on Colorado River Basin water management. This report concludes that "the preponderance of the evidence" that suggest conditions in the Colorado River Basin will be characterized by higher temperatures and lower stream flows. 12

The Colorado River District recognizes that there are no readily available (and generally accepted) data sets for future flows that could be used to generate alternative hydrology runs. However, the Executive Summary should certainly include a qualitative discussion of the available climate science (and its limitations) and what it MAY mean for future operations of Lake Mead and Lake Powell. 13 It is also be suggested that Reclamation obtain inflows from a source such as the Lettenmaier 2006 study and include it within Appendix N of the final EIS. 14

L-8

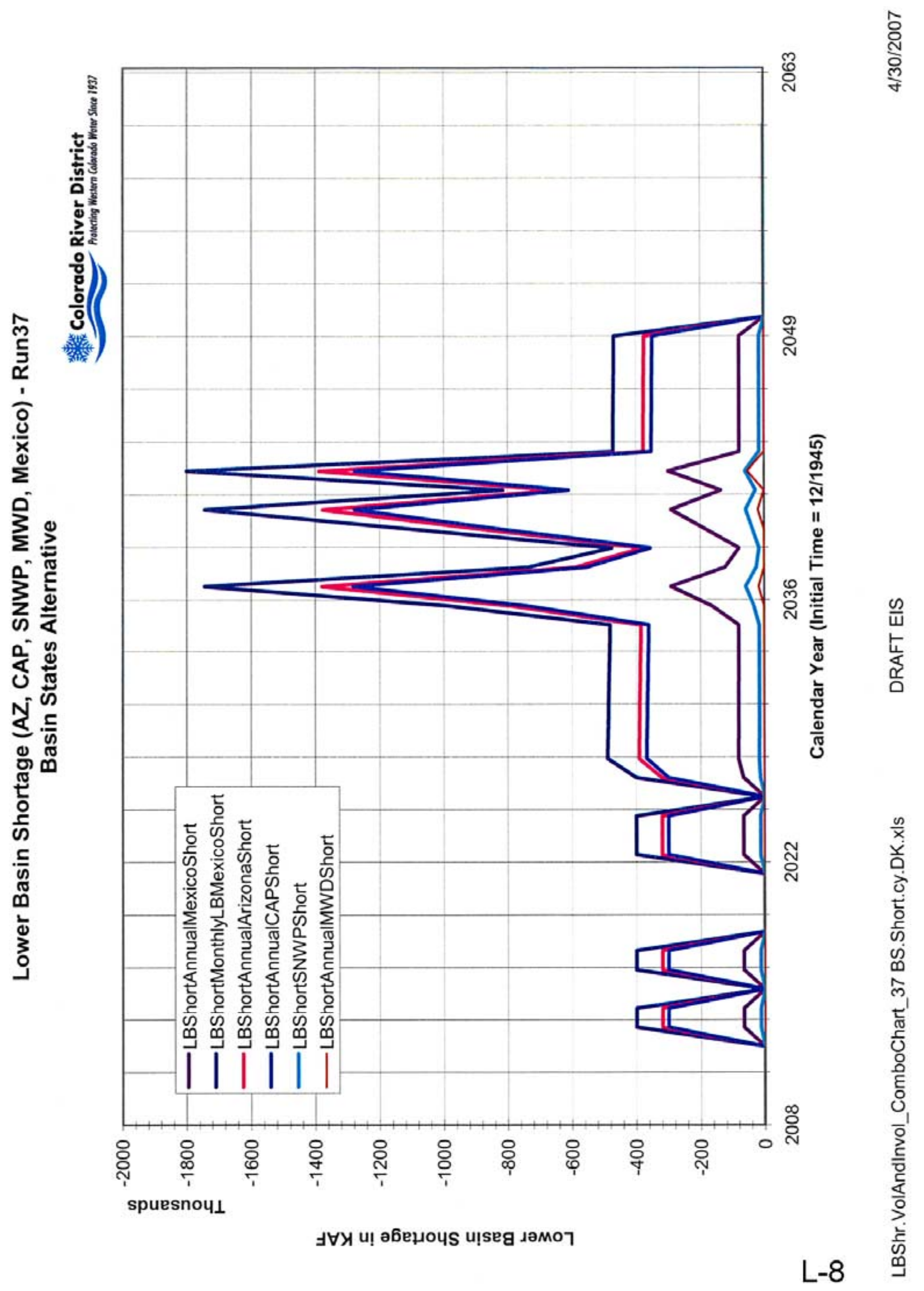
Jane Harkins, Regional Director
Lower Colorado Region, Bureau of Reclamation
River District Comments on the Shortage Criteria DEIS
April 30, 2007
Page 4

Sincerely,

Eric Kuhn
General Manager

REK/ldp
Attachments
c: (w/ attachments)
James Lochhead, Esq.
Scott Balcomb, Esq.
Randy Seaholm
Don Ostler

L-8


Lower Basin Shortage (AZ, CAP, SNWP, MWD, Mexico) - Run37
Basin States Alternative
Colorado River District
Protecting Western Colorado Water Since 1937
LBShortAnnualMexicoShort
LBShortMonthlyLBMexicoShort
LBShortAnnualArizonaShort
LBShortAnnualCAPShort
LBShortSNWPShort
LBShortAnnualMWDShort
Thousands
Lower Basin Shortage in KAF
-2000
-1800
-1600
-1400
-1200
-1000
-800
-600
-400
-200
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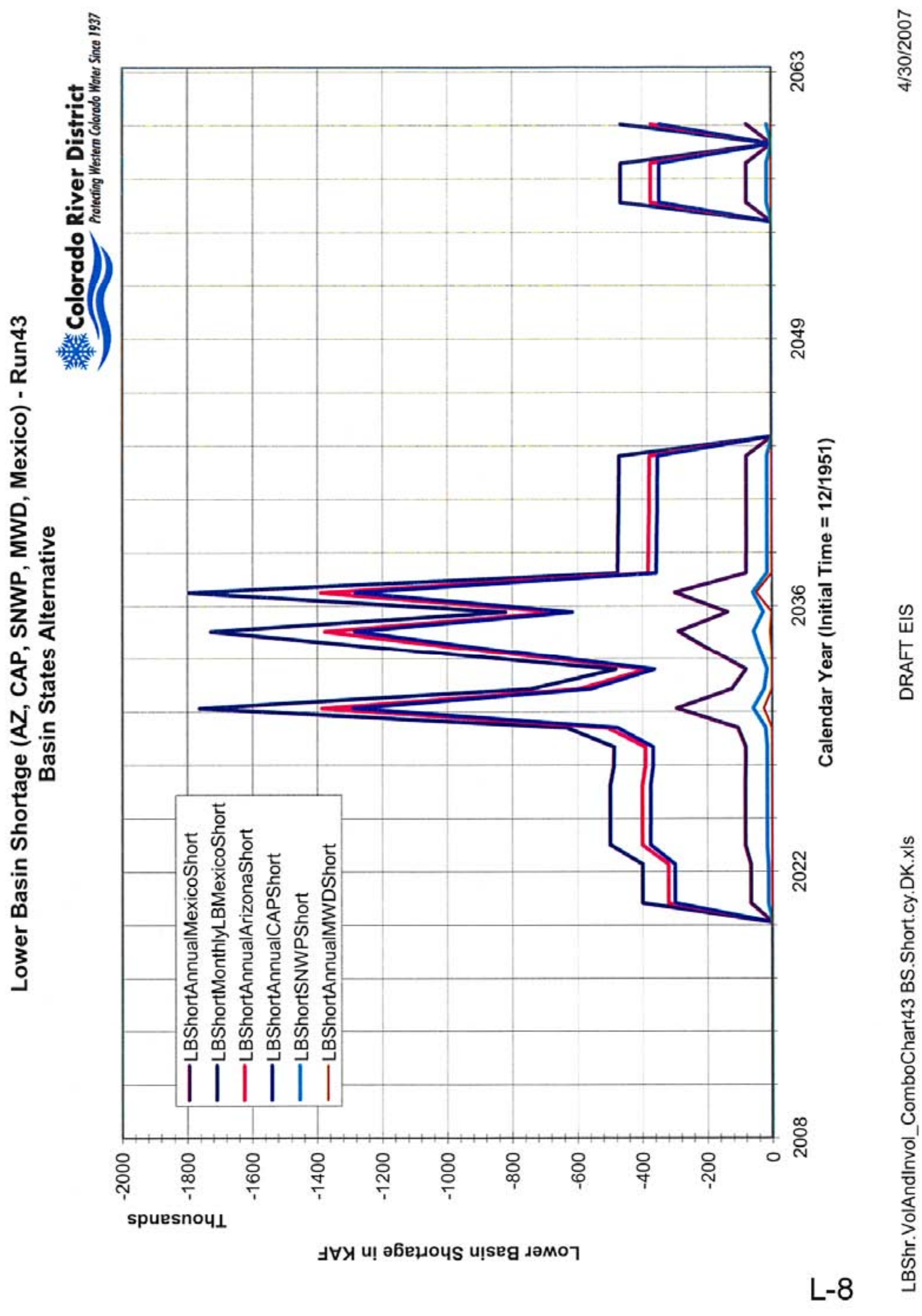
2008
2022
2036
2049
2063
Calendar Year (Initial Time = 12/1945)
L-8
LBShr.VolAndInvol_ComboChart_37 BS.Short.cy.DK.xls
DRAFT EIS
4/30/2007



Lower Basin Shortage (AZ, CAP, SNWP, MWD, Mexico) - Run43
Basin States Alternative
Colorado River District
Protecting Western Colorado Water Since 1937
LBShortAnnualMexicoShort
LBShortMonthlyLBMexicoShort
LBShortAnnualArizonaShort
LBShortAnnualCAPShort
LBShortSNWPShort
LBShortAnnualMWDShort
Lower Basin Shortage in KAF
Thousands
-2000
-1800
-1600
-1400
-1200
-1000
-800
-600
-400
-200
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2008
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2063
Calendar Year (Initial Time = 12/1951)
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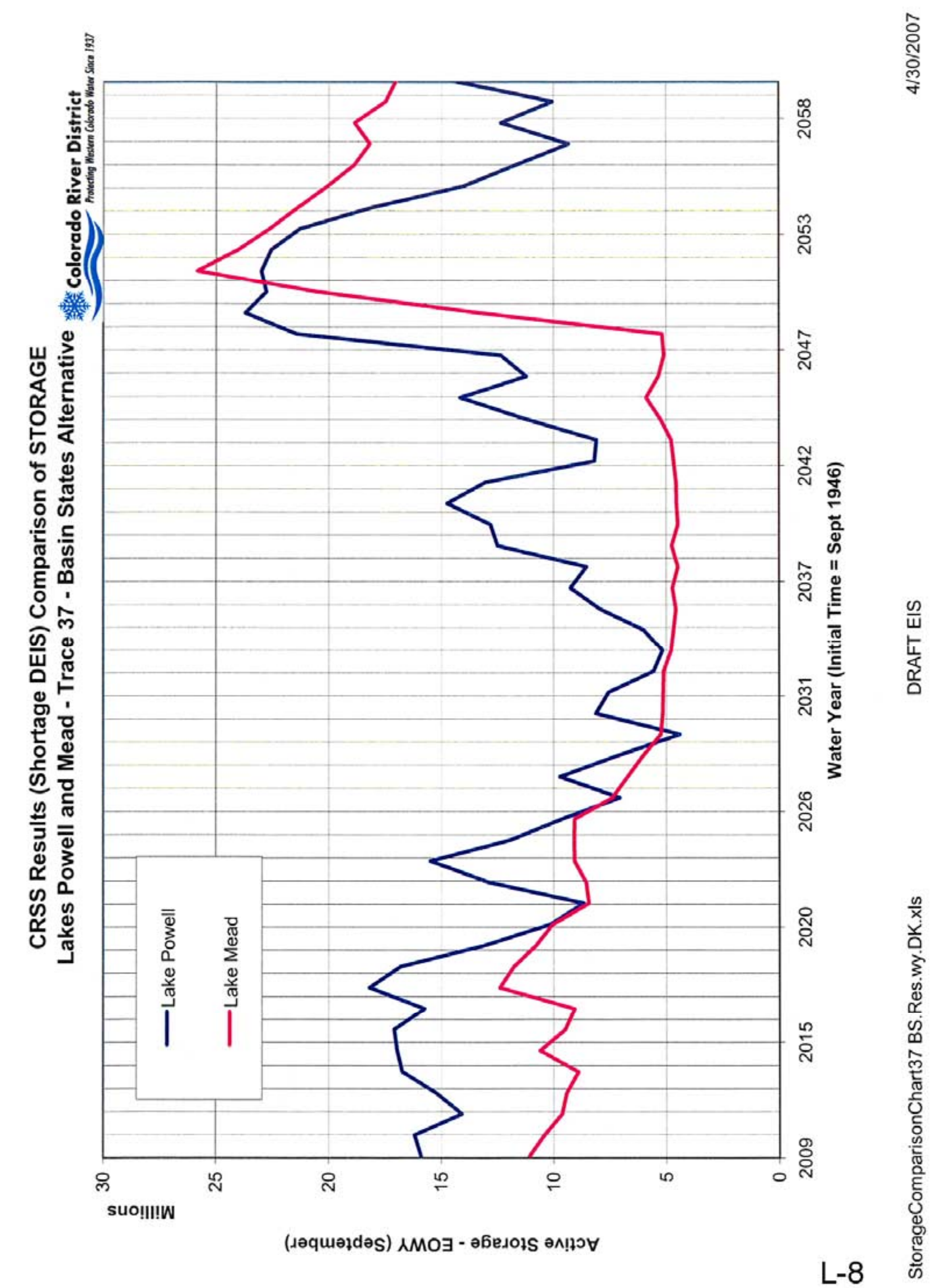
LBShr.VolAndInvol_ComboChart43 BS.Short.cy.DK.xls
DRAFT EIS
4/30/2007


CRSS Results (Shortage DEIS) Comparison of STORAGE
Lakes Powell and Mead - Trace 37 - Basin States Alternative
Colorado River District
Protecting Western Colorado Water Since 1937
Lake Powell
Lake Mead
Active Storage - EOWY (September)
Millions
30
25
20
15
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2009
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2031
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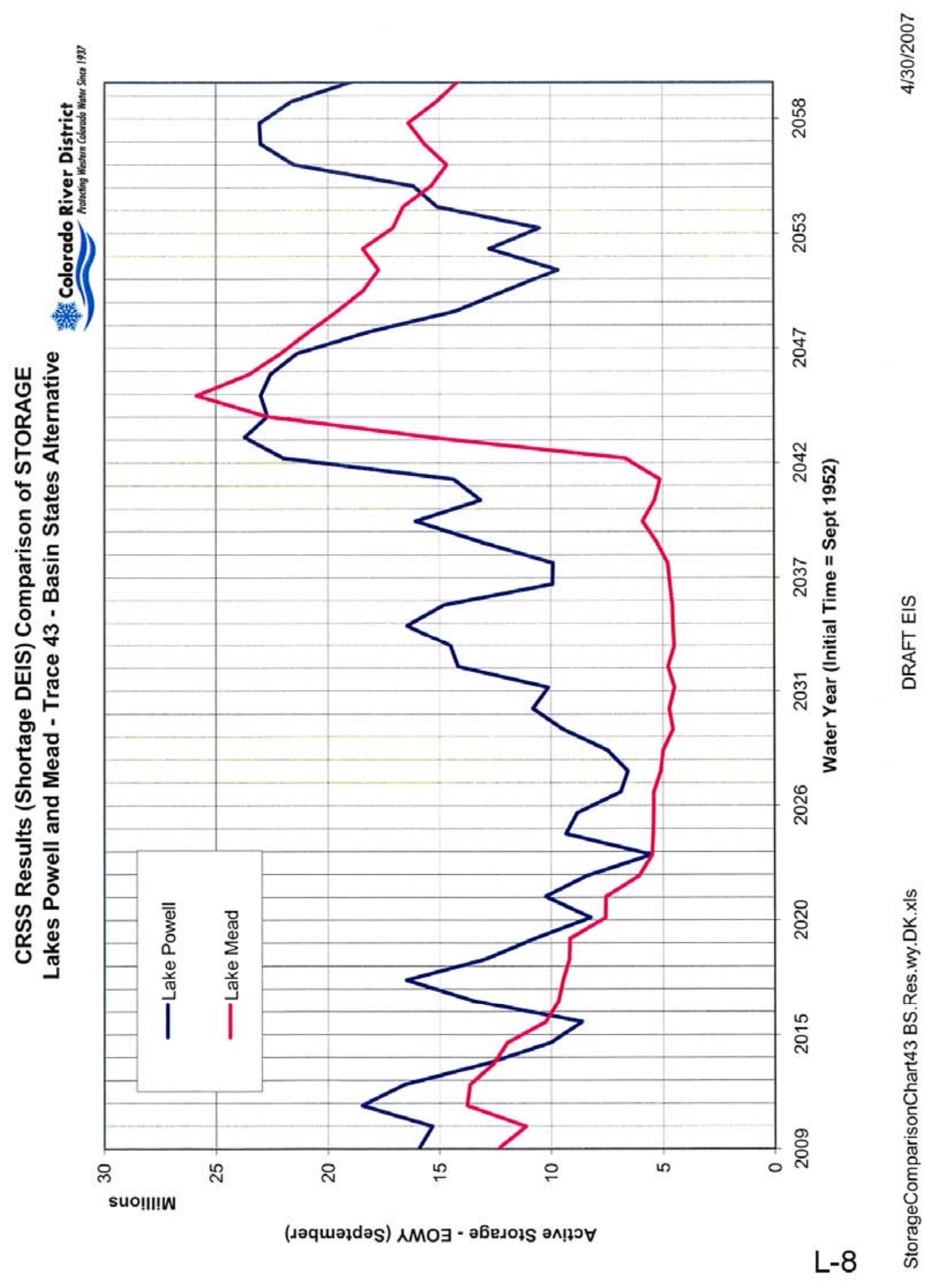
2058
Water Year (Initial Time = Sept 1946)
L-8
StorageComparisonChart37 BS.Res.wy.DK.xls
DRAFT EIS
4/30/2007


CRSS Results (Shortage DEIS) Comparison of STORAGE
Lakes Powell and Mead - Trace 43 - Basin States Alternative
Colorado River District
Protecting Western Colorado Water Since 1937
Active Storage - EOWY (September)
Millions
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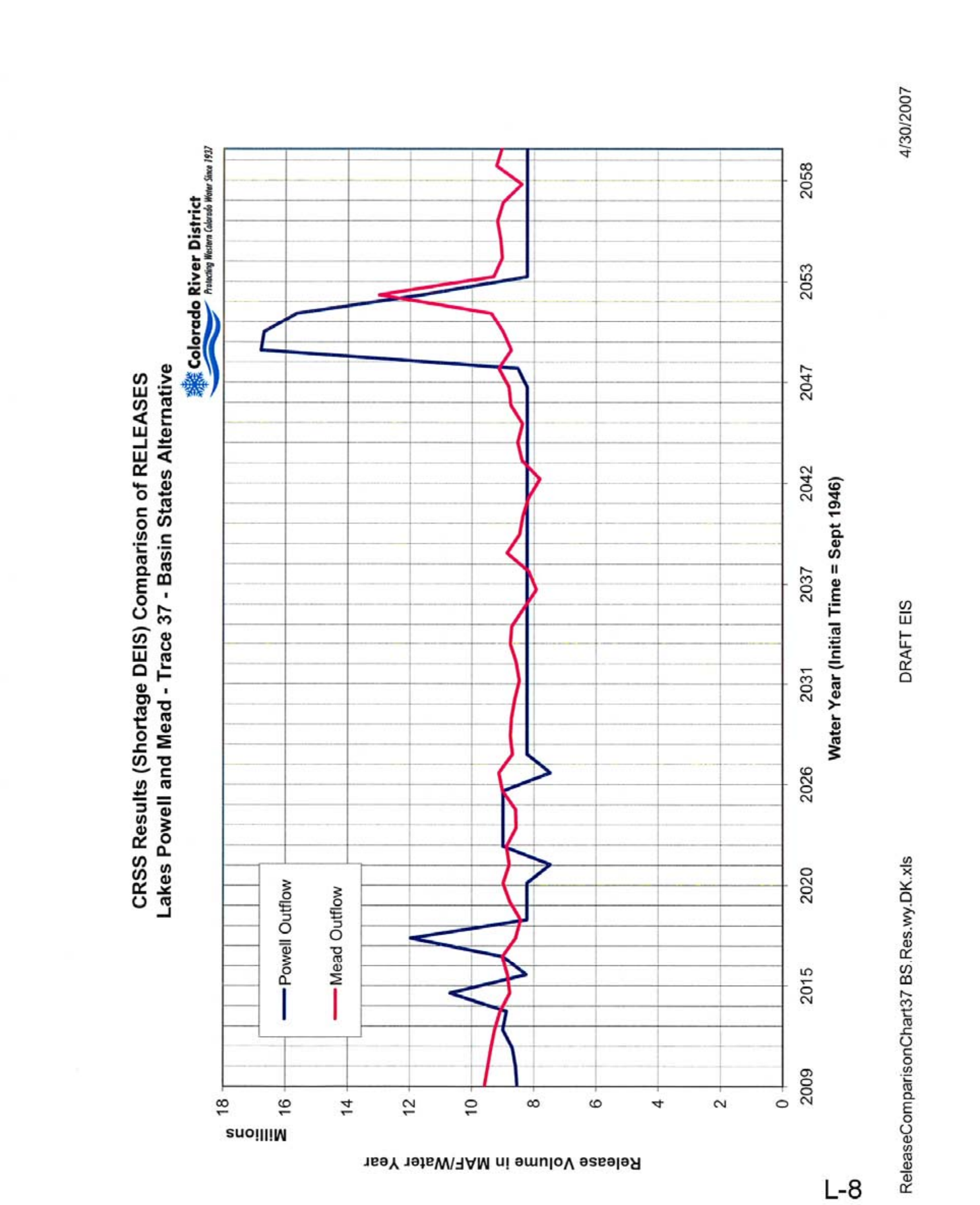
2058
Water Year (Initial Time = Sept 1952)
Lake Powell
Lake Mead
L-8
StorageComparisonChart43 BS.Res.wy.DK.xls
DRAFT EIS
4/30/2007


CRSS Results (Shortage DEIS) Comparison of RELEASES
Lakes Powell and Mead - Trace 37 - Basin States Alternative
Colorado River District
Protecting Western Colorado Water Since 1937
Powell Outflow
Mead Outflow
Release Volume in MAF/Water Year
Millions
18
16
14
12
10
8
6
4
2
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2009
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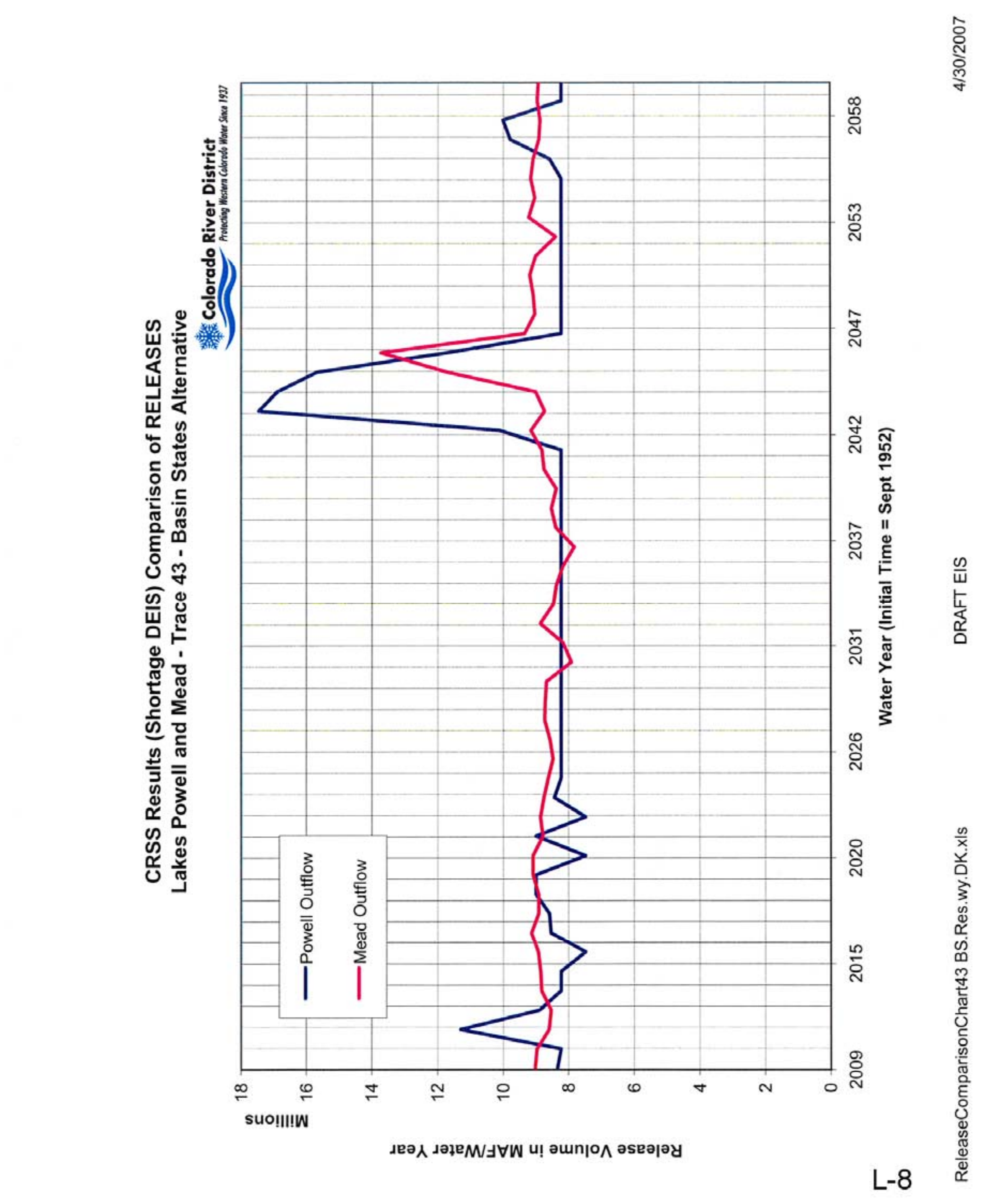
Water Year (Initial Time = Sept 1946)
L-8
ReleaseComparisonChart37 BS.Res.wy.DK.xls
DRAFT EIS
4/30/2007


CRSS Results (Shortage DEIS) Comparison of RELEASES
Lakes Powell and Mead - Trace 43 - Basin States Alternative
Colorado River District
Protecting Western Colorado Water Since 1937
Powell Outflow
Mead Outflow
Release Volume in MAF/Water Year
Millions
18
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10
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2058
Water Year (Initial Time = Sept 1952)
ReleaseComparisonChart43 BS.Res.wy.DK.xls
DRAFT EIS
4/30/2007
L-8

Reponses to Comment Letter L-8

L-8-1

Your comment is noted. No change to the Final EIS was necessary.

L-8-2

Your comment is noted. No change to the Final EIS was necessary.

L-8-3

Your comment is noted.

L-8-4

Your comment is noted. The Executive Summary is intended to provide a high level summary of some of the key issues or concepts discussed in substantial detail in the balance of the Final EIS.

L-8-5

The information requested is provided in the Draft and Final EIS. Section 4.2.6 of the Final EIS provides information on the post-processing and interpretation procedures for the statistical information provided in the EIS. Additionally, each resource area addresses the issues that are important to the respective resource, the analyses undertaken to evaluate potential impacts to that resource, and where statistics were used, how the statistics apply to that resource analysis.

L-8-6 through L-8-10

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

L-8-11

Reclamation has included single traces for in Section 4.3 and Appendix N of the Final EIS for explanatory purposes. Additionally, Reclamation has included an analysis of multi-year shortages in the Final EIS. See response to Comment No. L-1-11.

L-8-12 through L-8-14

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

CITY OF BULLHEAD CITY
1255 Marina Boulevard
Bullhead City, AZ 86442-5733
(928) 763-9400 TDD (928) 763-9400

April 30, 2007

Bureau of Reclamation
Attn: BCCO-1000
PO Box 61479
Boulder City, NV 89006-1470

Via Fax: 702-293-8156

To Whom It May Concern:

INTRODUCTION

The Mohave County Water Authority (MCWA) submits the following comments to the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement (February 2007). MCWA is comprised of members representing Bullhead City (BHC), Lake Havasu City (LHC), Mohave Water Conservation District (MWCD), Mohave Valley Irrigation and Drainage District (MVIDD), Golden Shores Water Conservation District (GSWCD), City of Kingman and Mohave County. BHC, LHC, MWCD, MVIDD and GSWCD represent the first (and probably only) municipal / industrial users in the State of Arizona to be significantly and immediately impacted by projected shortages during the interim period. Because of our unique position in the State of Arizona, we renew our previously denied request for consultation on this matter as the draft EIS makes it abundantly clear that no one with whom Reclamation consulted was adequately representing the interests of Arizona's 4th priority on river users.

THE SEVEN BASIN STATES ALTERNATIVE

MCWA recognizes Arizona worked diligently with the other Basin states to achieve agreement on the Basin States' Preliminary Proposal recommended to the Secretary of Interior and on February 3. 2006 following the publication of the Draft EIS, and that Arizona has continued to work closely with the other states to refine and improve the Basin States' Preliminary Proposal and to develop one set of comments to the Draft EIS on behalf of all of the states ("Basin States Comments"). We understand the Basin states will be submitting the Basin States' Comments, together with the Basin States' Proposal, which will include the Basin States' Agreement, Proposed Interim Guidelines for Colorado River Operations draft Forebearance Agreement and Arizona-Nevada Shortage Sharing Agreement (Basin States Proposal). While MCWA has some significant reservations regarding the Basin States Alternative we join in Arizona's letter 1

L-9

Bureau of Reclamation
Attn: BCCO-1000
April 30, 2007
Page 2

submitted this date and Arizona's conclusion recommending the Secretary choose the Basin States alternative as the preferred alternative in the FEIS and adopt an ROD with 1 the guidelines and criteria necessary to implement the Basin States Alternative in substantial conformance with the carefully negotiated Basin States Proposal provided such ROD adopts Arizona Department of Water Resources' Director's Shortage Sharing Workshop Recommendations, October 24, 2006 (Revised) final attached hereto as Exhibit 1.

COMMENTS TO ADDRESS CONCERNS SPECIFIC TO MCWA

1. No Action Alternative:
   This alternative would provide no guidance to the on river 4th priority users in planning for shortages. Our members could suffer 30% shortages in both M&I 2 and agricultural supplies as early as 2011. It gives no guidance as to how and when shortages would be imposed. It also assumes (a) the existing 602(a) interpretation would stand (see Arizona's letter for further discussion) and (b) the CRBPA requires on river agricultural and municipal/industrial users to be shorted immediately when CAWCD suffers shortages. This conclusion is not compelled by either the language in our contracts nor the CRBPA. This alternative leaves many unanswered questions both among the Basin States and within Arizona to be acceptable to MCWA.

2. Water Supply Alternative
   The DEIS indicates that there would likely be no shortages in Arizona during the interim period under this alternative. In the short term this is clearly the best alternative for us, but we recognize the potential long term adverse consequences of this alternative and the likely conflicts it would cause among the 3 Basin States. The compromises encompassed within the Basin States Proposal benefit the entire system and its long term benefits are reasons we support the Basin States Alternative versus the Water Supply Alternative.

3. Reservoir Storage Alternative
   The modeling provided in the DEIS shows that this alternative would have a 4 significant negative impact on the river communities in Mohave County. While the Reservoir Storage Alternative proposes to offset some of its impact with increased intentionally created surplus (ICS) the Arizona cities most immediately and severely impacted by this proposal, i.e., Lake Havasu City and Bullhead City, 5 would be unlikely to benefit from an ICS program without a legal battle within Arizona.

L-9

2

Bureau of Reclamation
Attn: BCCO-1000
April 30, 2007
Page 3

MCWA for the above reasons, as well as the reasons set forth in Arizona's letter, strongly objects to the Reservoir Storage Alternative. 6

4. CBS Alternative
MCWA believes the concept of voluntary fallowing, as well as the opportunity for participation by all parties (including Arizona's on river 4th priority users and Mexico) in the ICS program are laudable goals and request the FEIS adopt the Basin States Alternative as the preferred alternative but discuss further the steps which could be taken, within the Law of the River, to get the benefits likely to result from a voluntary following program (which would put fallowing contracts in place NOW for future shortages and to broaden participation in the ICS program. 7
Representing the communities which will take the first, and most significant, reductions in times of shortage we consider it incumbent upon the Secretary to take all reasonable steps to mitigate the impacts of shortage by supplementing the mitigation efforts we already have in place. 8

5. Additional Comments on the DEIS
A. ICS
Reclamation should, in the Final EIS, accurately describe ICS as a category of surplus, include a description of the forebearance necessary for the delivery of ICS to the entity that created the Surplus, and, in the record of Decision, adopt guidelines for the creation and delivery of ICS as set forth in the Proposed Interim Guidelines contained in the Basin States' Proposal. 9
Reclamation should also take reasonable steps to provide that the benefits of ICS are available to all users particularly those immediately and significantly impacted by projected shortages, i.e., our members. 10

B. On River 4th Priority Agricultural Users
The draft EIS includes the following statement: "Key to the impact analysis is the assumption that the most conservative way to estimate impacts is to assume that, if a shortage occurs, farmers would react by fallowing irrigated lands." (p.4-263) This is an adequate approach for analyzing shortage reductions expected to last for a single year. However, we disagree with the assumption that this approach captures the expected impact for multiple consecutive-year storage reductions. 11
Since fourth priority agricultural water users in Mohave County, Arizona have no reasonably available replacement water supply, a long term shortage will likely result in the permanent loss of production for some lands. 12

L-9

3

Bureau of Reclamation
Attn: BCCO-1000
April 30, 2007
Page 4

The DEIS also fails to adequately address the impact on the economies of the impacted communities of this loss of agriculture by comparing the impact to the State and County overall. This serves to very much dilute the direct and immediate impact on the on river 4th priority user communities. 13

C. On River 4th Priority Municipal and Industrial Users

- As with on river agricultural users, the DEIS fails in any manner to address the direct and immediate impact of the projected shortages and cumulative shortages on municipal users of 4th priority on river users and again, lumps the communities together by County which significantly dilutes the local impact. 14

- The DEIS depletion schedules underestimate by 25-35% on river M&I water use (as compared, e.g., to Reclamation's own 2006 water use report) which again, serves to underestimate the extent and effect of shortages and makes it difficult to determine the actual shortage amounts we would be expected to suffer based on the DEIS hydrologic modeling. 15

  The DEIS fails to address the significant costs borne by our members to date, and the even higher costs to be borne in the future, of the mitigation efforts taken to date (primarily participation in the Arizona Water Banking Authority (AWBA) program which costs include water, delivery, storage, recovery and replacement of any water used in times of shortage). 16 The significant economic hardship of using AWBA water in times of shortage, particularly in multiple year shortage occurrences, is totally ignored by the DEIS. The DEIS also ignores the hundreds of millions of dollars our communities have spent/are spending to convert from septic to wastewater treatment systems in order to generate effluent to offset the impacts of shortage. 17

Future estimated shortage reductions to mainstream users, including Lake Havasu City and Bullhead City, run as high as 30% of entitlement over a number of consecutive years. Despite the conclusion in the DEIS that no permanent changes in land use are expected (p.4-270) it is highly unlikely that such significant cutbacks 18

L-9

4

Bureau of Reclamation
Attn: BCCO-1000
April 30, 2007
Page 5

- in supply, and as early as 2011, would not alter land use patterns in the affected communities.

- The DEIS goes to great lengths to address impacts in Nevada (ostensibly in support of the extreme measures be proposed to solve both its long term and shortage supply needs) and the Central Arizona Project area while totally ignoring that Arizona's on river 4th priority users are in a far worse position for a number of reasons including: 19

(1) Neither our agricultural nor M&I users have a readily available alternative source of water (e.g., no adjacent tributaries, non related surface water flows, nor (based on Reclamation's current interpretation of Article v accounting under the Consolidated Decree in *Arizona and California*) is there any locally available, non-Colorado River water supply to offset shortage reductions.

(2) The small (relative, e.g., to the SNWA and CAP service areas) population in the area, and the large geographic distances separating the on river P4 users, make financing of any water importation project unlikely at best.

(3) Fallowing agreements, e.g. with farmers or tribes, as are available to Central Arizona Project communities are not available to on river P4 users for a variety of reasons including the trading of our priority for the CAP (which did not benefit, and arguably harmed, on river users), on river tribes in Mohave and LaPaz settling their claims before our communities existed and thus such settlements make no provision for leasing to adjacent municipalities and the apparent position of Arizona and CAP that ICS in any form is not available to us without forebearance by Arizona and CAP (parenthetically it is interesting to note forebearance for users in other states appears to take priority over Arizona's in state users).

(4) Limited, if any (investigation is ongoing) adjacent basins unconnected to the River in which recharge, and recovery, could occur (i.e., our own banking program).

- The ROD needs to include the Arizona –Nevada shortage sharing agreement and a provision that the proceeds of that agreement are 20

L-9

5

Bureau of Reclamation
Attn: BCCO-1000
April 30, 2007
Page 6

to first be used to hold the on river P4 M&I users, the first impacted by this "deal", harmless (i.e., as to water and money) from the impact of this sharing agreement. Arizona has verbally indicated to MCWA that this is the intent but due to the immediate and detrimental impact of the Arizona/Nevada agreement take the position this commitment should be included in the ROD. 20

D. Additional Comments

- An agreement with Mexico is a critical component of the Basin States Proposal and MCWA's support of same. The impacts of a failure to reach such an agreement are not modeled in the DEIS. 21
- MCWA, its members, and Arizona as a whole appear to be penalized in the DEIS for its active planning for drought for decades. 22 The DEIS dismisses the significant economic impact of the investments made to date, and projected into the future, by coming to the erroneous conclusion that due to Arizona's drought planning, there is no real impact on its M&I users. 23
- The projected depletion schedules and shortage impact tables in the DEIS do not accurately portray the various contracts and contract amounts held by MCWA and its various subcontractors. This should be corrected in the FEIS. 24
- Because a shortage has not been declared to date on the River, and because our M&I users take the most immediate and significant and disproportionate reductions, the FEIS should include a program for monitoring the economic, land use and public policy impacts of any declared shortage during the proposed interim period. 25
- Operation of the YDP at full capacity should commence as soon as possible in order to stop the loss of water now occurring as a result of the bypass flows to the Cienega de Santa Clara. 26
- Reclamation should immediately undertake programs and projects to augment system flows. 27
- Final shortage guidelines should be flexible in order to allow the appropriate response to changing conditions including, but not limited to, improved hydrologic conditions during the year(s) in which a shortage is declared and catastrophic conditions requiring cuts in excess of 600,00 a/f. 28

L-9

6

Bureau of Reclamation
Attn: BCCO-1000
April 30, 2007
Page 7

CONCLUSION

Subject to Arizona's comments as submitted by ADWR, and our comments as noted above, the Mohave County Water Authority strongly recommends that the Secretary choose the Basin States Alternative as the preferred alternative in the FEIS and adopt a ROD with the guidelines and criteria necessary to implement the Basin States Alternative in substantial conformance with the carefully negotiated Basin States' Proposal. 29

Sincerely,

Diane Vick
Mayor

L-9

7

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Reponses to Comment Letter L-9

L-9-1

Your comment is noted. No change to the Final EIS was necessary.

L-9-2

Your comment is noted. No change to the Final EIS was necessary.

L-9-3

Your comment is noted. No change to the Final EIS was necessary.

L-9-4 through L-9-6

Your comments are noted. No change to the Final EIS is necessary.

L-9-7 and L-9-8

Your comments are noted. No change to the Final IES is necessary.

L-9-9 and L-9-10

See responses to Comment Nos. G-5-93 and L-1-9.

L-9-11 and L-9-12

See response to Comment No. L-1-11.

L-9-13

See response to Comment No. L-1-13.

L-9-14

See responses to Comment Nos. L-1-13 and L-1-14.

L-9-15

See response to Comment No. L-1-15.

L-9-16 and L-9-17

See response to Comment No. G-1-25.

L-9-18

See responses to Comment Nos. L-1-11 and L-1-13.

L-9-19

See response to Comment No. L-1-14.

L-9-20

See response to Comment No. L-1-20.

L-9-21

Your comment is noted. No change to the Final EIS was necessary.

L-9-22 and L-9-23

See response to Comment No. G-1-25.

L-9-24

See response to Comment No. L-1-15.

L-9-25

See response to Comment No. L-1-25.

L-9-26

Your comment is noted. See also response to Comment No. F-4-9.

L-9-27

Your comment is noted. See also response to Comment No. L-1-9.

L-9-28

See response to Comment No. G-8-37.

L-9-29

Your comment is noted.

CITY OF TEMPE
WATER UTILITIES DEPARTMENT

CITY OF TEMPE ARIZONA

Mailing Address: P.O. Box 5002
Delivery Address: 255 East Marigold Lane
Tempe, Arizona 85280

Date: April 27, 2007 Pages to follow: 3

To: Regional Director - U.S. Bureau of Reclamation - Lower Colorado Regi

Fax No.: (702) 293-8156

From: Eric Kamienski, Water Resources Administrator
Tempe Water Utilities Department

Comments: City of Tempe comments on Draft EIS - Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lakes Powell and Mead.

City of Tempe – Water Utilities Department, Fax (480) 350-8336
If you do not receive all of these pages, please call (480) 350-2631
s:/forms/faxcvrsheet.doc

L-10

City of Tempe
255 E. Marigold Lane
Tempe, AZ 85281

Tempe

Water Utilities Department

April 27, 2007

Via Fax (702) 293-8156 and Regular Mail

Regional Director
US Bureau of Reclamation
Lower Colorado Region (Attention: BCOO-1000)
PO Box 61470
Boulder City, NV 89006-1470

Re: Draft Environmental Impact Statement (EIS) - Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lakes Powell and Mead, February, 2007

Dear Regional Director:

The City of Tempe ("City") provides these comments to the Draft EIS for Colorado River Interim Guidelines for Lower Basin Shortage and Coordinated Operations for Lakes Powell and Mead (72 Fed. Reg. 9026, February 28, 2007).

The City has previously provided comments to the U.S. Bureau of Reclamation during the scoping process for the Notice of Intent to Prepare the Draft EIS (November 30, 2005). The City has also participated in an Arizona stakeholder group process with the Arizona Department of Water Resources, the Central Arizona Project and Colorado River water users in Arizona to work together on development of shortage criteria for Lower Basin shortages that manage and minimize the impacts to Colorado River water users from shortage declarations by the Secretary of the Interior. This process led to recommendations that were adopted within the Seven Basin States Preliminary Proposal Regarding Colorado River Interim Operations (letter to the Secretary of the Interior, dated February 3, 2006).

The City has reviewed the Draft EIS for Colorado River Interim Guidelines for Lower Basin Shortage and Coordinated Operations at Lakes Powell and Mead. The City supports selection of the Basin States Alternative as the preferred alternative in the Final EIS and implementation of the Basin State Alternative through the Final Record of Decision. 1

L-10

Apr-27-07 11:02am From-City of Tempe Water Management Div. 6023508336 T-160 P.003/004 F-364

Importance of Central Arizona Project Colorado River Water Supplies

The City of Tempe provides water service to a population of over 171,000 people in our water service area, in addition to a large concentration of industries, businesses, and educational institutions in the heart of the greater Phoenix metropolitan area. Colorado River water delivered to Tempe via the Central Arizona Project (CAP) is a significant component of Tempe's water resources portfolio. Tempe holds CAP contracts for Municipal & Industrial (M & I) priority water, and lesser amounts of Indian lease water and non-Indian agricultural priority water.

Some portions of the Tempe water service area lack rights to use Salt River Project water supplies, such as the adjacent Town of Guadalupe, to which Tempe has provided water service for over 30 years. Colorado River water delivered by the CAP is the single most important water supply to meet the needs of these areas, and Colorado River reservoir operations are fundamental to the CAP supply. The CAP has a junior priority under the Law of the River, and all CAP water users have a significant interest in the management strategies being developed by the U.S. Bureau of Reclamation.

The Basin States Alternative

The Basin States Alternative, developed through extensive negotiations between the
seven Colorado River Basin States, is a compromise alternative acceptable to each of 2
these States. The Basin States Alternative is the only alternative that does not require
additional statutory authority and is the only alternative that can be implemented 3
immediately after the Secretary of Interior issues the Final Record of Decision. The Basin
States Alternative offers the most certainty to Colorado River water users in the Lower 4
Basin, and the unique level of collaboration between the seven Colorado River Basin
States should be considered in selecting this as the preferred alternative.

Other Alternatives in the Draft EIS

The "No Action" and "Water Supply" Alternatives do not propose operational changes 5
that will address future reservoir shortage conditions due to prolonged drought
conditions, and do not provide for coordinated operation of Lakes Powell and Mead. 6

The "Conservation Before Shortage" Alternative includes an intentionally created surplus
through forbearance, but no funding mechanism for this intentionally created surplus 7
exists. The "Conservation Before Shortage" Alternative also contains elements that 8
would require additional statutory authority and necessitate amendment of the 1944
Treaty with Mexico.

The "Reservoir Storage Alternative" contains provisions for intentionally created surplus
that protects water storage for power generation and recreation to the detriment of 9
downstream water users. These provisions are contrary to the Law of the River which
dictates that operation of the system for water supply purposes has a higher priority than 10
operation of the system for hydropower generation purposes. This alternative also

L-10

contains tiered shortage criteria that significantly increase the water shortages for the
Lower Basin compared to the Basin States Alternative (maximum shortage volume of 11
1,200,000 AF/year to the Lower Basin under the Reservoir Storage Alternative compared
to a maximum shortage volume of 600,000 AF/year under the Basin States Alternative).
The shortage criteria in the Reservoir Storage Alternative place nearly all the burden of
future shortages on the Lower Basin water users in favor of maximizing hydropower 12
generation capacity, contrary to the Law of the River. The Basin States Alternative is far
more balanced in its provisions to further consult with the Secretary of the Interior for 13
any potential reservoir operations requiring Lower Basin shortages greater than 600,000
AF/year.

Summary

The Basin States Alternative provides Lower Basin Colorado River water users with the
greatest degree of certainty of any of the alternatives. The Basin States Alternative is the
result of a unique collaborative effort on the part of all seven Colorado River Basin 14
States. The City of Tempe supports selection of the Basin States Alternative as the
preferred alternative in the Final EIS and implementation of the Basin State Alternative
through the Final Record of Decision.

Thank you for the opportunity to comment on the Draft EIS for Colorado River Interim Guidelines for Lower Basin Shortage and Coordinated Operations for Lakes Powell and Mead.

Sincerely,

Eric Kamienski
Water Resources Administrator
Tempe Water Utilities Department

cc: Herb Guenther, Director, Arizona Department of Water Resources

L-10

Reponses to Comment Letter L-10

L-10-1 and L-10-2

Your comments are noted. No change to the Final EIS was necessary.

L-10-3 and L-10-4

Your comments are noted. Also see response to Comment No. G-1-4.

L-10-5 and L-10-6

Your comments are noted. No change to the Final EIS was necessary.

L-10-7 and L-10-8

Your comments are noted. No change to the Final EIS was necessary.

L-10-9 through L-10-13

Your comments are noted. No change to the Final EIS was necessary.

L-9-14

Your comment is noted. No change to the Final EIS was necessary.

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PUBLIC WORKS DEPARTMENT
LAKE HAVASU CITY
Administration/Engineering Division
Email: publicworks@lhcaz.gov
Phone: (928) 453-6660
Fax: (928) 453-8502

FAXED, EMAILED AND MAILED

April 27, 2007

Regional Director
Lower Colorado Region, Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City, NV 89006-1470

RE: Lake Havasu City Comments Regarding the Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.

Dear Regional Director:

Lake Havasu City, Arizona, which holds a 4th priority mainstream Colorado River Water contract with the Bureau of Reclamation (Contract No. 3-07-30-W0039), submits the following comments to the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement (DEIS - February 2007).

Lake Havasu City favors the Basin States Alternative as the preferred alternative as this
alternative addresses the scope of the changes to reservoir operations. The City, although not 1
adverse to the Conservation Before Shortages Alternative (and would probably benefit more in
the short term), believes that the mechanism of voluntary shortages is not sufficiently clear in the 2
DEIS and could lead to operational problems. The other three alternatives would not be
beneficial to the City in the long run. Although the Water Supply Alternative would delay 3
shortages for quite awhile and give the City more time to prepare for reductions in water 4
delivery, the shortages that would result from this alternative could greatly impact the city.

Several critical issues are not sufficiently addressed in any of the DEIS alternatives including:

- Lake Havasu City along with other 4th priority mainstream users in Arizona have been
  largely ignored in the DEIS process, even though they will proportionally carry the brunt 5
  of the shortages. There will definitely be socioeconomic impacts along the river and on
  the city, particularly in generating new sources for water acquisition, such as the expected 6
  escalation in costs to recovery and replacement of firmed water taken from the Arizona

L-11

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www.lhcaz.gov

Lower Colorado Region, Bureau of Reclamation
April 27, 2007
Page 2

Water Banking Authority, and costs associated with acquiring other water sources such as fallowing deals with agricultural interests.

Due to significant restrictions on water use during shortage years, the city's economy and population growth are expected to noticeably slow. Although the water level of Lake 7 Havasu will probably remain unaffected during shortages, tourism may suffer, especially businesses associated with accommodations and restaurants, when water consumption restrictions are in place (a consideration not addressed in sections 3.12 or 4.12.5 in Volume I of the DEIS).

- Furthermore, Stage I and Stage II shortage-sharing modeling assumptions (discussed in Section 4.2.7.1 on pages 4-9 through 4-11), although run by the letter of the law, may not be practical in the sense that Stage II shortages are implemented only when supplies to Arizona 4th priority users have been totally cut off. In essence, the consequences of such 8 an eventuality that would lead to the displacement of tens of thousands of people from Lake Havasu City, Bullhead City, and various smaller communities have not been considered. Laughlin, Nevada would also suffer as that community relies on citizens and businesses of Bullhead City to operate normally. None of the Arizona communities have 9 enough firmed water banked to cover multi-year shortages of that magnitude. The socioeconomic impacts would not only affect the region, but also at the state and federal 10 level, not unlike the evacuation from New Orleans. As the probabilities are very low that Stage II shortage-sharing would be instituted within the 19 year interim period, that adjudication would "muddy the waters" of such an action, and since this operation 11 measure has not been adequately addressed in the DEIS, it should be deleted as part of the operational policy of the interim period until a closer examination of the overall effect is implemented.

- Who can participate in the Intentionally Created Surplus (ICS) mechanism is stated as unknown on page 4-12 (section 4.2.8) in the DEIS. Table 4.2-3 on page 4-13 shows that the ICS predominantly helps Nevada (to mitigate their conservation projects), but Arizona may take advantage during normal years. In Arizona, the Central Arizona Project's (CAP) contract with the Bureau of Reclamation (BOR) includes a clause stating that this agency may take any unused water allotted to other Arizona contracts. What is 12 the legality of a Record of Decision resulting from this EIS that includes a statement indicating all Arizona water providers with BOR contracts may participate without the threat of the CAP's assertion that they could use that water? The first M&I contracts to be affected by the shortages are from the on-river 4th priority users and this group 13 (although admittedly small) would benefit the most if they could participate since there are limited options to obtain water from other sources. Our concern is that in Arizona, only the CAP would benefit from conserved storage the way the law is currently devised. 14 Computer models from the Arizona Department of Water Resources (ADWR) indicate

L-11

Lower Colorado Region, Bureau of Reclamation
April 27, 2007
Page 3

that the CAP M&I users will not be directly impacted from the 400K – 600K reductions because of the way the CAP is structured. Much or all of the shortage borne on the CAP can be absorbed from their storage programs and agricultural entities.

- In Appendix D, Table D-1f on page D-6, the depletion schedule for Lake Havasu City used in the hydrologic modeling does not look correct. These numbers appear to be diversion volumes that ADWR provided to the BOR for Lake Havasu City, but they are not consumptive use values using calculated annual return flows. Although page 4-4 in section 4.2.3 of the DEIS states that the depletions include return flow credits where applicable, the numbers in Table D-1f do not reflect the 38% unmeasured return flow rate as calculated by the BOR for Lake Havasu City. The 12,322 ac-ft value for 2008 listed on Table D-1f is too low for a diversion number, particularly since the City's requested allocation for 2008 will likely be a bit higher than the 2007 allocation request of 16,079 ac-ft. The table also lists a use of 20,378 ac-ft by 2060, yet city projections based on population estimates from the Arizona Department of Economic Security and using a per capita rate of 250 gpcd, Lake Havasu City will reach its diversion entitlement of 25,180 ac-ft (15,611 ac-ft consumptive use) by 2040 under normal Colorado River supply years. 15

  Bullhead City representatives say that their depletion schedule is also not reflective of their current situation. 16 If these discrepancies are more widespread, than a possible underestimation of the probabilities, timing, frequency, and affects of shortages to the Arizona 4th priority users may result. The hydrologic model output sensitivity to this parameter is expressed on page 4-6 of Section 4.2.6 in the DEIS. 17

- ADWR has approximately 10,000 ac-ft of unallocated 4th priority water (according to ADWR or a "few thousand acre-feet" according to page 1-15 in the DEIS), which could possibly be made available to those affected by the shortage scenarios, yet this is not covered in the DEIS. It would seem that the unassigned allocation would be part of the Arizona shortage prior to contracted water. 18

- Lastly, the Supreme Court's Consolidation Decree of 2006 is mentioned several times (first mentioned on page 1-1 and in Table 1,7-1 (although somewhat out of place)) in the DEIS, but no reference to the specifics of the decree are given, only quick references as if everyone already knows the implications of the legal action. The decree is also not easily accessible on the internet as I had to ask a BOR employee to find it for me. It should be spelled out more in the DEIS. 19

L-11

Lower Colorado Region, Bureau of Reclamation
April 27, 2007
Page 4

Lake Havasu City appreciates the opportunity to express its concerns covering this very important document. If you have any questions, please contact me at (928) 453-6660 x4319 or at wilsond@lhcaz.gov.

Sincerely,

Doyle Wilson
Water Resources Coordinator

DW:sw

c: Richard Kaffenberger, City Manager
Kevin Murphy, Public Works Director
Robert P. Leuck, P.E. Deputy Public Works Director
Kelly Garry, Assistant City Attorney

L-11

Reponses to Comment Letter L-11

L-11-1 through L-11-4

Your comments are noted. No change to the Final EIS was necessary.

L-11-5 through L-11-7

See responses to Comment Nos. G-1-25 and L-1-14.

L-11-8 through L-11-10

Your comments are noted. See responses to Comment Nos. L-1-11 and G-1-25.

L-11-11

Your comment is noted.

L-11-12 through L-11-14

See response to Comment No. L-3-7.

L-11-15 through L-11-17

See response to Comment No. L-1-15.

L-11-18

Your comment is noted.

L-11-19

Your comment is noted. Section 1.7.2.1 of the Final EIS notes that Consolidated Decree is one of the many operating criteria, regulations, administrative decisions, etc. that make up the body of documents that are commonly referred to as the Law of the River. Where appropriate, the specific or relevant element of the document is referenced in the EIS. The reader can view summaries and copies of many of these documents at the following website address: http://www.usbr.gov/lc/region/pao/lawofrvr.html

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APR-30-2007 17:11 COG ECON DEVELOPMEN P.01/03

GLENDALE AZ

Environmental Resources Department

Fax Cover Sheet

DATE:	Monday, April 30, 2007
TO:	**Regional Director** **U.S. Bureau of Reclamation, Lower Colorado Region**
FAX #:	**(702) 293-8156**
FROM:	Stephen Rot, Environmental Program Manager
SUBJECT:	**City of Glendale, Arizona Comments regarding the Draft Environmental Impact Statement for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead**
PAGES:	**3 (including cover)**

City of Glendale
Environmental Resources Department
5850 W. Glendale Avenue
Glendale, AZ. 85301
TEL: (623) 930-2580
FAX: (623) 931-5730

L-12

APR-30-2007 17:11 COG ECON DEVELOPMEN P.02/03

GLENDALE AZ

April 30, 2007

Regional Director
Attn: BCOO-1000
Lower Colorado Region
US Bureau of Reclamation
PO Box 61470
Boulder City, NV 89006

Via Fax (702) 293-8156 and Regular Mail

Re: Draft Environmental Impact Statement for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Dear Regional Director:

The City of Glendale (City) appreciates the opportunity to provide the following comments on, the Draft Environmental Impact Statement for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (DEIS). As a member of the Arizona Municipal Water Users Association (AMWUA), the City endorses and supports the comments submitted by AMWUA regarding the DEIS. Additionally, the City supports the comments submitted by the Arizona Department of Water Resources on behalf of the State of Arizona.

The City of Glendale provides water service to over 244,000 people, and relies significantly upon Colorado River water supplies, delivered via the Central Arizona Project (CAP) to meet its water demand. The City's CAP water supplies include subcontracts for Municipal and Industrial priority water, leases for Indian priority water, and some non-Indian agricultural priority CAP water. Together these Colorado River supplies provide over 36% of the City's annual water demand. Because of its reliance upon CAP water supplies of differing priority, the City must effectively consider its exposure during a declared Colorado River shortage. As such, and in light of the fact that the CAP is the largest junior priority user under the Law of the River, the City is very interested in the outcome of the shortage criteria and coordinated reservoir operations process.

The junior priority of the CAP results in an increased risk to Arizona water users when a shortage declaration is made. It is imperative that the selection and implementation of a preferred alternative fully consider and minimize those risks. The selection and implementation strategies of a preferred alternative should also consider existing statutory authority and the Law of the River. The Basin States Alternative represents a unique collaboration effort on the part of each of the seven Colorado River Basin States, and is the only alternative that meets these criteria. Therefore, the City supports the selection of the Basin States Alternative as the preferred alternative in the final 1

City of Glendale
Municipal Complex • 5850 West Glendale Avenue • Glendale, Arizona 85301-2599 • Phone (623) 930-2000
www.ci.glendale.az.us

L-12

environmental impact statement, and implementation of the Basin States Alternative through the record of decision.

Additionally, the City of Glendale is concerned that the DEIS does not fully consider the
economic impacts of a Lower Basin shortage on municipal water providers in Central 2
Arizona. The DEIS incorrectly presumes that there will be no economic impacts on CAP
water users, and effectively penalizes those users for their advanced planning efforts and 3
activities. The City of Glendale has expended significant sums of money in developing a diverse water resources portfolio; implementing and maintaining a strong water conservation program; designing and constructing integrated infrastructure systems to efficiently utilize those diverse supplies; underground storage and recovery systems; and reuse of reclaimed water. In spite of the City's advance planning efforts, and the City's integrated drought management plan, there will be additional economic impacts associated with Colorado River supply shortages. Complete analysis of these impacts should be incorporated into the final environmental impact statement.

Economic considerations in the DEIS are further exaggerated by the fact that the DEIS
only analyzes impacts relating to shortages in a single year. Cumulative shortage impact 4
analyses should be incorporated into the final environmental impact statement.

Again, the City of Glendale appreciates the opportunity to provide comments on the DEIS.

Sincerely,

Stephen Rot
Environmental Program Manager-Water Resources

Cc: Herb Guenther, Director, Arizona Department of Water Resources

L-12

TOTAL P.03

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Reponses to Comment Letter L-12

L-12-1

Your comment is noted. No change to the Final EIS was necessary.

L-12-2 and L-12-3

See response to Comment No. G-1-25.

L-12-4

See response to Comment No. L-1-11.

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May 01 2007 11:22AM TOWN OF GILBERT PW 4805036401 p.1

GILBERT
ARIZONA

April 30, 2007

Via Facsimile 702-293-8156, 2 Pages

Regional Director
Lower Colorado Region
US Bureau of Reclamation
Attn: BCOO-1000
PO Box 61470
Boulder City, NV 89006

RE: Comments Regarding the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement (DEIS)

Dear Regional Director:

The Town of Gilbert, Arizona appreciates the opportunity to comment on the DEIS, and hereby submits its comments. Gilbert understands that the Arizona Department of Water Resources and the Arizona Municipal Water Users Association (AMWUA), of which Gilbert is a member, will also be providing comments on this issue and Gilbert supports those comments.

Gilbert has been the fastest growing city of over 100,000 people for the last several years, with a current population reaching 200,000, who rely on Gilbert to provide safe, reliable drinking water supplies. The Colorado River and Central Arizona Project (CAP) water supplies are key components of the Town's long-term water resources. Twenty-five percent of Gilbert's water supply is comprised of various types of Colorado River and Central Arizona Project water.

Gilbert has expended significant monies to manage our water resources, including development of redundant groundwater supplies, the policy of utilizing 100% of our reclaimed water through reuse and recharge, and the adoption of a Water Shortage Management Plan. The preferred alternative that is selected for implementation by the Bureau is of critical interest to the Town of Gilbert.

Town of Gilbert | Public Works
525 North Lindsay Road, Gilbert, AZ 85234 Phone: 480 503-6400 Fax: 480 503-6404 www.ci.gilbert.az.us

L-13

May 01 2007 11:22AM TOWN OF GILBERT PW 4805036401 p.2

Gilbert Supports the Basin States Alternative as the Preferred Alternative

Gilbert supports selection of the Basin States Alternative as the preferred alternative in the final environmental impact statement, which will provide Gilbert with the certainty of the continuation of its CAP and Colorado River supplies. Gilbert also supports implementation of the Basin States Alternative through the final Record of Decision (ROD). This alternative is a compromise acceptable to each of the seven Colorado River Basin States. In selecting the preferred alternative and finalizing the ROD, the Secretary of the Interior should recognize the value of this unique compromise. 1 2 3

Furthermore, the Basin States Alternative does not require any additional statutory authorization and is the only alternative that can be implemented immediately after the Secretary issues the final ROD. Implementation of the other alternatives, particularly the Conservation Before Shortage and the Reservoir Storage Alternatives, would require substantive changes to the Law of the River. 4 5

Gilbert urges the Secretary to choose the Basin States Alternative as the preferred alternative in the Final EIS. We also urge the Secretary to adopt a ROD that includes the guidelines and criteria necessary to implement the Basin States Alternative in a manner consistent with the carefully negotiated compromise agreements developed among the seven basin states. 6

We appreciate the opportunity to comment on the DEIS.

Sincerely,

[signature]

Lonnie Frost
Public Works Director

cc: Herb Guenther, Director, Arizona Department of Water Resources

L-13
2

Reponses to Comment Letter L-13

L-13-1 through L-13-3

Your comment is noted. No change to the Final EIS was necessary.

L-13-4 through L-13-5

See response to Comment No. G-1-4.

L-13-6

Your comment is noted. No change to the Final EIS was necessary.

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CITY OF MESA
Great People, Quality Service!
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Resources Division

April 30, 2007

Regional Director
Lower Colorado Region
Bureau of Reclamation, Attention BCOO-1000
P.O. Box 61470
Boulder City, NV 89006-1470

Re: Notice of Availability and Notice of Public Hearings for the Draft Environmental Impact ("EIS") Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.

Dear Regional Director,

The City of Mesa ("Mesa") submits its comments to the Draft EIS for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (72 Fed. Reg. 9026, February 28, 2007).

Mesa is the third-largest city in Arizona. Mesa receives electricity from the Colorado River system that it in turn delivers to approximately 15,000 power customers and receives water from the system that it delivers to over 450,000 water customers. Mesa currently makes beneficial use of nearly 55,000 acre-feet of water per year from the Central Arizona Project ("CAP"), and ultimately expects to use at least 80,000 acre-feet per year of CAP water, including water that is of Municipal & Industrial, Indian, and Non-Indian Agricultural priority. Because of this, and because the CAP is the junior diverter in the lower basin, the strategies for shortage criteria and coordinated operations for Lake Powell and Lake Mead currently being developed are of critical importance to our citizens. The prospect of shortage on the Colorado River system already impacts our citizens because Mesa expends enormous resources to mitigate the impacts of future shortages. 1 When actual shortage comes, the impacts will be even greater and the costs will be even higher. 2

L-14

640 North Mesa Drive
P.O. Box 1466
Mesa Arizona 85211-1466
480.644.3306 Tel
480.644.2426 Fax

For Mesa's proactive planning to be meaningful and productive, there must be some
reasonable degree of certainty regarding the manner in which shortages will be 3
determined and managed. Of those analyzed, the Basin States' alternative provides Mesa
with the greatest degree of certainty.

Some of the alternatives listed seem to penalize Mesa by assuming that Mesa can bear a
greater burden of Colorado River shortage precisely because it has taken a proactive
approach towards mitigation of shortages through efforts to diversify its water resources 4
portfolio. The Secretary should please remember that all resources used to protect against
shortages are a cost to citizens every bit as burdensome as resources expended after 5
shortage has been declared. Moreover these costs are cumulative over very long periods
of time.

Mesa has maintained active interest and involvement in the federal government's efforts
to finalize criteria for the declaration and management of shortage on the Colorado River.
Mesa provided previous comments to the U.S. Bureau of Reclamation during the scoping
process and participated in the Arizona stakeholder group to work collaboratively on 6
development of shortage criteria that both manage and minimize the impacts of shortage.

The Basin States' alternative is the result of a coordinated effort between all seven 7
Colorado River Basin States. Mesa urges the Secretary to adopt the Basin States' Proposal
as the preferred alternative in the final environmental impact statement and to implement 8
the Basin States' alternative through the final Record of Decision.

Sincerely

Kathryn Sorensen
Water Resources Coordinator

c: Herb Guenther, Director, Arizona Department of Water Resources

L-14

Reponses to Comment Letter L-14

L-14-1 through L-14-3

Your comments are noted. No change to the Final EIS was necessary.

L-14-4 and L-14-5

See responses to Comment No. G-1-25 and L-1-11.

L-14-6

Your comment is noted. No change to the Final EIS was necessary.

L-14-7 and L-14-8

Your comments are noted. No change to the Final EIS was necessary.

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San Diego County Water Authority
4677 Overland Avenue • San Diego, California 92123-1233
(858) 522-6600 FAX (858) 522-6568 www.sdcwa.org

April 30, 2007

Regional Director, Lower Colorado River Region
Bureau of Reclamation
Attention: BCOO-1000, P.O. Box 61470
Boulder City, NV 89006-1470

Re: Comments on *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

Dear Regional Director:

This letter provides comments on the *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* (72 Fed. Reg. 9,026) (Feb. 28, 2007) (DEIS). The San
Diego County Water Authority recommends selection of the Basin States' Alternative 1
described in the DEIS as the preferred alternative in the Final Environmental Impact Statement and as the selected action in the Record of Decision.

The Water Authority is highly dependent upon Colorado River water supplies, with the river historically providing most of the region's total water supply. The importance of Colorado River to the Water Authority further increased with the execution of the Quantification Settlement Agreement in 2003, which included the Water Authority's water transfer with the Imperial Irrigation District and the lining of the All American and Coachella canals. These projects will supply about 30 percent of the Water Authority's total water supply by 2020.

The Basin States Alternative resolves a number of outstanding problems of river
management, described in the DEIR, by using a consensus-based set of operating 2
guidelines and agreements among the seven Colorado River Basin states. The
agreements are necessary to ensure that plans for storing and delivering drought-year 3
supplies can be implemented, and for resolving differences among the states regarding
the allocation of supplies in a shortage year. As a result, the implementation of the
sought-after guidelines can be accomplished in a relatively expeditious manner. This is 4
important in light of the severe ongoing drought being experienced throughout the
Colorado River Basin.

L-15

A public agency providing a safe and reliable water supply to the San Diego region

1

Regional Director, Bureau of Reclamation
Page 2
April 30, 2007

The Water Authority participated in the formulation of draft agreements that would
provide for the creation and release of Intentionally Created Surplus (ICS). We urge 5
Reclamation to include this program as part of its preferred alternative. The Water
Authority is the recipient of mainstream water from our water transfer agreement with the 6
Imperial Irrigation District and from the All American and Coachella canal lining
projects. Transfer water under our agreement with IID is created by extraordinary
conservation and by fallowing. Delivery of conserved mainstream water to the Water
Authority is accomplished under contract with the Secretary of the Interior pursuant to
the Colorado River Water Delivery Agreement of October 10, 2003.

As the holder of a contract with the Secretary for delivery of mainstream water, and as
the holder of conserved water that is eligible for designation as Intentionally Created 7
Surplus, the Water Authority qualifies, under the Guidelines proposed by the seven
Colorado River Basin states, to participate in the ICS program. However, we understand
there may be interpretations of the Draft EIS that would question the Water Authority's
ability to participate in the ICS Program. It is critical that the Final EIS and Record of
Decision provide certainty that the Water Authority is fully eligible to participate in the 8
Program. We look forward to working with Reclamation to determine the structure under
which the Water Authority will participate in the ICS Program.

The Basin States' Alternative meets the Secretary of Interior's goals for addressing
limited water availability during times of low reservoir conditions and substantially 9
improves the predictability of water supplies. The Water Authority urges you to select
the Basin States' Alternative as the preferred alternative in the Final Environmental
Impact Statement and the selected action in the Record of Decision.

Sincerely,

Maureen A. Stapleton
General Manager

L-15

Reponses to Comment Letter L-15

L-15-1

Your comment is noted. No change to the Final EIS was necessary.

L-15-2 through L-15-4

Your comments are noted. No change to the Final EIS was necessary.

L-15-5

See response to Comment No. L-3-7.

L-15-6

Your comment is noted.

L-15-7 and L-15-8

See response to Comment No. L-3-7.

L-15-9

Your comment is noted. No change to the Final EIS was necessary.

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April 30, 2007

Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City, NV 89006-1470

VIA EMAIL: strategies@lc.usbr.gov

The Arizona Power Authority ("Authority") is a body, corporate and politic, of the State of Arizona established by Arizona Revised Statutes (A.R.S. 30-101 et seq.) on May 27, 1944, for the purpose, among others, of receiving the State of Arizona's share of hydroelectric power generated at Hoover Dam and Powerplant. The Authority appreciates this opportunity to provide comments on the Bureau of Reclamation's (Reclamation) draft environmental impact statement on the *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* (DEIS) (72FedReg. 9026-9028, February 28, 2007). In the event there is an extension of the comment period, or amendments to the DEIS, the Authority may supplement these comments at an appropriate later date.

Hoover power is the Authority's only source of power, therefore, it has vital interest in the disposition of the waters of the Colorado River, especially the flow of the river south of Lee's Ferry into the Lower Colorado River Basin. The Boulder Canyon Project Act of 1928 (43 U.S.C. 617 et Seq.) and all related laws amendatory or supplemental thereto, provide very specific instructions from the Unites States Congress to the Secretary of the Interior and onto the Bureau of Reclamation with respect to the operation of Hoover Dam, the management of the Colorado River into Lake Mead and the disposition of the Colorado River through and below Hoover Dam and its powerplant and the hydroelectric power produced therefrom.

The proposal for Reclamation or the Secretary of the Interior to assess an additional "surcharge" to the cost of hydroelectric power produced at Glen Canyon Dam and Hoover Dam powerplants is beyond the authority of either the Secretary or the Commissioner of Reclamation. The assessment of the Lower Colorado River Basin Development Fund (LCRBDF) charge was 1

L-16

specifically authorized by the Congress in the passage of the 1984 Hoover Power Plant Act.

Furthermore, the Secretary of Energy does not even have the authority to assess such a surcharge proposed in the DEIS as this falls outside DOE's legislative authority to set power rates for "cost of service" for generation and transmission of federal hydropower. 2

L-16

The proposed surcharge is not associated with the "cost of service" of generating federal hydropower at the afore mentioned dams and powerplants anymore than the LCRBDF charge is associated with the "cost of service" of Hoover, Davis or Parker Dams and their respective powerplants. Hence, the need for specific authorization in the 1984 Act. 3 4

The Authority supports the consensus process being undertaken by the Basin States in the development of the Basin States(BS) alternative. Further, the Authority also supports the comments and filed by the Colorado River Energy Distributors Association (CREDA) as filed on April 25, 2007 via EMAIL. 5 6

Thank you for the opportunity to comment on this DEIS.

Sincerely,

/s/ Joseph W. Mulholland

Joseph W. Mulholland
Executive Director
Arizona Power Authority
1810 West Adams Street
Phoenix, AZ 85007-697
(602) 542-4263

A710#719/comments LRC Draft EIS

L-16

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Reponses to Comment Letter L-16

L-16-1 through L-16-4

See response to Comment No. G-1-7.

L-16-5

Your comment is noted. No change to the Final EIS was necessary.

L-16-6

Your comment is noted. No change to the Final EIS was necessary.

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04/30/2007 MON 12:35 FAX 623 869 2332 Central Arizona Project 001/005

CAP
CENTRAL ARIZONA PROJECT

FAX COVER

P.O. Box 43020 • Phoenix, AZ 85080-3020
23636 N 7th Street • Phoenix, AZ 85024
Phone: 623-869-2333 • www.cap-az.com

Date: 4/30/07

To: Regional Director
Lower Colorado River Region
Bureau of Reclamation

Company:

Phone:

Fax: 702-293-8156

From: David S. Wilson

Phone: 623-869-2333

You should receive 5 page(s) including this cover sheet.

Comments:

If you do not receive all the pages or have problems with this transmission, please call: Sue @ 623-869-2378

L-17

CAP CENTRAL ARIZONA PROJECT

P.O. Box 43020 • Phoenix, AZ 85080-3020
23636 N. 7th Street • Phoenix, AZ 85024
623-869-2333 • www.cap-az.com

April 30, 2007

Via U.S. Mail and Facsimile at 702-293-8156

Regional Director
Lower Colorado Region
Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City, Nevada 89006-1470

Dear Regional Director:

The Central Arizona Water Conservation District (CAWCD) submits the following comments on the Bureau of Reclamation's February 2007 Draft Environmental Impact Statement on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (DEIS). CAWCD also endorses the comments on the DEIS submitted by the Arizona Department of Water Resources and the seven Basin States. 1

Support for Basin States Alternative

CAWCD supports adoption of the Basin States alternative as the preferred alternative. 2 The Basin States alternative is the only alternative that can be implemented under the existing Law of the River with the cooperation of the seven Basin States. 3

Under the Basin States Proposal, Arizona has agreed to take shortages during the interim period when Lake Mead reaches certain trigger elevations, even though water is still available in storage at those elevations to satisfy Arizona's full entitlement. 4 The significance of that concession by Arizona to accommodate a seven Basin States agreement cannot be overstated. 5 To prepare for those shortages, Arizona has already spent more than $100 million to store water and will spend hundreds of millions more for additional storage and future recovery. 6

No Action Alternative is Improper Both as a Baseline and for Future Operations

Each of the alternatives modeled in the DEIS assumes that Reclamation will return to the rules of the No Action alternative after 2026. But the rules of the No Action alternative are flawed and inconsistent with the Law of the River. 7

The No Action alternative employs an 80P1050 strategy, which would prevent Lake Mead from declining below elevation 1050 with an 80 percent probability. This operating strategy would

L-17

require Reclamation to declare shortages in the lower basin—more specifically, shortages to Arizona and Nevada—even when there was more than enough water in storage in Lake Mead to satisfy all lower basin entitlements. As shown in Figure 2.2-1 of the DEIS, the 80P1050 rule would dictate a shortage declaration in 2060 when Lake Mead was above 1150' msl and holding more than 16.5 million acre-feet in storage. There is no legal or rational basis for such action. 8

The operating rules of the No Action alternative also provide absolute protection for Southern Nevada Water Authority's lower intake at elevation 1000 in Lake Mead. The DEIS ignores the fact that SNWA will have lowered its intake to below elevation 895 by around 2012, making absolute protection of elevation 1000 both unnecessary and improper. 9

The No Action alternative also uses the Interim 602(a) Storage Guideline adopted by the Secretary in 2004 for use through 2016. As explained more fully in Arizona's November 28, 2005 scoping comments (copy attached to Arizona's comments on the DEIS), the current guideline does not properly implement the requirements of section 602(a) of the Colorado River Basin Project Act of 1968. 10

<u>Forbearance Required for Delivery of Conserved Water</u>

Both the Conservation Before Shortage (CBS) alternative and the Reservoir Storage alternative include provisions for the storage and delivery of conserved water, similar to that proposed under the Basin States alternative. But when the delivery of conserved water would result in a total consumptive use in excess of 7.5 million acre-feet in the three lower basin states, the excess must be apportioned among the lower basin states in accordance with Article II(B)(2) of the Consolidated Decree in *Arizona v. California*. The only way in which the Secretary can deviate from the requirement of the Consolidated Decree is if the States agree to forbear the delivery of such excess water. 11 The Basin States Proposal includes a draft forbearance agreement for that purpose. But the States have not agreed to forbear for purposes of the CBS or Reservoir Storage alternatives. Therefore, the provisions for storage and delivery of conserved water under those two alternatives cannot be implemented. 12

<u>Water Supply Alternative</u>

We note that adoption of the Water Supply alternative would result in no anticipated shortages to Arizona during the interim period. Accordingly, that alternative would appear to best satisfy Reclamation's contractual obligation to Central Arizona Project subcontractors. Each of the more than 60 subcontracts for delivery of CAP water for municipal and industrial and agricultural uses that Reclamation has entered into provides that, in determining the amount of Colorado River water available for delivery through the CAP each year, Reclamation "shall use [its] best efforts to maximize the availability and delivery of Arizona's full entitlement of Colorado River water over the term of this subcontract." Those subcontract commitments limit whatever discretion the Secretary might otherwise have in allocating shortages in the Lower Basin. 13

L-17

Regional Director, Lower Colorado Region
Bureau of Reclamation
April 30, 2007
Page 3

While the shortage guidelines of the Water Supply alternative are appealing to CAP water users, we recognize that this alternative does not have the support of the Basin States. Accordingly, CAWCD supports the Basin States Proposal, which reflects the many compromises that have been made by the seven states. 13

DEIS Mischaracterizes CAWCD's Water Delivery Contract

Table E-1 of the DEIS indicates that CAWCD is only entitled to the delivery of 1.49 million acre-feet as Arizona 4th priority water, and that the remainder of the CAP supply holds a "Bank" priority that is below Arizona 5th priority. That is incorrect. 14

CAWCD's master repayment and water delivery contract allows it to take all that remains of Arizona's 2.8 million acre-foot entitlement after Arizona's 1st through 3rd priority uses have been satisfied, sharing up to 164,652 acre-feet of that supply with other Arizona 4th priority water users. In general, the Arizona Water Banking Authority (AWBA) may not store Colorado River water that would otherwise have been used in Arizona by a Colorado River contractor. A.R.S. §45-2427(B). Because of that state statute, certain Arizona 5th priority water users have been allowed to take delivery of Colorado River water ahead of the AWBA. That does not give those users priority over CAWCD, and CAWCD may deliver its entire contract entitlement as Arizona 4th priority water. 15

This mischaracterization of CAWCD's priority distorts the results of the DEIS shortage allocation model. The model allocates the first increment of Arizona shortage solely to the CAP supply in excess of 1.49 million acre-feet, then apportions the remaining 4th priority water among all 4th priority water users, including CAP. The net effect is to overstate the total shortage to the CAP supply.

DEIS Improperly Allocates Shortages

In the Arizona-Nevada Shortage Sharing Agreement included as part of the Basin States Proposal, Arizona and Nevada have agreed to share specified shortages to the Lower Basin States. The DEIS should reflect the terms of that agreement in describing and modeling the Basin States alternative. 16

For any alternative other than the Basin States alternative, the Secretary would have to develop his own guidelines to address the issue of California's priority and the method of allocating shortages in accordance with the Law of the River. The shortage guidelines assumed in the DEIS do not comport with the law. 17

Article II(B)(3) of the Consolidated Decree in *Arizona v. California* requires that, in time of shortage, present perfected rights (PPRs) are to be satisfied first, in order of priority and without regard to state lines, and then the remaining available supply is to be apportioned after consultation with major Colorado River contractors and the Lower Basin States. Section 301(b) of the Colorado River Basin Project Act, 43 U.S.C. §1521(b), directs that pre-1968 contractors and federal reservations in all three Lower Basin States are to be satisfied after PPRs, with the remaining supply apportioned among CAP and other post-1968 uses. Thus, the Secretary is 18

L-17

Regional Director, Lower Colorado Region
Bureau of Reclamation
April 30, 2007
Page 4

required by the Law of the River to use a "bottom up" approach when allocating shortages within the Lower Basin, satisfying first PPRs, next pre-1968 uses, and finally CAP and other post-1968 uses.

Rather than follow the "bottom up" allocation method prescribed by law, the DEIS assumed a "top down" methodology under which the first step was to reduce consumptive uses in Arizona and Nevada. The effect of that approach is to overstate shortages to Arizona and CAP. 18

The DEIS also assumes that all consumptive uses in California are entitled to priority over Arizona's fourth priority users, including the CAP. But the priority granted to California in 43 U.S.C. §1521(b) applies only to water users in that state served under delivery contracts entered into before September 30, 1968, and by diversion works already constructed as of that date. 19

Conclusion

The Basin States alternative offers distinct advantages over every other alternative. First, it sets forth shortage guidelines that can be implemented by agreement among the Lower Basin States, thereby avoiding potential disputes over the meaning and application of the Consolidated Decree and the Colorado River Basin Project Act. 20 Second, it describes a program for the coordinated operation of Lake Powell and Lake Mead that all seven Basin States have agreed to accept for the interim period, postponing potential litigation over the Colorado River Compact and Long Range Operating Criteria. 21 Finally, it provides for the storage of conserved water in the Lower Basin and the forbearance necessary to allow delivery of that stored water to the storing entity. For these reasons, CAWCD urges the Secretary to adopt the Basin States alternative. 22

Sincerely,

David S. "Sid" Wilson, Jr.
General Manager

:smu
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901.06
c: Herb Guenther, Arizona Department of Water Resources

L-17

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Reponses to Comment Letter L-17

L-17-1

Your comment is noted. No change to the Final EIS was necessary.

L-17-2 through L-17-6

Your comments are noted. No change to the Final EIS was necessary.

L-17-7 and L-17-8

Your comment is noted. As noted in Section 2.2 of the EIS, the modeling assumptions used for the No Action Alternative are consistent with assumptions used in previous environmental compliance documents for the ISG, the Colorado River Water Delivery Agreement, and the LCR MSCP. The assumptions used in the No Action Alternative are not intended to limit or predetermine the action decision in any future AOP determination.

L-17-9

See response to Comment No. G-1-31.

L-17-10

Your response is noted. No change to the Final EIS was necessary.

L-17-11 and L-17-12

See response to Comment No. L-3-7.

L-17-13

Your comment is noted. No change to the Final EIS was necessary.

L-17-14 through L-17-15

Reclamation concurs with these comments. Appendices E and G of the Final EIS have been updated to reflect that the Arizona Water Bank in the CAP is co-equal to fourth priority.

L-17-16

See response to Comment No. G-1-4.

L-17-17 through L-17-19

In accordance with the Consolidated Decree, the CRBPA, and other key provisions of the Law of the River, the Secretary has the authority to declare and allocate shortages to the Lower Division states. Although some guidance exists with regard to how shortages would be allocated, e.g., PPR deliveries must be met without regard to state lines; there are no specific guidelines in place to further inform the Secretary's decision with respect to how shortages might be shared by the water users in the Lower Division states. Modeling assumptions with respect to the distribution of shortages to the Lower Division states and Mexico were necessary in order to analyze potential impacts to hydrologic and other environmental resources.

L-17-20 through L-17-22

Your comments are noted. No change to the Final EIS was necessary.

1

CITY OF TUCSON

TUCSON WATER DEPARTMENT

April 30, 2007

Honorable Dirk Kempthorne
Secretary of the United States Department of the Interior
1849 C. Street, NW
Washington, D.C. 20240

Re: City of Tucson, Arizona Water Department Comments Regarding the *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

Dear Mr. Secretary:

The City of Tucson, Arizona Water Department (Tucson Water) submits the following comments to the *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement* (February 2007).

Tucson is located in the northern semi-arid reaches of the Sonoran Desert. Tucson Water, a municipally-owned and operated utility, is the largest water provider in southeastern Arizona, serving about 700,000 customers over a 300 square-mile service area. In addition, Tucson Water has the largest municipal and industrial (M&I) allocation of Colorado River water in the state of Arizona, with delivery via the Central Arizona Project (CAP). Tucson Water is the only water provider in southern Arizona currently delivering Colorado River water to its customers, with almost half of annual customer demand met through use of this renewable resource. The Utility has both construction projects and financial mechanisms in place to rapidly increase the percentage of Colorado River water used to meet demand over the next several years.

The City of Tucson is keenly interested in the selection of a preferred alternative for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead. Of the 7.5 million acre-feet of Colorado River allocation available to the lower basin states of California, Arizona, and Nevada, Arizona's 1.5 million acre-foot CAP water supply has the most junior priority. Tucson's location at the very end of the 336-mile CAP canal introduces an additional level of vulnerability when discussing potential Colorado River shortages, especially since Tucson has no other access to renewable drinking water supplies. 1

L-18

TUCSON WATER
DIRECTOR'S OFFICE • P.O. BOX 27210 • TUCSON, AZ 85726-7210
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<u>The Proposed Alternatives</u>

There have historically been significant differences among the seven Colorado River Basin states concerning important elements of the Law of the River. Hydrological conditions on the River require that the Secretary, in consultation with the Basin states, adopt shortage guidelines. The process for adoption of such guidelines could have resulted in each of the Basin states asserting its legal positions - with extended litigation and years of uncertainty for Colorado River water users. The seven states chose, instead,
to seek agreement on shortage guidelines and guidelines for the management of Lakes 2
Mead and Powell for an interim period of nineteen years and to reserve their legal positions for later resolution if necessary.

<u>The Basin States Alternative</u>

Reclamation should Adopt the Basin States Alternative as the Preferred Alternative. 3
The Basin States Alternative provides the greatest degree of certainty for Tucson Water
because it is the compromise alternative developed by the Governor's Representatives of 4
the seven Colorado River Basin States and can be implemented upon approval of the Record of Decision ("ROD") without the need for additional action.

The Basin States Alternative is the only alternative that meets all the criteria discussed in 5
Section 1.1 of the Draft EIS that states, "[T]he Secretary intends to consider, adopt and implement the proposed federal action consistent with applicable federal law and judicial decisions, and, further, in a manner that will not require any additional statutory authorization." (DEIS at p. 1-1). This alternative also best meets the goals of the 6
proposed action discussed in the February 28, 2007 Federal Register Notice, i.e., "[T]his action is proposed in order to provide a greater degree of certainty to U. S. Colorado River water users and managers of the Colorado River Basin by providing detailed and objective guidelines for the operations of Lake Powell and Lake Mead, thereby allowing water managers and water users in the Lower Basin to know when, and by how much, water deliveries will be reduced in drought or other low reservoir conditions." (72 Fed. Reg. 9027 dated February 28, 2007.)

In addition, the certainty provided by the Basin States Alternative goes well beyond the actual criteria and numbers. The Agreement reached by the Basin States, as reflected in the Basin States Alternative, creates an increased level of confidence that legal issues
over the interpretation and implementation of the Colorado River Compact, the Mexican 7
Treaty, accounting under the Arizona v. California Decree, and equalization of Lake Mead and Lake Powell will not result in costly and divisive litigation with an uncertain outcome for water users. The value of collaboration by the Basin States cannot be overstated.

Further, the Basin States Alternative provides flexibility within the system and a mechanism for maximizing the efficiency of the system by allowing for the intentional
creation of surplus ("ICS") in Lake Mead by a Lower Colorado River mainstem 8
contractor and release of that surplus for use within the state that created it, with the
forbearance of the other Lower Division States. The State of Arizona recently enacted 9
legislation that allows the State to forbear ICS water if the Secretary "adopts substantially the same concepts as contained in the proposal of the seven basin states for shortage

L-18

guidelines and conjunctive management of lakes Mead and Powell," clearing the way, at least from Arizona's perspective, for ICS to be implemented if that alternative is memorialized in the ROD.

Certainty for water users and the ability of the Basin States Alternative to be immediately implemented is also enhanced by the fact that the Lower Colorado River Multi-Species Conservation Plan ("MSCP") provides compliance with the Endangered Species Act 10 ("ESA") for this alternative because the MSCP analyzed reductions of flow that exceed the reductions proposed in the Basin States Alternative. Additional ESA consultation that may be required under other alternatives raises uncertainties regarding the 11 implementation schedule for those alternatives.

The Basin States Alternative is the only alternative that allows for the extension and modification of the existing Interim Surplus Guidelines ("ISG") without the need for 12 further action. The package submitted to the Secretary by the Seven Basin States on February 3, 2006 includes provisions to amend the ISG by agreement of all the States and the Basin States Alternative adopts those amendments.

The No Action and Water Supply Alternatives

The No Action and Water Supply Alternatives analyze a broad range of environmental 13 impacts but do not meet the goals of the proposed action. Both alternatives fail to provide certainty for the timing and extent of shortages in the Lower Basin and fail to propose 14 viable criteria for the coordinated management of Lake Powell and Lake Mead. These two alternatives do not allow for the creation or use of ICS thus limiting flexibility in the 15 operation of the system and creating greater risk and uncertainty regarding shortages for water users in the Lower Basin.

The Water Supply Alternative reflects the traditional strategy for managing reservoir systems in the West, wherein shortages are declared only when water is physically unavailable for delivery. The DEIS also projects no likely shortages to Arizona during the 16 interim period under this alternative. However, there would be less water retained in storage in Lake Powell under this alternative and it lacks consensus Basin States' support.

The analyses of the No Action and Water Supply alternatives are important because they expand the range of analyzed impacts. However, neither alternative includes negotiated criteria for the coordinated operation of Lake Powell and Lake Mead or specific 17 guidelines for the implementation of future water supply reductions in the Lower Colorado River Basin under defined shortage conditions.

The Reservoir Storage Alternative

The Reservoir Storage Alternative ("RSA") proposes levels of shortages starting at 600,000 AF and increasing to 1,200,000 AF and the magnitude of the average shortage volumes during the interim period are the highest under this alternative. (DEIS at p. ES-10). The RSA does not meet the goal stated in the Federal Register Notice, i.e., "to (1) 18 Improve Reclamation's management of the Colorado River by considering the trade-offs between the *frequency and magnitude* of reductions of water deliveries…" (72 Fed. Reg.

L-18

9027 dated February 28, 2007. emphasis added). Furthermore, this alternative would 19
require changes to the Law of the River prior to its implementation.

The Reservoir Storage Alternative serves a valuable purpose by allowing analysis of a
broad range of impacts in the EIS, but it contains provisions that impound water for
power generation and recreation to the detriment of downstream agricultural and 20
domestic uses. This is prohibited by Article IV (b) of the Colorado River Compact
(Compact) which clearly states that "Subject to the provisions of this compact, water of
the Colorado River System may be impounded and used for the generation of electrical 21
power, but such impounding and use shall be subservient to the use and consumption of
such water for agricultural and domestic purposes and shall not interfere with or prevent
use for such dominant purposes."

The Conservation Before Shortage Alternative

The Conservation Before Shortage Alternative ("CBS") also falls short of meeting the 22
certainty provisions of the proposed action. With the CBS alternative, "shortages are
implemented in any given year to keep Lake Mead above SNWA's lower intake at
elevation 1000' (absolute protect of elevation 1,000)." Water users in the Lower Basin
will be left to the whims of the Annual Operating Plan for determining when and how 23
much of a shortage will be declared under this alternative. This greatly reduces certainty
for water users like Tucson Water.

This alternative essentially would allow 4.2 million AF of ICS in Lake Mead compared
to a maximum ICS of 2.1 million AF under the Basin States Alternative. Creating ICS of
this magnitude could create too much risk for losing expensive ICS water to spills in wet 24
years and earmark too much Lake Mead water for a particular water use, rather than for
the system.

Two additional drawbacks of the CBS alternative are: (1) no funding mechanism for 25
creation of ICS currently exists; and (2) including ICS by the Republic of Mexico could
necessitate amending the 1944 Treaty to allow for the creation and delivery of ICS water
to Mexico. Reclamation recognizes the limitations of the CBS alternative by stating, 26
"[T]he viability of the Conservation Before Shortage program funding proposal is not
known at this time. Reclamation currently does not have authority to implement all
facets of this proposal and additional legislation would be necessary to gain such 27
authority." (Draft EIS at p. 2).

Summary

In comparison of the proposed alternatives, it is evident that the Basin States Proposal is
superior to any of the other alternatives because it provides the greatest degree of 28
certainty to water users, avoids potential litigation, creates shortage criteria that are
reasonable in magnitude and are readily predictable based upon elevations at Lake Mead,
and presents a package that can be implemented without the need for further legislation
or ESA compliance. Furthermore, the Basin States Alternative best meets all the aspects
of the purpose and need for the action and has the support of the Basin States, which will
enhance the Secretary's ability to manage the Colorado River system in a collaborative 29
manner.

L-18

Tucson Water urges the Secretary to adopt the Basin States Proposal as the preferred alternative in the Final EIS.

Conjunctive Operation of Lake Mead and Lake Powell

The Basin States Alternative creates the ability to more effectively balance the contents
of Lake Mead and Lake Powell in a way that better controls large fluctuations in 30
reservoir elevations during extended periods of low inflow into the system. That
alternative also removes potential issues over the methodology for equalizing the 31
contents of Lake Mead and Lake Powell under other proposed alternatives.

Currently, equalization is largely governed by the Interim 602(a) Storage Guideline for
Management of the Colorado River, which contains a 14.85 million acre-feet storage
requirement. That guideline artificially limits equalization and has a detrimental effect 32
on storage in Lake Mead and thus on Tucson Water. While the current guideline was
also part of a package agreed to by the Seven Basin States as part of the ISG process, it
essentially provides for greater protection for power production at Lake Powell than is
otherwise authorized under the Law of the River. The Basin States Alternative replaces
this equalization requirement in favor of a strategy that is not as onerous for Tucson 33
Water.

If the Basin States Alternative is adopted and implemented in the guidelines set out in the
ROD, at the end of the interim period in 2026 or if the guidelines are changed, whichever
comes first, Reclamation must consult on the guidelines to assure that they are consistent
with the legal priorities established by the Law of the River. For these reasons and 34
because the coordinated operations of Lake Powell and Lake Mead are essential
components to shortage criteria, the Secretary should adopt the Basin States Alternative.

The Record of Decision and Implementation of the Preferred Alternative

Tucson Water supports the Basin States Alternative as the preferred alternative and
recommends that it be incorporated into the Record of Decision ("ROD"). Tucson Water
believes that the Secretary should work with the Basin States to create specific
implementation criteria and guidelines consistent with the adoption of the Basin States
Alternative as the preferred alternative. That document will serve as a road map that can
then be relied upon to better manage our water supplies and to better prepare for
shortages. To effectuate those guidelines and criteria so that the certainty outlined in the
proposed action is achieved, Tucson Water urges the Secretary to include a statement in
the ROD that "during the effective period of the guidelines the Secretary shall utilize the
established process for development of the Annual Operating Plan for the Colorado River 35
System Reservoirs (AOP) and shall use those guidelines to make determinations
regarding normal, surplus and shortage conditions for the operation of Lake Mead and for
the coordinated management of Lake Mead and Lake Powell."

Cumulative Impacts of Shortages in Arizona

The DEIS has only attempted to analyze the socio-economic impacts for shortages in a 36
single year. Analysis by the State of Arizona indicates a high probability that multi-year

shortages will occur. The socio-economic impacts of multi-year shortages should be analyzed and incorporated into the Final EIS for all of the alternatives. 36

Socioeconomic Impacts to Municipal Water Users in Arizona

The DEIS does not adequately analyze and describe the impacts to municipal water users in Arizona. The DEIS states, "Implementing statewide and local demand-side and supply-side strategies are expected to minimize adverse socioeconomic effects occurring during the maximum M&I shortage." This statement accurately reflects the strategies Tucson Water has historically used, and continues to use, for determining its long-term need for water supplies including supplies to help offset shortages. Likewise, demand restrictions are also part of the Utility's plan for dealing with actual shortages. Tucson Water's goal is to minimize the impacts on its citizens and on its economy. However, neither demand-side strategies nor supply-side strategies and actions come without a substantial price. 37 38

Arizona municipal water providers have already expended substantial sums of money in anticipation of shortages on the Colorado River. Municipal water users in Arizona, including Tucson Water, will rely in part on recovery of water stored underground by the Arizona Water Banking Authority to make up for shortfalls due to Colorado River shortages. Through calendar year 2006, the Arizona Water Banking Authority ("Bank") has stored about 2,243,000 AF of water at a cost of about $101 million. Funding for the Bank comes primarily from a property tax in Maricopa, Pinal and Pima Counties, from a pump tax paid by groundwater users in those counties and from some appropriations by the Arizona Legislature.

The DEIS does not analyze quantitatively, or even qualitatively, the costs associated with shortages. This is a glaring omission in the DEIS. The socioeconomic impacts on municipal water users in Arizona due to Colorado River shortages are significant and should be documented in the Final EIS. 39

Conclusion

Tucson Water reiterates that the Basin States Alternative is the only alternative that meets all the criteria defined in the proposed action for the EIS. Tucson Water urges that the Final EIS adopt the Basin States Alternative as the preferred alternative and that a Record of Decision be signed incorporating the terms of the Basin States Alternative.

Sincerely,

David V. Modeer
Director

DVM:kc

cc: Robert W. Johnson, Commissioner, U. S. Bureau of Reclamation
Rick Gold, Regional Director, U. S. Bureau of Reclamation, Upper Colorado Regional Office
Jayne Harkins, Acting Regional Dir., U. S. BOR, Lower Colorado Regional Office
Larry Walkoviak, Deputy Regional Dir., U.S. BOR, Lower Colorado Regional Office

L-18

Reponses to Comment Letter L-18

L-18-1 through l-18-6

Your comments are noted. See also response to Comment No. G-1-4.

L-18-7

Your comment is noted.

L-18-8 and L-18-9

See response to Comment No. L-3-7.

L-18-10 and L-18-11

See response to Comment No. L-2-8.

L-18-12

The Basin States, Conservation Before Shortage, and Water Supply alternatives and the Preferred Alternative all consider the extension of ISG.

L-18-13 through L-18-17

Your comments are noted.

L-18-18 through L-18-21

Your comments are noted. Also see response to Comment No. G-1-4.

L-18-22 and L-18-23

Your comments are noted. No change to the Final EIS was necessary.

L-18-24

See responses to Comment Nos. G-5-93.

L-18-25 through L-18-27

See response to Comment Nos. G-1-7 and F-5-2.

L-18-28 and L-18-29

Your comment is noted. No change to the Final EIS was necessary.

L-18-30 through L-18-34

Your comments are noted. No change to the Final EIS was necessary.

L-18-35

See response to Comment No. L-2-31.

L-18-36

See response to Comment No. L-1-11.

L-18-37 through L-18-39

See response to Comment No. G-1-25.

April 20, 2007

Technical comments on river operations DEIS from the Imperial Irrigation District

Preliminary comments

1. It is unclear as to whether the DEIS identifies any "significant" environmental effects from the proposed alternatives in accordance with the terminology used in NEPA. It would be helpful for Reclamation to summarize in the final EIS the environmental conclusions in terms of NEPA terminology, including any significant environmental effects and what mitigation requirements might be recommended beyond what will be covered by the MSCP program. 1

2. In addition to the specific comments set forth below, a general comment is that the overall socioeconomic impact analysis in the DEIS is insufficient. For example, for involuntary shortages it is assumed that the impact, with some resulting land fallowing, will occur within the CAP service area. However, as shortages become more significant in volume (up to 2.5 maf in the DEIS), and as CAP M&I and Indian uses are reduced to zero, it is likely that substitute water supplies for central Arizona urban areas will have to be obtained from higher priority agricultural sources along the Colorado river within Arizona. But the DEIS does not analyze the socioeconomic or other impacts of the land fallowing that will likely occur in those locations. Another example is the assumption that in involuntary shortage situations farmers will fallow lands with the least profitable crops (pages 4-463 and 4-465), which is unsupportable given actual experience (for example, with IID's QSA fallowing program). The realistic potential impacts from large scale fallowing, both under involuntary shortages or voluntary shortages, should be thoroughly and realistically presented in the final EIS. 2

Chapter 1

1. Page 1-7 – at the bottom of table 1.5-1 it is suggested that impacts to water rights are *not* addressed in this DEIS because Reclamation determined that water rights were not going to be impacted or were otherwise not "potentially significant." However, as explained below, in section 2.2.1 on pages 2-5 and 2-6 and in section 4.2.7.1 on pages 4-9 and 4-10 it is explained that Reclamation has assumed that in a Stage 2 shortage, reaching down into the 1929 to 1968 pool of rights, California will take 65% of the shortage. This is an incorrect assumption under the law of the river and does not reflect the most important attribute of lower basin water entitlements – and that is priority. If the Stage 2 shortage is imposed in accordance with Reclamation's assumption there will be a significant impact on water rights within California and that impact should be explained in the DEIS if this assumption is retained. 3 Alternatively, since table 1.5-1 is inaccurate it should be modified in the final EIS to better reflect the governing law. 4

2. Page 1-15, lines 20-21 – it is stated that the lower basin state apportionments were
established in the BCPA. In *Arizona v. California* the Supreme Court said: "Congress
intended the Secretary of the Interior, through his section 5 contracts, both to carry out
the allocation of the waters of the main Colorado River among the Lower Basin States
and to decide which users within each state would get water." (373 US at 580). And: "We
have agreed with the Master that the Secretary's contracts with Arizona for 2,800,000 5
acre-feet of water and with Nevada for 300,000, together with the limitation of California
to 4,400,000 acre-feet, effect a valid apportionment of the first 7,500,000 acre-feet of the
mainstream water in the Lower Basin." (373 US at 592) These quotes demonstrate that it
was not the BCPA that effectuated an apportionment of the Lower Basin entitlement
but it was instead the Secretary's contracts with Arizona, Nevada, and with users within
California, and the California Limitation Act, that resulted in the Lower Basin
apportionment.

3. Page 1-22, lines 4-6 – the statement made here infers that California is currently taking
actions to reduce its use of water in excess of 4.4 maf. This is an inaccurate statement,
and the same mistake is made on page 1-25 and in chapter 3 at page 3-36. Reclamation is
aware of the fact that as of January 1, 2003 California's Colorado River water use has
been limited to 4.4 maf/yr, and that has been the situation since 2003. Accordingly, it is
inaccurate to suggest that California needs to implement programs to assist "in reducing 6
its projected Colorado River depletion to its normal apportionment of 4.4 maf." (page 3-
36) Under the California Plan and other documents, such as the QSA agreements,
California is presently engaged in the process of *shifting* some water use within its 4.4
maf apportionment from agriculture to M&I *for a period of years*. Accordingly, it is
inaccurate to suggest that there is a need to "facilitate California's reduction of its use of
Colorado River water." (pages 1-25) There is currently no action underway for California
to *reduce* its use of Colorado River water.

<u>Chapter 2</u>

1. Page 2-4, lines 34-36 – it is stated that determination of deliveries to Mexico in times
of shortage "is not a part of the federal action." (And this statement is repeated elsewhere
in the DEIS) However, one aspect of this Secretarial action is to give the Lower Basin
users *certainty* as to what will happen in times of shortage declarations. That certainty
cannot be achieved without an understanding of the shortage cutbacks to be imposed on 7
Mexico in times of declared shortages. It is unhelpful to suggest that this determination
cannot be made because it involves the decision-making of the State Department. The
Department of the Interior should coordinate with the State Department *prior to the
issuance of the final EIS and the ROD* so as to include the State Department's Mexico
shortage determination in the final federal administrative action.

2. Pages 2-5 and 2-6 – this section explains the function of a Stage 2 shortage declaration
that would provide for water supply cutbacks into the 1929 to 1968 pool of rights. In this 8
section it is explained that in a Stage 2 shortage California can expect to take 60 to 65%
of the Stage 2 shortage cutback. This assumption reflects an inaccurate view of the law of

the river and should be corrected. As Reclamation understands, all of the contracts for the
major water users within California were executed in the early 1930's. Those contract
dates give the California users *priority* over users in other states with contracts dated in 8
the 1940's, 1950's, and 1960's. In other words, the assumption used by Reclamation to
arrive at the 60 to 65% California reduction ignores one of the most important attributes
of a water entitlement, and that is priority. This assumption should be changed in the final
EIS to more accurately reflect the governing law.

3. Pages 2-11, Section 2.4 – IID is on record in asserting that the conservation before
shortage alternative is without merit and should not be given further consideration in this 9
NEPA process (See letter to Robert Johnson dated November 30, 2005; and attached
appendix). IID also points out that on page 2-13 on line 27 it says that legislation would
be necessary, but on page 1-1 at the very beginning of the DEIS Reclamation states that it 10
intends to adopt an alternative that "will not require any additional statutory
authorization."

Chapter 3

1. Page 3-3, lines 17-24 – this section states that only limited water service areas within
the three states are included in the discussions of potential environmental impacts.
However, in chapters 2 and 4 it is provided that in relation to Stage 2 shortages, for the 11
1929 to 1968 pool of rights, California is assigned 65% of the shortage cutbacks. If
California is to take that kind of impact it is possible that other water service areas within
California could be impacted beyond the water service area of MWD. Also, in the context
of the conservation before shortage alternative many different water service areas might 12
be impacted, in terms of air quality, socioeconomic impacts, and other impacts.

2. Page 3-24, lines 12-15 – the statement regarding the average annual flow of the Bill 13
Williams River in Arizona does not make sense given the flow volumes cited.

3. Page 3-33, lines 6-7 – the allocations of water in the Lower Basin include Present
Perfected Rights. In the 1964 decree from the Supreme Court in *Arizona v. California* the
Court provided that: "Perfected rights means a water right acquired in accordance with
state law, which right has been exercised by the actual diversion of a specific quantity of 14
water that has been applied to a defined area of land or to definite municipal or industrial
works ….." Accordingly, any reference to the underpinnings of the entitlements held by
users in the Lower Basin should refer to the state law appropriation process.

4. Page 3-40, line 8 – IID's entitlement to Colorado River water has been capped at 3.1
maf *for a period of years* under the QSA agreements. IID's entitlement is not 3.0 maf/yr. 15

5. Page 3-40, Table 3.4-5 and lines 20-23 – first, it is inaccurate to say "upon 25,000" 16
acres for the Yuma Project in California. That entitlement is for "up to 25,000 acres" and 17
there is a current dispute about the actual number of acres appropriately included in the
Yuma Project on the California side. Second, there should be a footnote to this table 18

3 L-19

reflecting that there is an agreement between IID and the Coachella Valley Water District that subordinates the CVWD entitlement to the IID entitlement. This is also a problem in Table E-2 on page E-5 in Appendix E. Third, the discussion at the bottom of the page, and continuing on to page 3-41, should be modified to reflect the QSA agreements as opposed to the California 4.4 Plan. The rights of PPR holders relative to the Seven Party Agreement priorities, during the period of the QSA, is addressed in the QSA and related agreements. 18 19

6. Page 3-127, lines 9-16 – this paragraph appears to be inaccurate and misleading to the reader. The topic here is socioeconomics and land uses, but this paragraph suggests that the impacts are minimal or non-existent. It also suggests that the potential actions would not have any impact on prime or unique farmlands, which is likely to be inaccurate. First, this explanation should cover *two areas* of impact as opposed to one: 1) the consequences of formal shortage declarations; and 2) the consequences of the conservation before shortage alternative. In both situations there will be large scale land fallowing, over a period of years, with significant socioeconomic consequences. Indeed, those consequences are discussed in section 4.14 starting on page 4-261. Most importantly, the conservation before shortage alternative proposes a maximum fallowing plan of sufficient size to create 600,000 acre feet of water. This would require a likely fallowing of about 100,000 acres of land or more – which would result in major consequences, such as air quality impacts and socioeconomic impacts. The potential realistic impacts of shortage declarations and alternatives like conservation before shortages should not be minimized or ignored in the final EIS. 20

<u>Chapter 4</u>

1. Page 4-10, lines 5-10 and Table 4.2-2 – as noted above in point number 2 under Chapter 2, this discussion and Table 4.2-2 do not reflect the law of the river and do not reflect the most important attribute of Western water rights – which is priority. Accordingly, the assumptions use in this section for the Stage 2 shortages are inaccurate and should be modified in the final EIS. In order to determine the potential impact of a Stage 2 shortage Reclamation should use the *priority dates* of the contracts in the 1929 to 1968 pool of rights. 21

2. Page 4-11, footnote 1 to Table 4.2-2 – this footnote is not sufficient to cover the full range of assumptions used for Table 4.2-2. As noted above, Reclamation has utilized major assumptions regarding the 1929 to 1968 pool of rights that have nothing to do with the Mexican water treaty. 22

3. Page 4-125, lines 1-19 – the discussion in this section regarding the operation of Stage 1 shortages and no impact within California is a correct reflection of the law and should be retained in the final EIS. 23

4. Page 4-129, lines 34-36 and Table 4.4-16 – the statement in lines 34-36 does not seem correct in light of other information in the DEIS. For example, on page 4-125, Table 4.4- 24

4 L-19

16 it is stated that California could face a maximum shortage of 474,468 if the shortage
magnitude is 2.5 maf. Also, on page 4-127 it states that Nevada could face a maximum
shortage of 84,290 af under the same conditions. Also, Table 4.4-16 seems inconsistent 24
with Table 4.4-17 on page 4-126. On page 4-125 the maximum shortage to California is
474,468 af, and on page 4-126 the maximum shortage to California is 511,784 af.

5. Page 4-149, section 4.6 – this section does not reflect one of the most important
potential air quality impacts, and that is the massive land fallowing that is likely to occur
under *both* declared shortages and under the conservation before shortage alternative. 25
Although it is clear that certain types of water uses, such as within the CAP agricultural
area, may continue to be under agricultural production because of the availability of
stored water or pumped groundwater, as the involuntary shortages go deeper it is likely
that large areas of land within Arizona will need to be fallowed. On another front, the
conservation before shortage alternative suggests a maximum of 600,000 af to be created
through land fallowing. This could mean more than 100,000 acres of fallowed land – in
both Arizona and California. The potential air quality impacts resulting from that amount
of fallowed land cannot be ignored in the final EIS, and it is insufficient to suggest that
Reclamation cannot predict which lands in California or Arizona will be fallowed under
either proposed program. In light of the volume of land fallowing that may result from
both actions, it is imperative for Reclamation to make some reasonable assessment of the
likely air quality impacts from such actions.

6. Page 4-161, section 4.8.1.2 – this section addresses the MSCP but does not provide
enough detail for the reader to understand the nature and scope of the MSCP coverage 26
that will be relevant in relation to the preferred alternative and any impacts within the
river corridor. For example, this section does not explain that the MSCP coverage in the
corridor area includes both NEPA and ESA compliance. Also, this section does not
thoroughly explain the MSCP coverage for *both* lower basin shortage operations and
changes in points of diversion that would cover other actions, such as the ICS
mechanism, and potential impacts within the river corridor area.

7. Page 4-233, lines 21-27 – the discussion in this section does not make sense, especially
in the second sentence. First, the figure of 122,500 af of water does not make sense. For 27
the reader to understand the impact of the 600,000 af voluntary shortage the reader
should be told how much land might have to be fallowed and at what cost. Second, the
suggestion of $20 to $100 per acre foot is too low, and this assertion is supported by the 28
comments on the conservation before shortage proposal submitted by IID on November
30, 2005 (including the supplemental economic analysis by Rod Smith).

8. Page 4-270, lines 6-8 – the statement here is that: "No permanent change in land uses
would occur under any of the alternatives because shortages would be of a temporary
nature and agricultural lands would likely not be permanently removed from production." 29
This is a very cursory analysis of fallowing and the potential impacts from land fallowing
compared to the QSA Transfer Project EIR/EIS and the SSRP PEIR. The DEIS does not
mention the potential impacts of repeated temporary fallowing on the productivity of 30
agricultural lands and does not address a parcel's designation as prime farmland pursuant

to state statutes. It is also not clear whether only short-term fallowing would result from 30
both the conservation before shortage alternative and the ICS mechanism and in addition 31
who would be responsible for assessing such impacts.

9. Page 4-275, lines 10-18 – this section addresses the conservation before shortage alternative in the context of socioeconomic impacts. It is stated: "This analysis assumes that the voluntary conservation targets ……… would be met, assuming that farmers would participate voluntarily in the program and that losses resulting from voluntary shortages would be offset by payments made to farmers to forgo raising crops." This statement is confusing and the point to be made is not clear. If the assertion is that the 32
socioeconomic impacts of this alternative can be offset by payments to farmers that assertion is likely to be inaccurate. The socioeconomic impacts of fallowing enough land to create 400,000, 500,000, or 600,000 af of water under this alternative will be enormous and will manifest in the form of lost labor income, impacts on farm suppliers, and other negative economic impacts on nearby farm communities. Payments made to farmers to create the conserved water, by taking productive land out of production, will have no direct impact on the costs necessary to mitigate third party impacts. Such necessary costs will be *in addition* to the payments made to farmers to fallow the land. This should be corrected in the final EIS by demonstrating the significant socioeconomic impact that will result from the extreme land fallowing proposed under the conservation before shortage alternative, and the true costs associated with that alternative.

Appendix D

1. Page D-11, Table D-2a – there are several problems with this table. First, the numbers used for IID and CVWD do not match the Water Delivery Agreement. It is unclear why the numbers are inaccurate, but it may be related to the AAC project water conservation 33
schedule. Second, it should be noted that in 2048 IID no longer transfers 50kaf to CVWD. This change has not been reflected in the table.

Appendix E

1. Page E-5, Table E-2 – there are a number of problems in this table. First, the California priority system is well established and easily understood through reference to the 1931 Seven Party Agreement. Because of the clear priority designations in that agreement, it would be best to use the priority designations in the Seven Party Agreement as opposed to creating a new structure that is then confusing to the reader. For example, in Table E-2 the 5th priority is more properly designated priority 5 (a) to parallel the Seven Party Agreement. Similarly, the 6th priority in Table E-2 should be designated priority 5 (b). 34
Finally, the 7th priority in Table E-2 should be broken down into priority 6 (a) for IID and Coachella, and priority 6(b) for PVID. Second, the number used for the IID right in the 4th priority is not explained via footnote or otherwise. It is not clear to the reader why the IID entitlement in priority 4 in Table E-2 is quantified at 561,159 af. It has been clarified in judicial proceedings that IID's entitlement is 3.85 maf minus priorities one (PVID) and

two (Yuma Project). Third, the same problem applies to the notations for MWD and SDCWA under IID in the 4th priority. It is not at all clear why the number of 90,000 af is used for MWD and 30,000 af is used for SDCWA. Fourth, to the extent that there is intended to be included in Table E-2 any representation of the IID-SDCWA transfer, the priority date used should be IID's water delivery contract date of 1932. Fifth, under the listing of PPR's, under the 1st priority in Table E-2, the reference to the IID PPR is incorrect. IID's PPR applies only to lands *within the IID service area*. None of the lands within CVWD are included in the IID PPR. And finally, based on all that is said above, the footnote addressing IID's water rights (*) is incorrect in many respects and should be modified. IID recommends that the California agencies should present a revised Table E-2 to Reclamation for use in the final EIS. 34

Appendix M

1. Page M-5, sections M.3.1.1 and M.3.1.2 – Both of these sections state that it has been assumed that credits may be stored and delivered only during normal flow conditions. This is not a helpful assumption. ICS credits should be allowed to be stored and delivered during all conditions – normal, surplus, and shortage. First, it is obvious that stored ICS credits would likely be most useful to the developer of those credits during a shortage condition, so that benefit should be facilitated in the ROD. Second, even though the ICS rules are likely to state that no form of surplus water can be used to develop ICS credits, it should be recognized that during some surplus situations some entities might be allowed to take surplus water and others might not be allowed to take surplus water. For example, in a situation where MWD is taking special surplus water but IID is not, it would make sense to allow IID to develop ICS credits in that surplus condition year so as to obtain the general benefits of ICS development – for both IID and the system as a whole. 35

2. Page M-8, section M.3.2 – in this section Reclamation discusses the conservation before shortage alternative, but the reader is not given the benefit of an explanation of the *differences* between water developed for the conservation before shortage purpose and water developed for the purpose of creating ICS credits. Under the conservation before shortage alternative the main purpose is to create *storage* in Lake Mead, through compensated voluntary fallowing, that would then counteract the impact of an *anticipated* Lower Basin shortage declaration. The purpose of that water would be to be part of the storage in Lake Mead – so as to push off the shortage threat – as opposed to devoting that water to specific downstream uses (See page 2 of the conservation before shortage proposal in Appendix K – "Federal ICS credits created in excess of the federal cap [of 1.5 maf to be devoted to replacement of bypass flows] would become system water"). In contrast, the development of ICS credits by "others" is for the specific purpose of having water that can then be used for specific environmental or other purposes either within the United States or in Mexico. These concepts should not be confused in attempting to explain how the modeling was carried out to reflect these two *different* operational mechanisms. Stated differently, these concepts should be explained separately so that the 36

reader has a complete understanding of the actual function and impacts of these different operational mechanisms. 36

3. Page M-9, lines 5-6 – the concept of a delta pulse flow is a part of the development of ICS credits by "others" so that water sufficient for a pulse flow every five years can be developed on an annual basis and then used in the fifth year for the benefit of the environment. This section states that such pulse flows would be counted as a part of the treaty delivery to Mexico. This assumption seems to be in error. If it is assumed that the 250,000 af is developed over a period of years, and then is in storage in Lake Mead and is released after the fifth year of the development of that supply, there is no basis to assume that this water would be part of the Mexican treaty delivery in that year of release. In fact, the opposite is likely to be true – the pulse flow would be *in addition* to the treaty delivery because that 250,000 af would not have been created in the year of the release of the pulse flow and would not have any connection to the treaty delivery for that year. This assumption should be corrected in the final EIS. 37

Reponses to Comment Letter L-19

L-19-1

Your comment is noted. See also response to Comment No. L-2-8.

L-19-2

See response to Comment Nos. G-1-25, G-5-3, and L-1-11.

L-19-3

As noted in Section 3.4.2, the proposed federal action will not affect the apportionments and water rights of Colorado River water users. However, water deliveries to each Lower Division state and to users within each of the three Lower Division states may potentially be affected. These potential effects are analyzed and discussed in Section 4.4. See also response to Comment No. L-17-18.

L-19-4

Table 1.5-1 provides a list of the resource issues that were determined to be potentially significant and that were addressed in the EIS. The determination of the significance of the potential affected environmental resources and associated issues were identified through scoping and analyses of the environmental resources listed in this table. The determination on the potential impacts to water rights is addressed in the response to Comment No. L-19-3.

L-19-5

Information presented in the Draft EIS has been modified in the Final EIS (see Section 1.7.2.2) pursuant to this specific comment, as well as other public comments. Both the Boulder Canyon Project Act and the Section 5 Contracts establish the apportionments. Accordingly, the referenced line in Section 1.7.2.2 has been modified in the Final EIS to read as follows: “Lower Division state apportionments were established by Congress in the BCPA and by the Secretary's water delivery contracts under the BCPA."

L-19-6

Reclamation concurs with this comment. The referenced sections have been revised in the Final EIS.

L-19-7

Your comment is noted. Also see response to Comment No. F-5-2.

L-19-8

Your comment is noted. The modeling assumptions regarding the distribution of shortages (Section 2.2.1); particularly with respect to Stage II shortages were common to all alternatives and permitted a relative comparison of the alternatives.

L-19-9

Your comment is noted. No change to the Final EIS was necessary.

L-19-10

Your comment is noted. The Final EIS acknowledges that aspects of the Conservation Before Shortage Alternative could not be implemented without further legislative authority.

L-19-11

The information requested is provided in the Draft and Final EIS. The maximum observed reductions in water deliveries to the Lower Basin that was observed in the modeling of the alternatives was 2.97 maf and occurred in only one of the 100 modeled traces (one percent of the time) under the modeling of the Water Supply Alternative. All the other alternatives had maximum single-year water delivery reductions that were about 2.0 maf. Therefore, under almost all conditions, the California shortage is allocated to the Metropolitan Water District of Southern California.

L-19-12

See response to Comment No. G-5-3.

L-19-13

Reclamation concurs with this comment. The referenced paragraph in Section 3.3.6 that discusses the inflow from the Bill Williams River has been revised and updated to include the most current year records of flows from the Bill Williams River.

L-19-14

The referenced text in Section 3.4.2.1 only discusses the apportionments between the Lower Division states. All other references to priorities within each respective state are provided to inform the reader how water delivery reductions were distributed based on the modeling assumptions used in the analyses. These modeling assumptions are not intended to interpret specific provisions of the Law of the River or the state law appropriation process of any of the Colorado River Basin States.

L-19-15

Section 3.4.6.2 has been revised in the Final EIS to show an approximate 3.1 maf annual diversion by the Imperial Irrigation District.

L-19-16

Reclamation concurs with this comment. The referenced text in Section 3.4.6.2 has been revised to read under the Second Priority line, as follows – "Reclamation's Yuma Project for beneficial use on up to 25,000 acres."

L-19-17

Reclamation concurs with this comment. Appropriate modifications have been made to Table E-2 and the attachments to Appendix G.

L-19-18

Reclamation concurs with this comment. A footnote has been added to Table 3.4-5 in the Final EIS to reflect the referenced agreement between the Imperial Irrigation District and Coachella Valley Water District pursuant to the Quantification Settlement Agreement.

L-19-19

Reclamation concurs with this comment. The referenced text in Section 3.4.6.2 has been revised and the references to the California 4.4 Plan have been changed to the Quantification Settlement Agreement.

L-19-20

Chapter 4.14 of the Final EIS includes an expanded discussion on multi-year shortages and Appendix H-6 provides additional information on the impacts of voluntary fallowing. Also see response to Comment No. G-5-16.

L-19-21

See response to Comment No. L-17-18.

L-19-22

See response to Comment No. L-17-18.

L-19-23

Your comment is noted. No change to the Final EIS was required.

L-19-24

The distribution of shortages as discussed in Section 4.4 has been updated in the Final EIS to reflect the updated modeling of the alternatives.

L-19-25

Your comment is noted. No change to the Final EIS was necessary. A detailed analysis of potential air quality impacts associated with voluntary or involuntary land fallowing is note possible as it is unknown which specific lands would be affected. Such an analysis would require information associated with the lands that would be fallowed including specific locations, affected acreage, soils type, and prevailing wind data.

L-19-26

See response to Comment No. L-2-8.

L-19-27

See response to Comment No. G-5-37.

L-19-28

See response to Comment No. G-5-16.

L-19-29 through L-19-32

See responses to Comment Nos. G-1-25, G-5-3, and L-1-11.

L-19-33

For the modeling of the alternatives in the Draft and Final EIS, Reclamation used the future depletion schedules provided by the Basin States. The depletion projections for IID and CVWD provided as part of the California depletion schedules are generally consistent with the respective schedules outlined in Exhibit B of the Water Delivery Agreement (WDA) with a few exceptions. These exceptions or adjustments reflect modeling assumptions by Reclamation in the modeling of the alternatives for the EIS. These modeling assumptions enabled Reclamation to assess the potential effects to environmental resources of the proposed federal action.

L-19-34

Reclamation concurs with this comment. Table E-2 in Appendix E has been revised to reflect the provisions of the Seven Party Agreement and the contents of this table have also been coordinated with the quantified entitlements provided in the Quantification Settlement Agreement including references to the water transfers expressed in the Quantification Settlement Agreement.

L-19-35

See response to Comment No. L-3-7.

L-19-36

Chapter 2, Appendix A, and Appendix M describe the elements of the Conservation Before Shortage proposal that were included and modeled in the Conservation Before Shortage Alternative. Table M-5 in the Final EIS provides the storage and delivery of ICS credits assumed under the Conservation Before Shortage Alternative. This table provides a breakdown of the deliveries that were recommended by the proponents of the Conservation Before Shortage proposal which include; Delta Pulse Flows; Other Flows Below NIB, and Additional Environmental Uses. Section M.3.2 in Appendix M provides descriptions of these different flows.

L-19-37

Reclamation concurs with this comment. See response to Comment No. G-5-34.

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Comments Received At Public Meetings

This section contains oral comments received during the public meetings from the following:

PC-1 Sierra Club, Southwest Water Committee
PC-2 Living Rivers

RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Speaker Request Form

Please write clearly so that we do not misspell any personal details. Give the completed card to a project representative prior to the meeting's comment session.

4/5/07
Date

JIM WECHSLER
Name*

Address* ☐ ***Please check this box if you'd like your address withheld from publication***

2475 EMERSON AVE.
SALT Lake City, UT 84108

Sierra Club Southwest Waters Committee
Organization

(801) 583-2090
Telephone

***Mandatory Information**

PC-1

MR. FULP: June actually. I can almost guarantee there will be discussion. Yes.
MS. HOUSTON: Janice Houston, University of Utah. Just a quick question about water delivery. I see that on the slide. Was there any consideration taken into the modeling of water delivery with the potential project that the State of Utah is kicking around about building of the pipeline from Lake Powell to St. George?
MR. FULP: There was not any assumption made with regard to that. Now, what we would point out that we did take the, you know, essentially the depletion schedules that are in the model, and I think you're probably familiar with that, that the Upper Colorado River Commission has supplied. Those are constant through the alternatives and no additional assumptions were made.
Anyone else?
(BEGINNING OF COMMENT PORTION)
MR. WECHSLER: I'm Jim Wechsler, I'm with the Sierra Club Southwest Waters Committee, which is a Regional committee, and we were one of the environmental groups that submitted the conservation before shortage proposal which was originally submitted as a conservation before shortage and then later adapted to the basin states. And I haven't read the DEIS yet. I 1

0009

PC-1

have been practicing with the Manhattan telephone book, but I haven't read it yet. And so these comments are all taken from somebody else who glanced at Volume I and this managed to arrive in my E-mail this morning and I think it needs some clarification.

It's about how the conservation before shortage is represented in this DEIS. One thing that he noticed, and other people have said, is that the term voluntary shortage is quite common. We actually think that -- we didn't think anybody needs practice, and so we think voluntary conservation would probably be a better way to say it. Or as it said in one place, voluntary compensated reductions in water use. As Terry pointed out, compensation is a major feature. 2

And another comment is that the ICS intentionally created surplus under the conservation before shortage proposal, can be assigned to other entities, and they aren't specified. And the other entities that we would -- was in our mind and we thought in our proposal were U.S. agencies, non governmental organizations, Mexican agencies and water users. So for unassigned, read that. 3

And I'm not sure this is correct. But he said that the way he read it was that the federal funding for ICS appeared to be limited to flows that were bypassed to the wetlands of Mexico to the Senega to Santa Clara. 4

0010

PC-1

If it gives that impression, it's wrong, and I think 4
everybody agrees that would be wrong.
And finally, that the ICS has talked about,
relative to evaluation before shortage, suggests that
all of it is assigned to Mexico. One of the things that
the conservation before shortage proposal does is it's 5
saying why not add Mexico to the mix, not just the basin
states can create these, through extraordinary
conservation events, a intentionally created surplus,
but Mexico could as well. The reason for doing that is
one, it adds flexibility and two, it does go directly to
something we're interested in, which is the Delta area 6
New Mexico. And to give an example of how you could add
Mexico into that mix is, for example, southern Nevada is
looking for more water. Southern Nevada could fund a
project in Mexico that would conserve water. Some of 7
that water would presumably go to Mexico, and Mexico,
we've certainly had talks with them about the
possibility of using some of their, what amounts to
additional water. I mean, this could be lots of things.
But for example, taking the most, perhaps most
significant asset would be for southern Nevada to say 8
construct a desalinization plant for agricultural runoff
in Mexico, give some portion of that water back to
Mexico.

0011

PC-1

We would only be happy if we could convince Mexico in putting some of that to environmental uses in Mexico. The other portion would be stored in Lake Mead for southern Nevada's use. So, that that's a way for southern Nevada to gain more water out of the total system. That's one concept there, and that's why we added or suggested adding Mexico to the mix. 9
And those are just things I wanted to point out when you're reading this. Thanks.
MS. YODER: Thanks Jim.
MR. KANZER: I noticed on the list of areas where hard copies are available, none in western Colorado? I'm wondering whether the western area office could receive a copy? 10
MR. FULP: Absolutely.
MR. KANZER: Is this the full list, or what do you have to do to -- or maybe --
MR. FULP: We'll make sure they have it, we'll make sure they get a hard copy right away, that's an oversight.
(End of questions and comment session.)

0012

PC-1

STATE OF UTAH)

COUNTY OF SALT LAKE)

I, Linda J. Smurthwaite, Certified Shorthand Reporter, Registered Professional Reporter, and notary public within and for the county of Salt Lake, State of Utah do hereby certify:

That the foregoing proceedings were taken by me at the time and place set forth herein, and was taken down by me in shorthand and thereafter transcribed into typewriting under my direction and supervision.

That the foregoing pages contain a true and correct transcription of my said shorthand notes so taken.

In Witness Whereof, I have subscribed my name this 7th day of April, 2007.

LINDA J. SMURTHWAITE
CERTIFIED SHORTHAND REPORTER

0013

PC-1

Reponses to Comment Letter PC-1

PC-1-1

Your comment is noted. No change to the Final EIS was necessary.

PC-1-2

See response to Comment No. G-5-22.

PC-1-3

See responses to Comment Nos. G-5-21 through G-5-22.

PC-1-4 and PC-1-9

See response to Comment No. F-5-2 and F-5-5.

PC-1-10

The Draft EIS was electronically available at the Reclamation project website and CD's and hard copies were made available upon request. In addition, copies of the EIS were made available for public inspection at various libraries and Reclamation offices within the Upper and Lower Colorado Regions and in Southern California.

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RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Speaker Request Form

Please write clearly so that we do not misspell any personal details. Give the completed card to a project representative prior to the meeting's comment session.

4/4/07
Date

JOHN WEISHEIT (WHY-SIGHT)
Name*

PO BOX 466 MOAB UT 84532
Address* ☐ ***Please check this box if you'd like your address withheld from publication***

LIVING RIVERS
Organization

435-259-1063
Telephone

****Mandatory Information***

PC-2

Yes.

VAL DANOS: What's the nature of these meetings in California? Are they hearings or --

TERRY FULP: No, not at all. It's a request from an agency for information, so -- and so we'll -- we'll do that. We try to meet all the requests we get, so ...

They are not public hearings. They're just requests for either additional information or some dialogue in terms of explaining what the analysis is.

Okay. If that's the case, then we'll turn it back over to you, and ask you if anyone would like to make a public comment, please -- please do so.

NAN YODER: Okay. I have one.

Was anyone else going to be brave?

Okay. Well, then the spotlight is for John Weisheit. And if you would like to get up and give us your comment, we'd appreciate it.

JOHN WEISHEIT: My name is John Weisheit. I am the conservation director of Living Rivers. Our base is in Moab, Utah. I'm also a Colorado River Keeper, which has an affiliation of an international organization called the Water Keeper Alliance. As background, we submitted comments as an organization during scoping called the One Dam Solution, and it is a dam-decommissioning alternative to decommission Glen Canyon Dam. 1

The reason is to save water through the loss of evaporation because of its existence, to also reduce salinity in the Colorado River, and also to take care of the environmental problems that are being -- that are occurring in Grand Canyon National Park as the result of the operations of Glen Canyon Dam.

This alternative was not -- was rejected in this EIS. There is a -- a ban, congressional rider, against federal funds being used to study -- to decommissioning of Glen Canyon Dam, and that is why it was not considered as an alternative. 2

I did bring some copies of our document. It's outside the door on a chair on the right as you're leaving if you care to look at it. I have extra copies in my backpack, too, in case we run out.

These are my comments.

Models are only as valuable as the inputs they receive. While the sophistication and effort put into these projections are unprecedented and well-appreciated, the models' inputs, however, fail to provide the public the results necessary from which to make an informed decision as to merits of any of the proposed alternatives. 3

Garbage in, garbage out, as they say, but this garbage is so well masked that the people of the Colorado River Basin are being asked to put the rubber stamp on a

Katrina in the making. Those levees in New Orleans did not hold, nor will the assumptions painted on what otherwise is probably a very valuable model.

Scientists have been in agreement for decades that the Colorado River flows through the past century were among the wettest in 1200 years. Scientists are also in agreement that the Colorado River Basin in modern times has warmed upwards to two degrees during this period, and the trend is expected to continue, compromising streamflows upwards of 20 percent in the next 50 years. 4

We're now in the longest drought in recorded history. Things are changing all over the Basin, but not at the Bureau of Reclamation.

The results produced by their inflated inputs are based on historical streamflows that, while useful, in and of themselves must not alone be used to gauge future runoff.

Failing to account for a more long-term historical view of streamflow coupled with the climate change we are already experiencing is tremendously misleading to the public when developing shortage strategies. 5

Even under Reclamation's inflated scenario, this system is headed for an imbalance of water use, namely an oversupply of 400,000 acre-feet annually in the next 50 years. Corrected for a more accurate presentation -- representation of historical streamflow, this increases to 6

1.1 million-acre-feet. 6

But most importantly, we must begin to accept the reality of climate change. Anyone can notice how the reservoirs are dropping. A ten percent reduction on long-term flow estimates show an annual deficit right now of 1.1 million acre-feet rising to 2.8 million acre-feet by 2060.

Adjust this to 20 percent, as an increasing number of scientists are recommending, and we're looking at a 2.6 million -- million acre-feet deficit now, and nearly 4 million acre-feet in 50 years.

We're at ground zero tonight. Phoenix, Chandler, Tucson are not going to be protected by token changes in reservoir operations or even its ground-water banking Arizona is first in line for cuts, and there is no plan or how -- for how the state will survive if the rosy inputs put into this model evaporate away as Lakes Powell and Mead drop lower and lower.

The public is quite fortunate that the National Research Council has completed its recent Colorado River Report at this time. It reiterates the warnings that have yet found their way into the assumptions used by this model. 7 We certainly hope these changes in the final EIS will present a more realistic view of what the future may hold.

And the public would also benefit from a more

PUBLIC HEARING - 4/4/07

comprehensive presentation of what the real benefits are to these minimal dam operational changes it is being asked to support.

Chart 4.3, dash, 26 and 27 illustrate that a significant amount of water savings, at least in terms of increased levels for Lake Mead, occur not because of new operating plans that are the focus of these documents, but the results of anticipated but as yet mostly undetermined water-conservation activities. 8

It's already clear in looking at the plotted data represented from the 50th percentile the net volume of stored water in Lake Powell and Mead is greater under the No Action Alternative than what the Basin States -- States hope to implement. 9

Reclamation must present a comparable analysis of strictly the reservoir-operation component of the Basin States Alternative, not volumes of studies and charts based on undefined activities that may be exaggerating these limited benefits. 10

There is no question that the objective of this DEIS is critical or that valuable work has not gone into developing the model, but the public is anxiously awaiting some assurances that the water managers they rely on will develop a real strategy to guide us through what looks to be a very parched future ahead. 11

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PC-2

Unfortunately, Reclamation is still hoping history repeats itself and high flows will bail us out as demand continues to grow and temperatures continue to rise. But we're already at the end of what the river has historically provided. 11

There's no water left, and climate change is taking what their -- what's there back. It's time for Reclamation to admit this and get on with the real task ahead: Developing a solution for managing the system headed for failure. 12

Thank you.

NAN YODER: John, thank you for your comment.

Is there anyone else? No?

Okay. All right. So we'll remind you one more time that we're in our public-comment period. It closes April 30th. And we are more than welcome to hear from you tonight or also from here forward to fax or e-mail. And again, your input is valuable to our process. Thank you very much.

(Whereupon the presentation was concluded at 7:30 p.m.)

(Whereupon the public-comment session at this public meeting was concluded at 9:00 p.m.)

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

BE IT KNOWN that the foregoing Public Meeting was taken before me, RABIN´ MONROE, RMR, CRR, a Certified Reporter, No. 50653, in and for the County of Maricopa, State of Arizona; that the proceedings were taken down by me in machine shorthand and thereafter transcribed by computer-aided transcription under my supervision and direction; that the foregoing pages, numbered from 1 to 24, inclusive, constitute a true and accurate excerpt of all the proceedings had upon the taking of said public meeting, all done to the best of my skill and ability.

I FURTHER CERTIFY that I am in no way related to any of the parties hereto, nor am I in any way interested in the outcome hereof.

DATED in Phoenix, Arizona, this 20th day of April, 2007.

RABIN´ MONROE, RMR, CRR
CR #50653

Reponses to Comment Letter PC-2

PC-2-1 and PC-2-2

See response to Comment No. G-6-18.

PC-2-3 through PC-2-7

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

PC-2-8 through PC-2-10

The information requested is provided in the Draft and the Final EIS in Section 4.4.5.1. A sensitivity analysis for each of the action alternatives for total water deliveries to each state is displayed with and without the storage and delivery mechanism.

PC-2-11 through PC-2-12

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

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Comments Submitted By Special Interest Groups and Non-Governmental Organizations

This section contains comment letters submitted by the following special interest groups and non-governmental organizations:

- G-1 Arizona Municipal Water Users Association
- G-2 Santa Cruz Water & Power District's Association
- G-3 Western Business Council for New Energy Technologies
- G-4 Southern California Water Committee
- G-5 Defenders of Wildlife, Environmental Defense, National Wildlife Federation, Pacific Institute, Sierra Club, Sonoran Institute, Western Resources Advocates
- G-6 Glen Canyon Institute
- G-7 Irrigation and Electrical Districts Association of Arizona
- G-8 Living Rivers
- G-9 Colorado River Energy Distributors Association

arizona municipal water users association
4041 north central avenue • suite 900 • phoenix, arizona 85012 • phone • (602) 248-8482 • fax (602) 248-8423

April 30, 2007

Regional Director
Attn: BCOO-1000
Lower Colorado Region
U.S. Bureau of Reclamation
P.O. Box 61470
Boulder City, NV 89006

Dear Sir or Madame:

The Arizona Municipal Water Users Association (AMWUA) has reviewed the "Draft Environmental Impact Statement for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead" (DEIS). For the reasons set forth in these comments, AMWUA supports selection of the Basin States Alternative
as the preferred alternative in the final environmental impact statement and implementation of 1
the Basin States Alternative through the final record of decision. Additionally, AMWUA
endorses and supports the comments of the Arizona Department of Water Resources (ADWR) 2
submitted on behalf of the State of Arizona.

Interest of AMWUA

The AMWUA members--the Arizona Cities of Avondale, Chandler, Goodyear, Glendale, Mesa, Peoria, Phoenix, Scottsdale and Tempe, and the Town of Gilbert--collectively represent 3.29 million persons, or over 87% of the population of Maricopa County, Arizona. The AMWUA members have allocations for Central Arizona Project (CAP) Municipal and Industrial (M&I) priority water totaling 297,267 acre-feet, which is 46% of the total allocation of 638,823 acre-feet of CAP M&I priority water. The CAP is vital to the continuing economic growth and health of central Arizona in general and the AMWUA members in particular. Consequently, the AMWUA members have an especial concern regarding the frequency and magnitude of shortages for the lower Colorado River basin.

AMWUA Supports the Basin States Alternative as the Preferred Alternative

The Basin States Alternative, developed by the seven Colorado River Basin States, is a compromise alternative acceptable to each of these States. In selecting the preferred alternative
and finalizing the record of decision, the Secretary of the Interior (Secretary) should recognize 3
the value of this unique compromise. The Basin States Alternative does not require any
additional statutory authorization and it is the only alternative that can be implemented 4
immediately after the Secretary issues the final record of decision.

The DEIS indicates, and the Bureau's presentation at the public hearings held in early April
reiterated, that the Secretary's preferred alternative may be a hybrid of some or all of the
alternatives identified in the DEIS. AMWUA does not support a hybrid of the DEIS alternatives. 5
For example, a hybrid that prioritizes power generation over water supply is flawed or 6
unacceptable for the reasons explained below. A hybrid alternative that provides for the land
fallowing provisions of the Conservation Before Shortage Alternative is problematic from a
funding perspective since the DEIS does not indicate or analyze how a land fallowing program 7
described in the Conservation Before Shortage Alternative will be funded.

AMWUA Water Management Programs

The AMWUA members' location in the Sonoran Desert has historically required them to conservatively manage their water supplies. With enactment of the Arizona Groundwater Management Act of 1980 (GMA) and the GMA's restrictions on groundwater use, the AMWUA members initiated extensive and costly efforts to comprehensively:

a. Evaluate the amount and reliability of their individual sources of renewable supplies;

b. Augment their supplies; and,

c. Develop and implement demand management programs related to both ongoing water conservation and drought response.

For decades, the AMWUA members have been actively planning and preparing to address water
shortages. Indeed, the AMWUA members' water management plans are recognized nationally as
models of effective planning to conserve water and ease the negative impacts of drought on the
customers of municipal water systems. Adoption of the Basin States Alternative as the preferred
alternative in the final environmental impact statement will provide the certainty necessary for
the AMWUA members to continue the responsible planning necessary to address the adverse 8
impacts that could occur during Colorado River shortages.

Record of Decision Guidelines

AMWUA's members expect and need the final record of decision to clearly and unambiguously 9
set forth the guidelines that the Secretary will use to declare a shortage in the lower basin. The
record of decision should identify and adopt guidelines consistent with implementation of the 10
Basin States Alternative that the Secretary must follow in formulating each of the annual
operating plans through 2026 to:

a. Determine the conditions under which a shortage will be declared in the lower Colorado River basin;

b. Determine the amount of water which will be released from Lake Powell to the lower basin;

G-1

c. Determine how much of the shortage will be borne by each of the three lower basin States and Mexico; and,

d. Determine how much of the Arizona shortage will be borne by each of the Priority 4 water contractors located in Arizona pursuant to the Arizona recommendations identified below in the Lower Basin Shortage Sharing section of this letter.

The Basin States Alternative requires that the record of decision acknowledge that the lower basin States must agree to the terms and conditions for forbearing, if necessary, their rights to delivery of Colorado River water in order to allow for the development, storage and delivery of any Intentionally Created Surplus (ICS) as defined by the DEIS. AMWUA would object if the Secretary issued a unilateral authorization that allowed for the creation of an ICS. 11 12

Finally, the record of decision should state that the Secretary will consult with the seven basin States if the Secretary is considering declaring a shortage to the lower basin States exceeding 500,000 acre-feet. The goal of this consultation should be to minimize the impacts on the lower basin States in general, and on Arizona and the CAP in particular. 13

Lower Basin Shortage Sharing

As contemplated by the Basin States Alternative, Arizona and Nevada have finalized and executed a Shortage Sharing Agreement dated February 9, 2007. The preferred alternative and the record of decision must be consistent with this Shortage Sharing Agreement. 14

In 2004, ADWR established an intrastate process involving all interested and affected parties in Arizona to develop an Arizona position regarding shortage sharing between the CAP and the other Arizona Priority 4 Colorado River contractors located along the River. The Arizona position regarding intrastate shortage sharing is described in the "Director's Shortage Sharing Workgroup Recommendation, October 24, 2006, (Revised) Final" and it is AMWUA's understanding that the October 24, 2006 Recommendation has been transmitted to the Bureau by ADWR prior to the issuance of the DEIS, and that another copy is being transmitted by ADWR in their comments on the DEIS. The preferred alternative and the record of decision must also be consistent with this Recommendation. 15

Statutory Considerations

The Secretary should not adopt an alternative that prioritizes power generation ahead of water supply. Historically, and contrary to law, the Bureau's models of Colorado River operations, the results of which have been used to develop the annual operating plans, have "protected" the minimum power pool at Lake Powell. Operation of Lakes Powell and Mead for generation of electrical energy at the expense of water supply is inconsistent with the provisions of the Colorado River Compact of 1922, the Boulder Canyon Project Act of 1928 and the Colorado River Storage Project Act of 1956. This reason alone argues against selection of the Reservoir Storage Alternative as the preferred alternative. 16 17 18

G-1

Like the Reservoir Storage Alternative, the Conservation Before Shortage Alternative requires 19 statutory changes in order to be implemented. Creation of an ICS in Mexico would require a change in the 1944 water treaty between the United States and Mexico if the net effect is to 20 provide for the delivery of water to Mexico in excess of the United States' treaty obligation. Moreover, any water released as a result of land fallowing in Arizona is subject to diversion by the CAP absent any agreement to forbear by the State of Arizona and the Central Arizona Water 21 Conservation District (CAWCD).

The Yuma Desalting Plant

The DEIS analysis assumes that the Yuma Desalting Plant is not operating, thereby ignoring a 22 water source of almost 100,000 acre-feet that could minimize the impact of future shortages. AMWUA's November 30, 2005 letter to the Bureau during the scoping process stated that the DEIS should assume full operation of the Yuma Desalting Plant, yet the DEIS does not indicate 23 why the Bureau made the no operation assumption for the DEIS. Additionally, if there is an obligation to replace the bypass flows, then the final environmental impact statement should 24 describe the obligation and cite the relevant requirement(s) establishing the obligation.

Economic Impacts on CAP Municipal Water Users

The DEIS is woefully inadequate in its explanation of the economic effects that would result 25 from changes in deliveries of Colorado River water to municipal water users in Arizona. The DEIS all but dismisses these effects by concluding that "implementing statewide and local demand-side and supply-side strategies are expected to minimize adverse socioeconomic effects occurring during the maximum M&I shortage." (DEIS at p. 4-283)

As pointed out earlier, the AMWUA members have already taken aggressive and costly steps to address water shortages. Since enactment of the 1980 Groundwater Management Act, they have spent more than $33 million on water conservation programs that include ordinances governing landscaping, plumbing retrofit rebate programs, leak detection and control programs, grant programs, and water rate increases. Consequently, the opportunity to make up for shortages in 27 deliveries of CAP water through conservation programs is very limited.

Additionally, to ensure that adequate water supplies are available for their customers, the AMWUA members have also implemented comprehensive effluent reuse programs, adopted 26 development impact fees, and established extensive recharge programs. All of these programs come at considerable expense. For example, the Arizona Water Bank (AWB) is storing water underground to firm the basic CAP M&I priority allocation. According to its 2006 Plan of Operation, the Arizona Water Banking Authority (AWBA) will have spent over $62,000,0000 through 2006 to store water in Maricopa County. These funds are a combination of ad valorem taxes collected in Maricopa County, pump taxes collected in the Phoenix Active Management Area, and a modest contribution from the State's general fund.

AMWUA members also rely on CAP Indian priority and CAP Non-Indian Agricultural priority water for a portion of their renewable water supplies. The members have been storing water independently of the AWB to firm this portion of their CAP supplies.

G-1

The AWBA and the CAWCD have been working with local interests to develop a plan for recovery of the water stored by the AWB. When the recovery plan is developed and finalized, there will be additional costs incurred to recover the stored water. Moreover, the AMWUA members will incur significant costs to replace the shortfall in their CAP Indian and NIA priority supplies. 28 29

In summary, it is incorrect to assume that the socioeconomic impacts on the AMWUA members from changes in deliveries of CAP water can be minimized in any material way by demand-side and supply-side strategies. 30

Other Issues

1. The final environmental impact statement should recognize that the Southern Nevada Water Authority is planning on modifying its intakes at Lake Mead to provide the capability to withdraw water at an elevation of 856 feet starting in 2011. 31

2. The final environmental impact statement should note that while the guidelines that are the subject of the DEIS are considered interim and expire at the end of 2026, the impacts, especially the economic impacts, will carry over post-2026. 32

We appreciate the opportunity to comment on the DEIS. For the record, this letter is being transmitted via email with a paper original to follow.

Sincerely,

Steven L Olson

Steven L. Olson
Executive Director

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G-1

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Reponses to Comment Letter G-1

G-1-1

Your comment is noted. No change to the Final EIS was necessary.

G-1-2

Your comment is noted. No change to the Final EIS was necessary.

G-1-3

Your comment is noted. No change to the Final EIS was necessary.

G-1-4 through G-1-6

Your comment is noted. While Reclamation acknowledges that some of the elements considered in the action alternatives may require additional statutory authority to fully implement, we note that most do not and that they were all developed to address the purpose and need for the proposed federal action. Further, Reclamation notes that the Preferred Alternative can be implemented without additional statutory authority.

G-1-7

As noted in Section 2.4.5 of the EIS, the Conservation Before Shortage proposal postulated several potential funding sources which the Department currently does not have the authority to implement in their entirety absent additional legislation. As such, the viability of this funding proposal is not known at this time and therefore there is some uncertainty as to whether all of the elements of the Conservation Before Shortage proposal can be implemented.

G-1-8

Your comment is noted. The action alternatives, including the Basin States Alternative, all include a shortage guideline operational element that would specify when, and by how much, water deliveries will be reduced to water users in the Lower Basin during drought and low reservoir conditions thereby providing a greater degree of certainty to those water users and managers of the Colorado River Basin than continuing without the benefit of such guidelines.

G-1-9 through G-1-12

The information requested is provided in Appendix S of the Final EIS. Reclamation has developed draft operational guidelines that are included in Appendix S of the Final EIS. The guidelines are anticipated to be finalized and adopted through the Record of Decision for this action. Following publication of this Final EIS, additional and updated information regarding the content and development of guidelines is anticipated to be provided to the public through the dedicated project website, (http://www.usbr.gov/lc/region/programs/strategies.html).

G-1-13

Your comment is noted. The Basin States Alternative, the Preferred Alternative and the proposed draft operational guidelines (Appendix S)include a provision for undertaking appropriate consultation, including with the Basin States, to discuss further measures that may be undertaken when Lake Mead is below elevation 1,025 feet msl.

G-1-14

Your comment is noted. The modeling assumptions in Section 4.2.7.1 of the EIS are consistent with the Arizona and Nevada Shortage Sharing Agreement.

G-1-15

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment, as well as other public comments. As noted in Section G.4.6, the Shortage Allocation Model has been updated to reflect the Arizona Department of Water Resources Director's Shortage Sharing Workgroup recommendations.

G-1-16 through G-1-18

Your comments are noted. No change to the Final EIS was necessary.

G-1-19

See response to Comment No. G-1-4.

G-1-20

See response to Comment No. F-5-2.

G-1-21

Your comment is noted.

G-1-22 through G-1-24

See response to Comment No. F-4-9

G-1-25 through G-1-30

Your comments are noted. As described in Section 4.14.1.2 in the EIS, potential socioeconomic consequences of shortages occurring in the M&I sector were qualitatively assessed since it was not known to what degree a specific economic sector considered an M&I use would be affected. The effects on individual cities or communities are indeterminate for various reasons. Each city or community has a different mix of water supplies, and in most cases, have formulated a shortage or drought response plan that is specific to their respective community. Also, individual response plans typically include varying combinations of demand-side and supply-side actions and these differ by community.

Several Arizona communities noted in their respective comments that their communities have invested in actions to offset future shortages and are contemplating further as yet undefined investments. Additionally, they expressed the importance that preferred alternative adopt the Director's Shortage Sharing Workgroup Recommendation. The recommendation represents the culmination of an intrastate public effort that established the appropriate, manageable volume of shortages for Arizona and process for allocating shortages between the CAP and equivalent priority Arizona mainstream water users. As noted in Section 3.4.6.1 and Appendix G of the EIS, the modeling assumptions and analysis for the distribution of shortages within Arizona are consistent with that recommendation. The recommendation coupled with Arizona's existing statewide and local demand-side and supply-side strategies would minimize the impacts of shortages to the M&I sector.

G-1-31

Your comment is noted. As described in Section 5.2.2 and analyzed in Section 5.2.7 of the EIS, SNWA's proposed Intake No. 3 project is being constructed to ensure that SNWA can maintain full system capacity at lake levels as low as 1,000 feet msl. As such, the modeling assumptions with respect to SNWA's ability to pump from Lake Mead below an elevation of 1,000 feet msl are still appropriate.

G-1-32

The information requested is provided in Section 4.2.2. of the Final EIS.

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SANTA CRUZ WATER & POWER DISTRICTS ASSOCIATION

41630 W. Louis Johnson Dr., Maricopa, AZ 85239
Phone (520) 876-4982 • Fax (520) 424-3281

Central Arizona Irrigation and Drainage District
Maricopa-Stanfield Irrigation and Drainage District
Electrical District No. 3
Electrical District No. 4

Dan Thelander, President
Bryan Hartman, Vice-President
DeWitt Weddle, Vice-President
Mark Hamilton, Secretary/Treasurer
Grant R. Ward, General Manager
Paul R. Orme, General Counsel

April 27, 2007

Ms. Jayne Harkins, Acting Regional Director
U. S. Bureau of Reclamation
Lower Colorado Region
Attn.: BCOO-1000
P. O. Box 61470
Boulder City, NV 89006-1470

RE: Santa Cruz Water & Power Districts Association's Comments Regarding the Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead ("Draft EIS")

Dear Ms. Harkins:

The purpose of this letter is to provide comments on the above referenced Draft EIS. The Santa Cruz Water & Power Districts Association (SCWPDA) consists of two irrigation districts and two electrical districts, which combined represent over 200,000 acres, all located in Pinal County, Arizona. The two member irrigation districts (Maricopa-Stanfield Irrigation & Drainage District and Central Arizona Irrigation & Drainage District) are the largest Central Arizona Project ("CAP") agricultural excess water contractors, and together are allocated more than 50 percent of the 400,000 acre foot CAP Agricultural Pool.

SCWPDA's concerns about the Colorado River Interim Shortage Guidelines in general, and the Draft EIS in particular, stem from the vulnerable position of its member irrigation districts to Colorado River Lower Basin shortages. Given CAP's lower priority with respect to California, and agriculture's lower priority within the CAP, these shortage concerns are self-evident. For this reason, SCWPDA was an active participant in the Arizona Department of Water Resources Director's Shortage Sharing Workshop which led to Arizona's contribution to the Basin States Alternative set forth in the Draft EIS. Consequently, SCWPDA urges that Reclamation adopt the Basin States Alternative as the Preferred Alternative in the final EIS and Record of Decision. 1

G-2

Ms. Jayne Harkins, Acting Regional Director
U. S. Bureau of Reclamation, Lower Colorado Region
April 27, 2007
Page 2

Of the various alternatives considered in the Draft EIS, the "Reservoir Shortage Alternative" is of most concern to our Districts. This Alternative would clearly violate Article IV (b) of the Colorado River Compact which subordinates the impoundment of water for generation of electrical power to direct consumption of water for "agricultural and domestic purposes". The proposed cuts to Lower Basin water supplies would have an enormous negative impact on CAP agriculture. 2 3

SCWPDA supports the official comments of ADWR Director, Herbert R. Guenther, on the discussion of the various alternatives discussed in the Draft EIS and will not elaborate further on these comments. In addition, SCWPDA supports the anticipated comments of the Arizona Municipal Water Users Association ("AMWUA") and the Colorado River Energy Distributors Association ("CREDA). We support CREDA's views that power users should not be required to fund non-power water conservation programs such as is suggested in the Conservation Before Storage Draft EIS Alternative. 4 5 6

In conclusion, SCWPDA supports the Basin States Alternative as the Preferred Alternative to be adopted in the final EIS and Record of Decision.

Sincerely,

Grant R. Ward
General Manager

c: Robert W. Johnson, Commissioner, U. S. Bureau of Reclamation
Rick Gold, Regional Director, U. S. Bureau of Reclamation, Upper Colorado Regional Office
Larry Walkoviak, Deputy Regional Director, U. S. Bureau of Reclamation, Lower Colorado Regional Office
Herbert Guenther, Director, Arizona Department of Water Resources
Sid Wilson, General Manager, Central Arizona Water Conservation District
Leslie James, Executive Director, Colorado River Energy Distributors Association
Steve Olson, Executive Director, Arizona Municipal Water Users Association

G-2

Reponses to Comment Letter G-2

G-2-1

Your comment is noted. No change to the Final EIS was necessary.

G-2-2

Your comment is noted. No change to the Final EIS was necessary.

G-2-3

Your comment is noted. No change to the Final EIS was necessary.

G-2-4

Your comment is noted. No change to the Final EIS was necessary.

G-2-5

Your comment is noted. No change to the Final EIS was necessary.

G-2-6

Your comment is noted. No change to the Final EIS was necessary.

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Colorado River Draft EIS
Comments from the Western Business Council for New Energy Technologies

Penelope Purdy
Director, Clean Energy Programs
WBCNET
1625 Broadway Suite 950
Denver CO 80202
(303) 592-4066 (office)

Introduction

The U.S. Department of Interior and its bureaus and agencies deserve applause for tackling the very difficult issue of how the Colorado River Basin states should share the pain of future droughts. Government officials at the federal and state levels displayed the political courage by trying to resolve the potential resource conflicts before the next crisis arrives.

The Western Business Council for New Energy Technologies believes that economic prosperity and environmental protection go hand in hand. Our members work in Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming, which also are six of the seven Colorado River Interstate Compact states. For the American West, the proper use of water is fundamental to the concept of sustainable, environmentally responsible business.

In this regard, we are concerned that there are significant omissions in the U.S.
Bureau of Reclamation's draft environmental impact statement of February 2007, dealing 1
with the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated
Operations for Lakes Powell and Mead.

Our overarching criticism is that the document is not forward-looking, but instead
shows that the Bureau assumes climate conditions will remain more or less similar to 2
ones found in the historical climate records. However, new scientific data prove the
Bureau's assumption to be a risky one that could render the EIS' conclusions invalid, 3
undermining the proposed alternative plans.

We are further concerned that the Bureau and the Western Area Power 4
Administration have not considered the interplay of water supply and energy resources.
Specifically, many states in the Colorado River drainage, including the lower basin states,
continue to rely on, and are considering additional construction of, conventional coal-
fired power plants, whose water demands are both large and inflexible. The increased
energy demands for water from the Colorado River and other regional sources could 5
reduce the region's ability to respond to changing water use patterns and climate
conditions.

The Bureau itself has noted that doing nothing is unrealistic, as outlined in the No 6
Action Alternative in Section 2.2. The Water Supply Alternative, detailed in Section 2.5,
is similarly unacceptable because it only delays the inevitable need for the Bureau and the 7
Basin states to make tough decisions.

G-3

Ultimately, we believe that a final record of decision should be based on the 8
Conservation Before Shortage Alternative, as shown in Section 2.4. This alternative
could be blended with the Basin States Alternative described in Section 2.3, which also 9
acknowledges the need for better conservation of resources. Indeed, with the prospect of looming shortages, efficient water use is simply prudent business.

Climate change

The EIS fundamentally errs by not adequately considering how changing climate 10
conditions will affect water supply and water use in the Colorado River basin. In Chapter
1, covering the EIS' Purpose and Need, the Bureau says that there will be no effect on 11
climate change. In Chapter 3, the EIS also says that there will be no cumulative impacts. 12
Both statements are wrong.

Only in Appendix N does the EIS discuss climate change in any depth. Even then,
the document only considers data produced from tree rings and other past climate 13
research. It does not discuss the numerous studies showing that future climate conditions may be much drier and hotter in the Southwest than they have been anytime in the past.

The dearth of discussion is surprising in an organization such as the Bureau, which prides itself on sound engineering and scientific principles.

The omission is especially puzzling because credible climate change studies are readily available in the public domain, such as *the U.S. Climate Change Research*
Program of 2002. In spring 2007 the respected journal *Science* (Jian Lu & Seeger 2007) 14
warned that future droughts associated with climate change will be unlike anything the region has previously experienced. Instead, droughts could become a near-permanent fixture in the Southwest. "It will be like a permanent 1930s or 1950s drought." (Seeger, quoted by reporter Katy Human, *the Denver Post*, April 6, 2007 p. 2B)

Arrayed against such warnings, it is inexcusable for the most important EIS on water shortages in our region to ignore the climate change issue.

Energy use

Energy policy is the proverbial elephant in the room regarding Western water supplies. Basin states have some of the fastest-growing populations in the country, with Nevada and Arizona among the top two. As the states' populations grow so will their demands for water and energy resources. Moreover, if the Southwest does, as predicted, enter into chronic drought conditions then demand for electricity likely will increase as more residents and businesses turn up their air conditioners.

Realistically, water policy cannot be separated from energy use. The Bureau, 15
cooperating federal agencies such as WAPA and the governments of the Basin states
clearly have a responsibility for determining energy resources and use patterns, so the 16
EIS should analyze how their decisions on water use relate to their similarly important decisions regarding energy production and consumption.

We applaud efforts by some basin states to embrace alternative energy sources: Arizona has stepped up its use of solar and Colorado has boosted its commitment to wind power, for example. These projects will enable states to meet their energy needs without consuming large quantities of the arid region's limited water supplies.

By contrast, water devoted to coal-fired power plants will make it harder for water managers at the federal, state or local levels to also meet the demands of other industries such as tourism, agriculture, light manufacturing and housing developments. Unlike tourism, agriculture and municipal use, water use by coal-fired power plants is inflexible unless the plants reduce their power output. Water use by coal plants thus represents a hard demand that is at odds with the need for flexibility in water supply from the Colorado River and non-system sources, as described in the Basin States and the Conservation before Shortage alternatives. 17 The EIS should analyze whether the construction of new conventional coal-fired power plants in the Basin states will reduce the sought-after flexibility in water supplies. 18

There are many to make electricity: wind, solar, biomass and hydro, as the Bureau and WAPA have done for years. But in our arid region, there are only a limited number of places to find water for uses other than energy production, and even those supplies may be at risk as the climate changes. The EIS needs to reflect these realities. 19

G-3

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Reponses to Comment Letter G-3

G-3-1 through G-3-3

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

G-3-4 through G-5

As noted in Section 2.6 of the EIS, the Reservoir Storage Alternative was developed in coordination with the cooperating agencies and other stakeholders. This alternative would keep more water in storage in Lake Powell and Lake Mead to benefit power and recreation interests and protect against future shortages. Section 4.2 addresses information regarding the potential impacts of climate change and hydrologic variability, Section 4.11 discusses the potential effects on electrical power resources, and Chapter 5 discusses the potential cumulative impacts of the proposed federal action.

G-3-6 and G-3-7

Your comment is noted. No change to the Final EIS was necessary.

G-3-8 and G-3-9

Your comments are noted. No change to the Final EIS was necessary.

G-3-10 through G-3-14

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

G-3-15 through G-3-19

Your comments are noted. Section 4.11 describes the potential impacts to energy production from the proposed federal action. An analysis of current and future energy use and patterns in the West, the effects of construction of new conventional coal-fired power plants, and alternative energy sources are outside the scope of this study.

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SOUTHERN CALIFORNIA WATER COMMITTEE INCORPORATED

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Phone (909) 980-4760
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4/25/07
BCOO1000
1003

April 23 , 2007

Ms. Jayne Harkins
Acting Regional Director
Lower Colorado Region
Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City, Nevada 89006-1470

Draft EIS Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Dear Ms. Harkins:

On behalf of the Southern California Water Committee (SCWC), I am please to submit our comments on the Draft EIS on the proposed adoption of specific Colorado River interim guidelines for Lower Basin shortages and operations for Lake Powell and Lake Mead. With the purpose of proposed federal action to improve Reclamation's management of the Colorado River, the SCWC supports the Basin States Alternative as the preferred action alternative. 1

Important to California is the ability to coordinate the operations of Lake Powell and Lake Mead because, with that coordination, water shortages would be minimized in the Lower Basin, while also avoiding the risk of curtailments of Colorado River water in the Upper Basin. 2 3 In addition, the Basin States Alternative allows for water storage in Lake Mead, which benefits not only California, but also Arizona and Nevada. 4 Water stored in Lake Mead stays in the Colorado River system, rather than that water being diverted by Metropolitan Water District of Southern California to Diamond Valley Reservoir for storage. 5

The Basin States Alternative calls for an extension of the Interim Surplus Guidelines for water deliveries from Lake Mead to 2026 which would provide assurances that Metropolitan Water District could access supplies above California's basin apportionment of 4.4 million acre-feet of water. 6 Given the potential for water supply shortages in the Sacramento-San Joaquin Delta, the other major source of water for Southern California, the Basin States Alternative would provide a measure of insurance in case of a catastrophic loss of water in the Delta. 7

The Southern California Water Committee appreciates the opportunity to comment on the draft EIS and look forward to a preferred alternative that will provide California a greater degree of predictability in the amount of water that can be delivered from the Colorado River in future years. 8

Very truly yours,

Joan Anderson Dym
Executive Director

G-4

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Reponses to Comment Letter G-4

G-4-1 through G-4-5

Your comments are noted. No change to the Final EIS was necessary.

G-4-6 through G-4-8

See response to Comment No. G-1-8.

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DEFENDERS OF WILDLIFE · ENVIRONMENTAL DEFENSE · NATIONAL WILDLIFE FEDERATION
PACIFIC INSTITUTE · SIERRA CLUB · SONORAN INSTITUTE · WESTERN RESOURCE ADVOCATES

April 30, 2007

VIA ELECTRONIC DELIVERY (strategies@lc.usbr.gov) AND U.S. MAIL

Regional Director
Lower Colorado Region
Bureau of Reclamation
Attention: BCOO-1000
PO Box 61470
Boulder City, NV 89006

Re: Comments of NGO "Conservation Before Shortage" Consortium on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement

Dear Regional Director:

We greatly appreciate the inclusion of the "Conservation Before Shortage" Alternative by the U.S. Bureau of Reclamation (Reclamation) as one of the five alternatives under consideration in the "Draft Environmental Impact Statement on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead," dated February, 2007 (DEIS). We also greatly appreciate Reclamation's technical support and assistance, including its extensive modeling work, as we developed and revised the Conservation Before Shortage proposal.

We offer the following comments on the DEIS on behalf of Defenders of Wildlife, Environmental Defense, National Wildlife Federation, Pacific Institute, Sierra Club, Sonoran Institute, and Western Resource Advocates, collectively representing more than four million members nationwide.

I. Critical Preferred Alternative Components

The importance of developing shortage guidelines for Colorado River management cannot be overstated. System storage has decreased steadily through the past eight years of drought, while basin-wide uses continue to increase. We commend Reclamation's efforts to develop shortage guidelines, and urge Reclamation to adopt a policy that will facilitate increased flexibility in water use.

We point Reclamation specifically to two key elements of the "Conservation Before Shortage" alternative (CBS) that we believe should clearly be incorporated into the preferred alternative for the "Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lakes Powell and Mead." As discussed further in our comments below, the analysis provided in the DEIS supports the inclusion of both of these elements in the preferred alternative.

First, the preferred alternative should allow for a program of *voluntary and compensated forbearance* as the volume of water in storage at Lake Mead drops below key thresholds. The 1

G-5

benefits of this approach, relative to the involuntary and uncompensated water shortages
proposed in all other alternatives, are multiple. Rather than cutting water deliveries to the same
users each time, the voluntary program would be available to all Lower Basin and Mexican water 2
users, dispersing the impacts of reduced water use. Participants would be compensated for 3
forbearance, decreasing or eliminating the economic impacts of the guidelines. Finally, the
federal government would replace bypass flows in times of decreased reservoir storage, when 4
they are most needed. This approach, which was recommended as a part of the YDP/Ciénega de
Santa Clara Workgroup recommendations,[1] offers a more efficient way to meet the bypass flow 5
obligation.

Second, the preferred alternative should accommodate an *extended program for Intentionally*
Created Surplus (ICS), including the reservation of additional banking capacity in Lake Mead
for this purpose. This program should expressly allow for the participation of the U.S. federal 6
government, entities other than existing Colorado River contractors (including U.S. NGOs), and
should leave the door open to future participation by Mexico in the event that the United States
and Mexico adopt an appropriate international framework for this participation.

By allowing the U.S. federal government to participate in the ICS program, Reclamation will
introduce critically-needed flexibility into the Lower Colorado River system, allowing a
mechanism by which water could be acquired for a variety of purposes – including accumulation 7
of bypass flow replacement credits, water for environmental purposes, shortage mitigation, and
other needs. Similarly, by allowing entities other than just existing Colorado River contractors to
participate in the ICS program, the federal government would open the door to private 8
conservation efforts to dedicate water to environmental restoration projects. Perhaps most
importantly, by leaving the door open for Mexico to create and deliver ICS credits, Reclamation
would not preclude new water exchanges that could benefit water users in both the United States 9
and Mexico, the Mexican creation of pulse flows for the Colorado River Delta, and binational
agreements about shortage sharing on the Colorado River that might not be politically feasible in
the absence of a binational ICS program.

We urge Reclamation to define a preferred alternative and final guidelines in the Final Environmental Impact Statement and Record of Decision that include these two policies.

II. Comments on CBS

In the following comments we further discuss the benefits of certain elements of CBS, identify various legal and technical issues associated with the alternatives presented in the DEIS and the presentation of CBS, and discuss several ways that the analysis of environmental and socioeconomic impacts of the various alternatives presented in the DEIS could be improved.

Relative Benefits of an Expanded ICS Program

In their proposal for ICS, the basin states have taken an important step forward in Colorado River management. With the river over-allocated, the best way to accommodate new uses (and

[1] *See* Balancing Water Needs on the Lower Colorado River: Recommendations of the Yuma Desalting Plant/Ciénega de Santa Clara Workgroup (April 22, 2005), available at http://cals.arizona.edu/AZWATER/publications/YDP report 042205.pdf.

G-5

2

existing municipal and industrial (M&I) uses that are not predicated on firm supplies) is to re-allocate water. ICS will be an important new tool facilitating this re-allocation. The three basic premises of the ICS mechanism, that water can be transferred between a seller/lessor and a buyer (as allowed by the forbearance agreements), that it can be stored over time in Lake Mead (as allowed by the proposed banking arrangements), and that it can be delivered upon request, are critical to developing a water market in the Lower Colorado River basin.

Although the basin states have proposed limiting the creation of ICS to existing contractors, CBS proposes that other entities should be able to participate in the ICS mechanism, including U.S. federal agencies; state agencies; private entities, including U.S. non-governmental organizations; Mexican federal agencies; and Mexican water users and non-governmental organizations. 10

The benefits of expanding the ICS mechanism are multiple, including a probable increase in water stored in Lake Mead, opportunities for improving riparian habitats throughout the Lower Colorado River through dedicated instream flows, as well as an opportunity for Mexico to improve its management of Colorado River water. The benefits of this approach are partially, but not completely, discussed in the DEIS. Reclamation's analysis illustrates the first two of these benefits:

- **More water remains in storage, decreasing the probability of shortages, and increasing hydropower generation.** Reclamation's analyses consistently suggest that the greater the potential size of the ICS mechanism, the higher the probable elevation at Lake Mead (table 4.3-25) and the lower the probability of shortages in any given year (figure 4.4-2 and table 4.4-4). Reclamation's analysis also suggests that CBS would result in modest increases in hydropower generation at both the Glen Canyon power plant and the Hoover power plant when CBS is compared to both the no action and the Basin States alternatives (tables 4.11-4 and 4.11-10). 11

- **New opportunities to create and improve Colorado River riparian habitats.** An extended ICS policy could allow an entity such as a conservation organization or the Mexican government to generate ICS for the purpose of creating a dedicated pulse flow below Morelos Dam, which would result in a considerable improvement in riparian conditions on the southernmost reach of the Colorado River. The DEIS analysis notes this benefit (tables 4.8-1 and 4.8-8) as the greatest possible positive impact to biological resources for any of the contemplated alternatives, with "relatively high flows expected past Morelos Diversion Dam, which would benefit the riparian corridor" (DEIS at 4-172) including the neotropical migratory birds that rely on native riparian forest, such as the endangered Southwestern willow flycatcher and Yuma clapper rail. As discussed further below, we believe this analysis should be expanded. 12

There are additional benefits to an expanded ICS mechanism that are not discussed in the DEIS:

- **Mexico gains ability to improve Colorado River management.** As discussed in detail elsewhere below, at present, Mexico does not have the ability to store Colorado River water, and must use its entire allocation on an annual basis. Multiple examples can be found in the Lower Basin states demonstrating the advantages of storage for water management. Offering 13

Mexico this benefit would allow Mexico to address urban water supply challenges, and could open the door to U.S. entities purchasing temporary ICS credits in Mexico. 13

- **United States enters negotiations with Mexico over Colorado River shortages with something to discuss beyond unilateral imposition of shortage guidelines.** While noting that any determination of shortages with respect to deliveries to Mexico is not a part of the proposed federal action, and that any such determination would be made in accordance with the 1944 Treaty, Reclamation acknowledged the probability of a shortage agreement with Mexico by incorporating it into modeling assumptions. As Reclamation develops new rules for domestic shortages, the State Department will need to negotiate new rules for shortages to Mexico. An expanded ICS program may well be perceived by Mexican negotiators as a benefit, and may help negotiators for the United States reach a satisfactory agreement regarding Mexican shortages. 14

Benefits of Voluntary, Compensated Forbearance Compared to Involuntary, Uncompensated Shortage

CBS would provide compensation to willing sellers/lessors of water to forbear use, while the Basin States alternative would eliminate water deliveries, without compensation, to water users with low priority rights. The benefits of the CBS approach are numerous, and are only partially discussed in the DEIS:

- **Involuntary shortages are rare.** During the term of the guidelines, Reclamation's analysis projects that the probability of involuntary shortages under CBS remains less than 10%, while the probability under the Basin States' alternative is as high as 35% (figure 4.4-1 and table 4.4-2). 15

- **The economic impact of reduced water use is significantly diminished or eliminated completely.** Because of the low probability of involuntary shortages under CBS, any reductions in water use are likely to be compensated. Although Reclamation has not yet analyzed the economic impact of compensated forbearance (see further comments below), we expect that such analysis would show that the income received by water users for forbearance would substantially offset any negative impacts of reduced water use. Because CBS would solicit proposals for forbearance from willing sellers, water users would be able to choose whether or not to participate, and could make this decision based on whether or not participation would benefit them economically. 16

- **Reductions in water use are spread among a larger pool of water users.** Under the Basin States' alternative, reductions in water use would always be imposed on the same water users, in the same order of priority. In a stage 1 shortage (by far the most probable, see tables 4.4-5 through 4.4-9), California water users are not included in the pool of impacted water users, and prescribed shortage volumes would be imposed repeatedly on select water users in Arizona, Nevada, and Mexico. Under CBS, water users throughout the Lower Basin and Mexico would have the opportunity to participate in a voluntary and compensated forbearance program, and water users could choose whether or not to participate in the forbearance program in any given year. As discussed further below, these benefits are not adequately recognized in the DEIS. 17

G-5

4

- **The low rates of return on some crops suggest that the cost of the forbearance program could be less than $75/acre-foot.** Reclamation's analysis suggests that Arizona water users growing wheat, cotton, and alfalfa hay produce varied economic results with every acre-foot of water used generating anywhere from a loss of $46.43 to a profit of $70.48 (see table H-2). These and other water users could have an economic incentive to participate in such a forbearance program. As discussed below, Reclamation's analysis on this subject could be substantially improved. 18

- **Decreased probability of shortages imposed on urban water users with low priority rights.** While Reclamation's analysis of impacts to urban water users with low priority rights is limited, the DEIS notes that shortages to municipal and industrial water users of up to 283,000 acre-feet (af) could occur (DEIS at 4.14.3.1). Because of the very small probability of shortages under CBS, it is unlikely that urban water users would be denied water under that alternative. However, there is a considerable probability of shortages to urban users under the Basin States alternative. 19

- **The federal government would replace bypass flows in a cost-efficient manner.** CBS would have the volume of water conserved by the federal government under voluntary forbearance agreements count as bypass flow replacement. Reclamation has acknowledged the federal obligation to replace bypass flows (see letter from Reclamation to interested public, September 22, 2005) and is studying how the agency should proceed. By implementing a program during conservation conditions (as defined in CBS) to conserve water through payments to voluntary participants in a forbearance program, Reclamation could ensure that bypass flow replacement would occur during times of low water supply, and that bypass flow replacement water would not be lost during flood control releases. Moreover, Reclamation could avoid other, more costly alternatives for bypass flow replacement. 20

The remainder of this letter addresses changes Reclamation could make to improve the DEIS.

Characterization of CBS Alternative in the DEIS

Apart from Appendix K, in many instances the DEIS does not accurately or fully present CBS, which materially limits the comparison and analysis of CBS. Accordingly, we ask that Reclamation properly characterize and analyze CBS in the Final EIS and formulate the preferred alternative only after CBS has been properly characterized as follows: 21

- As discussed above, CBS proposes that involuntary and uncompensated water shortages on the lower Colorado River should be managed and avoided through voluntary conservation or reductions in water deliveries that are compensated through market mechanisms. In Chapter 2 and Appendix M that fundamental concept is properly expressed as "voluntary conservation" or "voluntary, compensated reductions in water use," but in Chapter 4 and elsewhere CBS is improperly characterized as the imposition of "voluntary shortages." Compensated reductions in deliveries under CBS should be consistently termed as "voluntary water conservation" or "compensated reductions in water use" where appropriate in any discussion of the preferred alternative and the final EIS. 22

G-5

5

An essential component of CBS is that the mechanism for ICS would be opened up to federal and state agencies, to non-governmental organizations in the U.S., and to federal and state agencies, traditional water users, and non-governmental, conservation water users in Mexico. Clearly, any international extension of this market mechanism to Mexico must go through diplomatic channels, as is repeatedly recognized by CBS and Reclamation's commentary. 23 The DEIS does not fully disclose this key difference between CBS and the Basin States' alternative (see, for example, reference to "unassigned" ICS credits in table 2.4-1). That first discussion of CBS should disclose the other entities that could participate in the more extensive water banking proposed by CBS. To the extent such international water banking could be beyond the scope of the proposed action it should not be precluded; such up-front disclosure could be qualified and footnoted in the same way as the modeling assumptions specific to CBS in the chapter on environmental consequences (DEIS at 4-11) and in Appendix M (page M-1). In addition, to fully serve its informational role, an EIS should identify all relevant, reasonable mitigation measures that could improve the project, even if 24 they are outside the jurisdiction of the agency. *See* 40 C.F.R. §§ 1502.16(h), 1502.14(c).

- The DEIS should clarify that under CBS up to 600,000 acre-feet of ICS could be generated by federal agencies just to avoid that magnitude of shortage in the U.S., while up to 325,000 acre-feet of ICS could be generated by other entities in any one year to restore environmental 25 flows in both the U.S. and Mexico, and possibly to avoid shortages to municipal, industrial, and irrigation uses in Mexico. The total amount of ICS that can be banked by such other entities in any one year including all banking by federal agencies to avoid shortages should 26 therefore be corrected to 925,000 acre-feet (Tables 2.4-1 and M-4). To the extent that the banking of ICS by current contractors under the Basin States Alternative reduces the need for banking by federal agencies to avoid shortages, however, this cap will not be reached under CBS.

  This greater scope of water banking as proposed by CBS should be not be obscured, as it is by Table M-5, whose headings indicate that such ICS generation is limited to environmental flow restoration. The heading for the second column of that table should be corrected to 27 illustrate the international water banking proposed by ICS to meet municipal, industrial, and irrigation water needs in Mexico, and so that the last column illustrates banking to provide environmental flows in the U.S., including the limitrophe below Morelos Dam. Figure P-61 should be clarified to separate out the deliveries of banked water to municipal, industrial, and water users who would divert such deliveries at Morelos Dam, from all water that would 28 flow past Morelos Dam as deliveries of ICS water or otherwise.[2]

- We also understand that the interplay of the CBS proposal to generate 600,000 acre-feet of ICS to avoid that magnitude of shortage in the U.S., while at the same time maintaining the elevation of Lake Mead above 1000 feet so as to not cut-off the physical supply to Las Vegas, has not been modeled correctly. That is, the modeling now simply imposes involuntary shortages whenever necessary to keep Lake Mead above 1,000 feet, without first

[2] When Figure P-61 is so clarified, we expect to see the dramatic reduction of flows past Morelos Dam under the Basin States alternative to be contrasted with the delivery of banked water to maintain critical flood pulses to the Delta's river ecosystem.

G-5

6

seeking to develop up to a full 600,000 acre-feet of ICS to avoid involuntary shortages. This modeling assumption overstates the shortage volumes that could be required under CBS and understates its benefits in comparison to other alternatives.[3] To properly characterize CBS, the model should assume that the 'absolute protect 1000' involuntary shortage provision would be triggered only if 600,000 acre-feet of voluntary conservation would not be sufficient to keep Mead above an elevation of 1000 feet. 29

Moreover, involuntary water shortages in the U.S. greater than 600,000 acre-feet may be implied in the Basin States alternative in the event that Lake Mead would be drawn below 1000 feet of elevation during an extreme drought and the physical supply to Las Vegas is cut-off. This alternative cannot be fairly compared to CBS unless the involuntary shortages greater than 600,000 acre-feet inherent in the Basin States alternative are added to the operational modeling and all related analyses. 30

- To assess the longest possible stretches of river where flows might be reduced, the operational modeling for the DEIS creates the impression that all ICS proposed by CBS is generated in Mexico even for the replacement of bypass flows in the U.S (DEIS at M-8 and 9). So that the actual parameters of CBS are not mistaken with that analytical assumption, those parameters should be disclosed simultaneously. 31

  CBS proposes that the ICS to replace bypass flows could be generated in both the U.S. and in Mexico. CBS also presumes that ICS for environmental flows in the U.S. or Mexico or to meet other Mexican water needs can be generated in either the U.S. or Mexico, and for such ICS to be delivered for use in either the U.S. or Mexico, as illustrated in Appendix K.3.[4] 32 One might expect that most ICS generated in the U.S. would be applied to manage U.S. shortages, and most ICS generated in Mexico to be applied to flow restoration and other water needs in Mexico, but CBS would not be unilateral and would keep the door open to substantial cross-border investments, water banking, and transactional innovations. We recommend that the FEIS include a sensitivity analysis of changes that would occur if ICS were distributed more broadly across users downstream of Lake Mead. 33

- Along with leaving the impression that ICS would only be generated in Mexico, the DEIS fails to explain a basic mechanism in CBS. When ICS is generated in Mexico in one year for delivery back to Mexico in another, the deliveries to Mexico under the Treaty with the U.S. should be reduced by the amount of the ICS in the year that it was generated, but then in the year that it was delivered back to Mexico, the amount of the ICS delivered would be in addition to all deliveries obligated by the Treaty. 34

- The modeling of CBS may properly apply the 5% system charge by not assessing this charge against the bypass flow account until ICS is generated to avoid water shortages in the U.S., 35

[3] This mis-modeling may explain much of the difference between CBS and the Basin States alternative in the probabilities of involuntary shortages and consequent socio-economic impacts summarized in Tables 4.14-3 and 4.14-4.

[4] CBS does not include water transactions entirely within Mexico to restore base flows, but such transactions could be combined with CBS and riparian land restoration for a comprehensive plan to conserve the river dependent ecology of the Delta.

G-5

and not assessing it against any ICS that is generated and delivered to meet Mexican river flow or other needs, but that modeling assumption could be confirmed. The assessment of the 5% system charge against all other generation of ICS under CBS might then be footnoted as it is for the Basin States alternative in Table M-3, or the 5% charge added to Table M-3, as it was for Table M-4, so that is clear that the system charge is not applied differently across these alternatives. 35

- The DEIS misses several important aspects of the approach to funding forbearance when the water surface elevation at Lake Mead declines, which evolved after we submitted the original CBS proposal in 2005 and is described in the proposal we submitted in 2006 (CBS II). Federal funding would not be limited to the volume of voluntary water conservation needed to replace bypass flows in any year in which such conservation was triggered (page 2-13), but would be sought for all such conservation up to the maximum storage of 1.5 million acre-feet of ICS generated by federal agencies, because of the benefits of both bypass flow replacement and environmental flow restoration. The funding for banking additional ICS beyond that maximum for U.S. agencies would then be shared 50/50 by U.S. agencies and Lower Basin power and water users, and the water and power users would split their share 50/50 (see Appendix K, page K-5). Such cost sharing offers a strong incentive for state, private, and international investment in ICS for environmental flow restoration and provides an initial basis for discussion of how to distribute such costs equitably. 36

  It appears that the DEIS misapplies this funding concept to suggest that CBS would impose a $20-$100 surcharge for every acre foot of hydropower generation in the Lower Basin, which is incorrect. The concept of hydropower users sharing in perhaps 25% of the cost of generating ICS for environmental flow restoration is only applicable after a maximum of 1.5 million acre-feet of ICS is banked by federal agencies, and therefore would not be automatically applied or at all times. Such cost sharing also is illustrative and needs to be adjusted in proportion to the benefit to hydropower generation associated with the greater water banking at Lake Mead proposed by CBS, as indicated by Table 4.11-29,[5] and all other benefits of ICS, as properly characterized. 37

III. Comments on the Draft Environmental Impact Statement

Legal Considerations

As demonstrated in CBS, we encourage efforts to increase flexibility in Colorado River management. Such flexibility, however, should not come at the expense of the Secretary of the Interior's environmental authorities and obligations nor should the Secretary relinquish his role as water master in lower Colorado River management to achieve such flexibility. 38 If Reclamation and this EIS make clear that the creation, storage, and delivery of ICS is within its authority to oversee and implement, then Reclamation should adopt the ICS program that is most environmentally beneficial. Reclamation must also expand the scope of the EIS to include the direct, indirect, and cumulative impacts of all who may participate in the ICS program. 39

[5] Per Table 4.11-29, 13% more hydropower energy is generated under CBS than the Basin States alternative and the present value is about $14 million more. The benefits to hydropower generation mostly at Lake Mead could also be greater over the interim period.

G-5

8

Both the DEIS and this letter note that various aspects of the alternatives, such as funding 40
mechanisms in CBS, may require additional legislative authority. What has not been addressed
is the potential need for additional federal rules or guidelines administering the ICS program as
proposed in the CBS, Basin States, and Reservoir Storage Alternatives. The DEIS implicitly 41
assumes that each alternative would implement the ICS program consistently, not altering the
rules under which an entity would participate in ICS, change the relative size of any of the states'
ICS banks, or, fundamentally, interpret the Law of the River differently than another alternative.

The DEIS, however, largely is silent as to how the Secretary would administer the ICS program. 42
The Secretary has a prominent role in managing the Colorado River and will play a decisive role
in implementing any of the alternatives, including ICS. An ICS program will entail a range of
federal actions, from oversight and accounting to storage and delivery, possibly in the form of
agreements to reduce water use and create ICS credits, to store ICS credits, and to delivery ICS 43
credits. To ensure that this EIS process enables the adoption of the ICS program in CBS and sets
the stage for future site-specific actions under the ICS program, it is critical that Reclamation
expand the scope of the EIS.

Scope of the DEIS

The scope of an EIS depends not only on the range of actions and alternatives, but on the range of impacts resulting from each alternative, including direct, indirect, and cumulative impacts. 40 C.F.R. § 1508.25. The scope of the DEIS is particularly important for those actions which may require additional NEPA analysis and which may wish to tier to the instant EIS. *See* 40 C.F.R. §§ 1502.20, 1508.28 (Tiering is a process of addressing a broad program or proposal in a programmatic environmental impact statement and analyzing a site-specific proposal related to the initial proposal in a subsequent NEPA document).

The DEIS overlooks several geographic regions, and thus environmental resources, that 44
potentially may be affected by the alternatives and their direct, indirect and cumulative impacts.
For example, CBS contemplates voluntary conservation by any water user within the Lower
Basin or Mexico. Because the conservation would be voluntary, and not based strictly on 45
relative priorities of water entitlements, the impacts analyses must consider reductions in water
use across the entire spectrum of water uses and users in the Lower Basin and Mexico. These
omissions are most pronounced in the discussion of the affected environment and environmental
consequences for biological resources, socio-economics, and land use. *See e.g.,* DEIS at 3-3
(including a narrow set of service areas in the affected environment); DEIS at 3-27 (expecting no
change to Yuma area drainage flows); DEIS at 3-127 (limiting study area to those where
"shortage" may occur); DEIS at 3-131 (limiting study area to MWD service area); DEIS at 4-261
(excluding Nevada and California from analysis); DEIS at Table 4.14-1; DEIS at 4-281
(concluding no effect to agricultural production in California or Nevada because no shortage);
DEIS at 4-282; DEIS at 5-14 (exclusion of decreased flows and altered timing of flows in
the Muddy River due pumping of groundwater under Coyote Spring Valley that may then be
wheeled through or banked as ICS in Lake Mead); and DEIS at Table M-4 (exclusion of
decreased river and spring flows, altered timing of flows, and significant wetland impacts from
pumping 80,000 acre-feet/year of groundwater whose return flow credits are then banked as ICS
at Lake Mead). The discussions of the affected environment and environmental consequences 46

G-5

9

are presently deficient because the full scope of the alternatives and their impacts are not examined. 46

Climate Change

As Reclamation considers various policies to manage droughts in the Lower Basin, it would be useful to have an understanding of how climate change might impact water supply. The Intergovernmental Panel on Climate Change issued a report[6] in early 2007 documenting the high level of scientific confidence in projections that the Colorado River basin will change significantly over the next century, both warming and drying. Under all scenarios, the report suggests an increase of one-to-two degrees Celsius for the southwestern United States from 2020-2029, as compared to 1980-1989. Such a rise in temperature will increase evaporative losses and evapotranspiration demand throughout the basin, coinciding with the proposed term of Reclamation's surplus and shortage guidelines. Moreover, the report documents that more than 90% of the models examined agree that winter precipitation in the southwestern United States will decline by 10-20% by 2090-2099, as compared to 1980-1989. While this timeframe is longer than that contemplated by the shortage guidelines, it suggests that precipitation changes might occur within the period of the guidelines. Some models show a significant drying of the Southwest U.S. as soon as the 2021-2040 period.[7] As the United States Geological Survey recently said, "We need to look at a large range of possible futures for water and [evaluate] how well will our designs, plans and allocations work under a whole range of climate scenarios – because we can't narrow it down."[8]

It would be useful for Reclamation to include in the FEIS a robust attempt to consider the impacts of all alternatives in consideration of the projected impacts of climate change. Moreover, we suggest that this analysis not be buried in an appendix, but that it should be discussed in the central text of the EIS, concomitant with the absolutely paramount importance of planning realistically for climate change. 47

The sensitivity analysis presented in appendix N (Analysis of Hydrologic Variability Sensitivity) is useful, as it expands the hydrologic variability modeled based on recent historic and paleo-hydrologic data. However, it is not adequate as a substitute for meaningful modeling that represents the expected impacts of climate change. 48

Term of the Proposed Guidelines

In our scoping comments we suggested that shortage guidelines should not be interim. However, recent IPCC and other climate change projections suggest that hydrologic assumptions driving 49

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[6] International Panel on Climate Change, 2007. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Summary for Policymakers, available at http://www.ipcc.ch/WG1_SPM_17Apr07.pdf. See also: P.C.D. Milly, K. A. Dunne, and A. V. Vecchia, 2005. Global pattern of trends in streamflow and water availability in a changing climate. *Nature* **438**: 347-350; M. Hoerling and J. Eischeid, 2007. Past Peak Water in the West. *Southwest Hydrology* **6**: 18-19,35; and N. Christensen and D.P. Lettenmaier, 2007 (in review). A multimodel ensemble approach to assessment of climate change impacts on the hydrology and water resources of the Colorado River basin. *Hydrology and Earth System Sciences.*

[7] Seager, et. al., 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. *Science Express.* April 5.

[8] Lucy Kafanov, *Water Managers Must Gird for Extreme Conditions*, E&E News PM (April 27, 2007).

the current analysis (namely, that past hydrology is a reasonable predictor of future flows) might not be reasonable or informative. Given the potential for climate change to dramatically alter 49
Colorado River hydrology – probably for the worse – we now believe that the limited lifespan of the shortage policy will be appropriate.

Nonetheless, it would have been useful to see the effects of leaving the alternatives in place past 2026. Projecting hydrologic impacts out to 2060 while arbitrarily assuming that shortage 50
guidelines would not be extended only masks the likely conditions of the system beyond 2026.

Salinity

The DEIS neglects to explain why the CRSS salinity module (DEIS at 4-131 and F.1) was not expanded or modified to analyze changes in salinity below Imperial Dam. Projected salinities at the Northerly International Boundary (NIB) should be included in the final EIS, as it bears 51
directly on salinity management measures in the Yuma area. As noted on Figure ES-1, the NIB clearly falls within the geographic scope of the action; salinity itself is a recognized water quality parameter analyzed for upstream reaches.

Pursuant to Minute 242, the Unites States has agreed to deliver Colorado River water to Mexico upstream of Morelos Dam with an annual average salinity of no more than 115 ppm ± 30 ppm over the annual average salinity of the Colorado River waters which arrive at Imperial Dam. Projecting the salinity at NIB would very likely distinguish among the alternatives, and would 52
also be of great value in projecting the ability of the U.S. to meet a recognized treaty obligation. Whether an alternative may or may not adversely affect the ability to meet legal obligations would aid in the selection of a preferred alternative; the extent of adverse impact would also contribute to the significance of the impact. *See* 40 C.F.R. § 1508.27(b)(10).

The single greatest factor increasing the salinity of the Colorado River between Imperial Dam and NIB is the return of agricultural drainage to the river. In recent years, the salinity differential has approached the maximum value set by Minute 242. Diminishing the volume of 'non-storable flows' at the border will further increase the challenge of meeting the differential. CBS presumably could reduce the volume of these drainage flows or increase the delivery of water to 53
Mexico from Lake Mead, thereby decreasing the river's salinity at NIB and facilitating Reclamation's ability to meet the salinity differential. Modeling a range of sources of voluntary reductions under ICS and CBS, including some that would otherwise discharge brackish return flows to the Colorado River between Imperial Dam and NIB, would provide better information to the reader and allow for better analysis of the alternatives.

Table ES-2 (DEIS at ES-18) should include a row describing projected salinities at NIB under 54
each of the alternatives, and/or the salinity differential relative to Imperial Dam. The discussion of salinity at the NIB in Section 3.5.1 should be expanded, and should include a figure depicting 55
annual salinities and flow at the border, similar to the figures included for other points along the river.

Biological Resources

We recognize that Reclamation has taken the position that it is under no obligation pursuant to 56
NEPA to evaluate the impacts of this federal action on environmental values in Mexico.

G-5

11

However, we nevertheless suggest that some consideration of these impacts is warranted, if 57
nothing else as a matter of international comity. This is particularly true in light of the fact that, of all of the portions of the Colorado River most likely to be directly affected by this action, the limitrophe and the Mexican portions of the Colorado River Delta will likely bear the greatest risk.

Conservation groups have defined restoration of the riparian corridor of the Colorado River delta as a major priority,[9] and have identified restoration of pulse flows to the delta as a central requirement for success. There are long-standing debates over how this water should be supplied, but no disagreement about the benefits of such pulse flows. By adopting an ICS program that leaves the door open to an international agreement that would allow for the generation and delivery of ICS as dedicated flow for the delta, the federal government would 55
facilitate the best remaining opportunity to restore native habitat on the Colorado River, impacting the 23 miles of the delta's riparian corridor in Arizona, and the final miles of the river down to its outlet in the Upper Gulf of California.

The significance of restoring the riparian corridor below Morelos Dam is immense, as this is one of the only reaches of the Lower Colorado River where an opportunity exists to use pulse flows to create overbank flooding necessary to sustain viable native cottonwood and willow habitat. 59
Above Morelos Dam, scheduled year-round water deliveries create high base flows in a relatively large channel, such that very large floods would be necessary to re-create such floods throughout most of the corridor. Below Morelos Dam, there are no scheduled deliveries for water users, base flows are low in a relatively small channel, such that relatively small floods, such as those contemplated in the CBS proposal, could provide the necessary overbank flows. Please see our letter to Reclamation, dated February 15, 2007, regarding the Environmental Assessment for the Lower Colorado River Drop 2 Storage Reservoir Project, for additional 60
information on the environmental resources and affected environment in the limitrophe reach.[10]

Several existing and planned habitat restoration projects would benefit directly from pulse flows in the delta, including 20 acres already planted with native vegetation between the railroad bridge and the Carranza Crossing, with 4,400 more acres planned for restoration, 90 acres 61
planned in the near term for Hunters Hole, and 100 acres planned for the near term on the Cocopah Reservation. The entire riparian corridor of the Colorado River below Morelos Dam has been identified as a priority for restoration in the long term.[11]

Of particular concern for Mexico in the Basin States alternative will be the provisions related to the implementation of shortages on the Lower Colorado. Although the 1944 Treaty provides that 62
Mexico is to share "proportionately" with U.S. users in times of "extraordinary drought," the precise meaning of this provision remains unclear, and it has never been invoked since the time

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[9] Sonoran Institute et al., 2005. Conservation Priorities in the Colorado River Delta: Mexico and the United States.

[10] The exceedingly brief description of baseline conditions for wildlife in the limitrophe yields a similarly deficient impact analysis. For example, the DEIS (at 4-200) states that there will be no impacts to special status fish, plants or amphibians from the NIB to SIB because none exist. There are, however, several special status species in this reach, as demonstrated in Table 3.2-4 of the Drop 2 EA. The DEIS is also completely silent as to special status birds, such as the Southwestern willow flycatcher and the Yuma clapper rail. The EIS must account for impacts – adverse and beneficial – to these species.

[11] Conservation Priorities in the Colorado River Delta: Mexico and the United States (2005; Sonoran Institute et al).

G-5

12

of the Treaty's execution. The Basin States Alternative unilaterally and precisely defines a set of proposed parameters under which shortages would be implemented against the Mexican 63
allocation. We recognize that Reclamation has not itself proposed any specific shortage amount to Mexico; it has only adopted a potential shortage value as a modeling assumption. However, 64
this modeling assumption demonstrates that Mexico will bear a significant risk of shortage under the Basin States Alternative (as well as other alternatives).

Because Mexico has no readily available mechanisms to reduce or mitigate against shortage impacts on its users (such as reservoir storage or water banking), shortages in Mexico will 65
generate impacts as significant, if not more significant, than those that would arise among low-priority users in the U.S. These impacts would translate directly to environmental impacts in the Colorado River delta, which relies primarily on excess deliveries and agricultural drainage flows 66
for its water supply.

Just as significantly, both the Basin States alternative and CBS will create incentives to further increase the efficiency of U.S. water delivery systems by providing opportunities to receive ICS 67
credits for the funding of these projects (e.g., Southern Nevada Water Authority's proposed funding of the Drop 2 reservoir). On an individual and cumulative basis, these projects will reduce normal-year deliveries to Mexico by decreasing the volume of non-storable flows. 68
Combined with gradually increasing efficiency in agricultural water use throughout the system, the restriction of ICS as proposed by the Basin States will continue to pose challenges for the maintenance of critical environmental values in the delta, which receive virtually all of their 69
current water supplies from agricultural return flows, excess deliveries, canal leakage, and occasional flood events.

Regardless of whether Reclamation is required to consider environmental impacts south of the border, Reclamation need not ignore environmental benefits that might be associated with a 70
given alternative, particularly where those benefits would implicate endangered species and migratory birds in the United States. Indeed, a primary advantage of CBS is that it would provide a storage mechanism that could be used to improve environmental conditions in Mexico 71
(assuming the adoption of appropriate international agreements), some consideration of these benefits, however speculative, seems appropriate.

We urge Reclamation to expand the discussion of biological resources in section 3.8.1.4 and 72
potential negative and positive impacts of the proposed alternatives in section 4.8.4.7. For your consideration, we include the following relevant information.

Biological resources below NIB
The remnant riparian and marsh wetlands areas in the Colorado River delta in Mexico, and the 73
limitrophe area in the U.S. provide crucial habitat to several threatened and endangered species listed in Mexico and the U.S. and a key stopover along the Pacific Flyway. These wetlands provide habitat essential to over 350 species of land and aquatic migratory birds on their seasonal traverse of the continent. A recent survey of birds found densities to be 10 times higher in the Colorado River delta, than on the river above Morelos Dam.[12] Endangered species, including

[12] Hinojosa-Huerta, 2006. Conservation of Birds in the Lower Colorado River Delta, Mexico. Dissertation from the University of Arizona, Tucson.

G-5

the Yuma clapper rail and the Southwestern willow flycatcher, as well as the Yellow-billed cuckoo (under consideration for federal protection) rely on Colorado River habitat south of NIB, as do a number of species listed as wildlife of special concern by the state of Arizona. Ten species of breeding birds and fourteen species that use the Colorado River south of NIB as stopover or wintering ground have acquired legal protection status under Mexican laws (Endangered, Threatened, or Special Protection).[13]

Table 1.[14] Bird species under a protection category in Mexico or of conservation concern in the Colorado River delta.

Species	Protection Category	Breeding Status	Relative Abundance	Temporal Presence
Least Grebe	SP	NB	CA	SU
Laysan Albatross	TH	NB	RA	SP
Black Storm-Petrel	TH	NB	CO	PE
Least Storm-Petrel	TH	NB	CO	PE
Reddish Egret	SP	BR	RA	SU
Roseate Spoonbill	NP	NB	EX	WI
Fulvous Whistling-Duck	NP	BR	EX	SU
Brant	TH	NB	UN	WI
Bald Eagle	EN	NB	UN	WI
Sharp-shinned Hawk	SP	NB	UN	WI
Cooper's Hawk	SP	NB	UN	WI
Harris' Hawk	SP	NB	UN	WI
Red-shouldered Hawk	SP	NB	CA	WI
Swainson's Hawk	SP	NB	UN	WI
Ferruginous Hawk	SP	NB	RA	WI
Peregrine Falcon	SP	NB	UN	WI
Prairie Falcon	SP	NB	RA	WI
California Black Rail	EN	BR	RA	PE
Yuma Clapper Rail	TH	BR	CO	PE
Virginia Rail	SP	BR	CO	PE
Sandhill Crane	NP	NB	EX	WI
Snowy Plover	TH	BR	UN	SU
Heermann's Gull	SP	NB	CO	PE
Gull-billed Tern	NP	BR	CO	PE
Elegant Tern	SP	BR	RA	SU
Least Tern	SP	BR	UN	SU
Yellow-billed Cuckoo	NP	BR	UN	SU
Western Screech-Owl	NP	BR	RA	SU
Short-eared Owl	SP	NB	RA	WI
Gilded Flicker	NP	BR	EX	SU
Southwestern Willow Flycatcher	NP	BR	EX	SU
Bell's Vireo	NP	BR	RA	SU
Lucy's Warbler	NP	BR	EX	SU
Summer Tanager	NP	BR	EX	SU
Large-billed Savannah Sparrow	SP	BR	CO	SU

[13] See Table 2 in Diario Oficial de la Federación (DOF), 2002. Norma Oficial Mexicana NOM-059-ECOL-2001, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Secretaría de Medio Ambiente y Recursos Naturales. México, D.F. Marzo 6.

[14] From Hinojosa-Huerta, 2006. Four codes are given for each species: **Protection Category** in Mexico (SP – Special Protection, TH – Threatened, EN – Endangered, NP – No Protection), **Breeding Status** (NB – Non-breeding, BR – Breeding), **Relative Abundance** (EX – Extirpated, CA – Casual, RA – Rare, UN – Uncommon, CO – Common), and **Temporal Presence** (WI – Winter, SP – Spring, SU – Summer, PE – Perennial). Abundance categories follow M.A. Patten, E. Mellink, H. Gómez de Silva, and T.E. Wurster. 2001. Status and taxonomy of the Colorado Desert avifauna of Baja California. *Monographs in Field Ornithology* **3**:29-63.

G-5

The importance of the Colorado River riparian corridor south of NIB for the conservation of birds has been recognized both nationally and internationally. In Mexico, a portion of the delta's wetlands are protected by the Upper Gulf of California and Colorado River Delta Biosphere Reserve.[15] The delta is also an Important Bird Area in Mexico, and a priority site for the conservation of biodiversity as decreed by the National Commission on Biodiversity.[16] This ecosystem has additionally been recognized as a wetland of international importance by the Ramsar Convention,[17] and is part of the Western Hemisphere Shorebird Reserves Network.[18]

A century ago, the cottonwood-willow forest was very common in the Colorado River delta. Currently, only approximately 7,500 acres of cottonwood-willow forest remain. Most of the present vegetation in the riparian corridor has been regenerated by flood releases from the U.S. over the last 20 years. These areas of native vegetation have been maintained by non-storable flows from the U.S, and Mexico. Reclamation estimates an average of more than 70,000 acre-feet/year of deliveries in excess of Treaty requirements at NIB (see Drop 2 Draft Environmental Assessment, November 2006), some of which are passed directly below Morelos Dam, and some of which reach the riparian corridor via wasteways.

The riparian corridor is used by migrating species, and thus its ecological value cannot be considered in isolation. Neotropical migratory songbirds travel through this region on their journey to northern breeding areas in the U.S. and Canada and to their wintering grounds in southern Mexico and Central America. These species migrate along the Sonoran coast of the Gulf of California, and the Colorado River delta provides their first opportunity to stop in native riparian habitat where food and cover are abundant. The rarity of cottonwood-willow forest in this reach of the migration route —populations of riparian obligates have been significantly reduced on the Lower Colorado River—adds significantly to the importance of the remaining Colorado River riparian corridor below Morelos Dam.

While there is a distinct difference between the quality of Colorado River riparian habitats below and above Morelos Dam, it remains important to recognize the connectivity of the water source and the potential for connectivity in habitat. The abundance of water birds in the delta's riparian corridor has been increasing during recent years, with the creation of lagoons and marshes. Several species of waterfowl are now common in the area, with an estimated 2,000-4,000 thousand individuals each winter, in particular Mallard, American Widgeon, Northern Pintail, Green-winged Teal, and Cinnamon Teal. The riparian corridor also provides unique habitat types (freshwater river banks) for some sensitive species, such as the Spotted Sandpiper.

Flood control releases and over-deliveries, as well as groundwater and local agricultural returns are all important water sources for the Colorado River riparian corridor south of NIB, and each of these water supplies might be impacted as system efficiency improvements are implemented.

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[15] SEMARNAP. 1995. Programa de Manejo Reserva de la Biosfera del Alto Golfo de California y Delta del Río Colorado. Secretaria del Medio Ambiente, Recursos Naturales y Pesca, Publicacion Especial 1, México D.F.
[16] M. Cervantes, M.J. Román, y E. Mellink. 1999. AICA: NO-17 Delta del Río Colorado. En: Benítez, H., C. Arizmendi, y L. Márquez. Base de datos de las AICAS. CIPAMEX, CONABIO, FMCN y CCA. (http://www.conabio.gob.mx).
[17] Ramsar Convention Bureau. 1998. See http://www.iucn.org/themes/ramsar/about_infopack-2e.htm
[18] Western Hemisphere Shorebird Reserve Network. 1993. Western Hemisphere Reserve Network Site Profiles. WA publication No. 4, Wetlands for the Americas, Manomet and Buenos Aires.

G-5

Significantly, the CBS alternative creates a mechanism to deliver conserved water to the riparian corridor south of NIB. 74

Socio-Economic Impacts

One significant benefit of CBS as compared to any other alternative under consideration in the DEIS is that the first 600,000 acre-feet of potential "shortages" are avoided under CBS through 75 voluntary, compensated forbearance rather than involuntary shortages imposed on lower-priority users. The existence of a compensation mechanism clearly limits the extent of economic impact that will be associated with a "water delivery reduction," since the individual farmer or water user that experiences the reduction receives fair market compensation for voluntarily undertaking 76 the reduction. Properly designed, such a mechanism should have the effect of mitigating economic impacts to individual farmers, local farm economies and labor markets, and local tax bases.

Under market conditions, forbearance should be distributed preferentially to those uses of water that produce the lowest economic returns. As such, one would anticipate that low-value crops would be fallowed before any higher-value crops or municipal uses. To the extent that farmers or other users seeking to participate in such a program might be able to obtain higher returns for their water via forbearance than they could via the normal use of that water, these users would realize greater economic benefits from voluntary conservation than they would otherwise receive.

These same assumptions cannot be made for involuntary shortages, since these will be governed by the water right and contract priority systems within each state. Within Arizona, for example, the existing system of priorities among CAP and the various on-river users would leave on-river municipalities exposed to significant shortages well before lower-value, higher-priority agricultural uses, and virtually every user on the CAP canal would be exposed to shortages prior to any of the present perfected right holders in the state. Moreover, even within the agricultural community, agricultural users would be reduced based on the relative priority of their rights. As such, CAP contracts for high-value agricultural users could be reduced before contracts or higher priority on-river rights dedicated to low-value agricultural crops. A market based program could also reflect the additional value of senior water right or contract priorities and tends towards the reduction of the lowest value and lowest priority users, but those choices would be made in the 77 marketplace.

In addition, the benefits and/or costs of voluntary conservation efforts would not necessarily accrue in just one state – for example, although few if any involuntary shortages would ever reach California under the Basin States alternative, farmers and other water users in any of the 78 Lower Basin states could potentially participate in voluntary fallowing, depending on market demand. Under CBS, the door would be left open to potential Mexican participation as well – mitigating the socio-economic and environmental impacts from involuntary shortages in Mexico 79 and avoiding international conflict over the unilateral imposition of shortages.

The DEIS makes clear that once shortages occur, there is a significant likelihood that they will be sustained over multiple years. Involuntary shortages will necessarily be distributed to low-priority users for long periods, causing sustained economic disruptions in the communities where

G-5

16

those users are located. By contrast, voluntary conservation will not necessarily fall on the same
users year after year, since individual users will be able to decide whether or not they can and 80
should participate in voluntary conservation or fallowing efforts each year.

Insofar as the DEIS has followed existing priority schedules within Arizona when assigning
involuntary shortages and has not evaluated the greater geographic and more flexible distribution 81
of voluntary conservation, it has underestimated both the economic impacts associated with
involuntary shortages under the Basin States alternative and the relative benefits of voluntary 82
conservation under CBS. In analyzing socio-economic impacts, the DEIS implies that data on
cost of water and on market prices for irrigation forbearance are needed to compare the Basin
States alternative and CBS (DEIS at 4-264 through 266). In fact, no cost of water or market data
were considered in analyzing the impacts of the involuntary shortages imposed under either
alternative, while the same partial farm budgets that were applied to compare the socio-economic 83
impacts of involuntary shortages in the agricultural sector in Arizona, could be applied to
quantify a monumental difference in the socio-economic impact of these two alternatives. That
is, the net agricultural income from voluntary conservation at a large scale would not be lost
under CBS, and would offset such direct socio-economic losses from the involuntary shortages
that could be imposed under the Basin States alternative. Institutionalizing the rotational
elements of voluntary conservation and not permanently retiring irrigation would also offset 84
much more of the indirect socio-economic losses.

Although it may not be possible to quantify all the socio-economic benefits of CBS, the preferred 85
alternative should not be formulated without recognizing them clearly and concretely.

CBS Funding

The DEIS notes that "the viability of the Conservation Before Shortage program funding
proposal is not known at this time. Reclamation does not have the authority to implement all
facets of this proposal and additional legislation would be necessary to gain such authority."
(DEIS at 2-13). While we fully recognize that some aspects of CBS would require new
legislative authority to implement, we would also note that with year-to-year appropriations, the
funding viability of any federal program is not known with certainty. Key aspects of both CBS 86
and the Basin States alternative are contingent on the outcome of future international diplomacy,
which is currently unknown.

This blanket statement also fails to recognize the fact that the authority and funding for one 87
major element of CBS – the bypass flow replacement component – is better known.
Reclamation does have a mandate, or at least authority and some annual funding, to engage in
compensated water reductions on the Lower Colorado River. Under the Colorado River Basin
Salinity Control Act, 43 U.S.C. § 1574, the replacement of the annual MODE bypass flow is a 88
"national obligation" for which Reclamation is responsible. Until recently, this obligation was
satisfied by the lining of the Coachella Valley Canal; however, at this point it is once again an
active federal obligation. As such, the consideration of a compensated mechanism for reducing
water use - at least to the extent of the national bypass flow replacement obligation – is entirely 89
consistent with the existing requirements of federal law. We note that Reclamation is currently 90
considering several potential mechanisms for bypass flow replacement resulting from the work

G-5

17

of the YDP/Ciénega de Santa Clara Working Group. These include a voluntary fallowing program that would operate in a manner essentially similar to that proposed by CBS. 90

Moreover, Reclamation has the ability in a NEPA analysis to consider alternatives that are outside its jurisdiction, *see* 40 C.F.R. § 1502.14(c), or require legislation for implementation. *See City of Sausalito v. O'Neill*, 386 F.3d 1186, 1208-09 (9th Cir. 2004) (cautioning that an alternative may be reasonable and not excluded from an EIS even if it requires additional legislative action); *Natural Resources Defense Council v. Morton*, 458 F.2d 827, 837 (D.C. Cir. 1972) (reasoning that "[t]he mere fact that an alternative requires legislative implementation does not automatically establish it as beyond the domain of what is required for discussion, particularly since NEPA was intended to provide a basis for consideration and choice by the decision-makers in the legislative as well as the executive branch"). 91

Environmental Justice

The action alternatives' potential environmental justice impacts merit greater consideration and description in the FEIS. Other sections in the DEIS assess potential impacts over a range of shortage volumes. Instead, section 4.15 uses only one example, of the potential job loss of a 500,000 acre-foot shortage, in an effort to suggest that potential effects on environmental justice communities would be negligible. This is insufficient and unsubstantiated. 92

Expanded Opportunities for Bi-National Conservation

The inclusion of an expanded ICS program and a federally-controlled bank allotment in Lake Mead that would allow for U.S. federal, future Mexican participation, and/or non-contractor participation in ICS will also produce a series of potential benefits that deserve consideration in the NEPA process. 93

The Basin States alternative is largely concerned with water delivery operations between and among the Basin states, particularly the states of the Lower Basin. However, there are other interests that could potentially be met through U.S. federal participation in a Lake Mead banking program, including obtaining temporary water supplies for federal reservations, environmental programs (including MSCP), salinity control needs, protection of the power head at Hoover Dam or of recreational values, speculative accumulation of bypass flow replacement or other credits, or providing a reserve supply for water exchanges. This same mechanism could be used by current non-contractors to meet private water supply needs as well.

Reclamation's modeling clearly demonstrates that there would be no net increase in shortage risk associated with the maintenance of a federal bank allotment; quite to the contrary, the modeling shows a net benefit from the existence of such a bank insofar as this would tend to keep reservoir levels in Mead somewhat higher than would be expected with the smaller banking allotments provided by the Basin States Alternative. Given this net benefit to water users and the significant ancillary benefits that could be realized through a federal allotment, the inclusion of such a mechanism in the final preferred alternative adopted through the NEPA process is appropriate. 94

It should also be noted that the inclusion of a federal banking allotment and ICS program would be consistent with and build on the Basin States Alternative, as it would not alter the rules under which the Basin States would participate in ICS, change the relative size of any of the states' ICS 95

G-5

18

banks, or require interpretations of the various provisions of the Law of the River different than those implicated by the Basin States Alternative. All of the activities discussed above would seem to be well within Reclamation's inherent river regulation authority under the Boulder Canyon Project Act. 95

Obviously, any Mexican participation in an ICS program would require appropriate amendments to the current international framework to allow for temporary reductions or increases in Treaty deliveries. These could clearly be accomplished via the adoption of a new Minute to the Treaty of 1944 by the International Boundary and Water Commission. 96

Since these amendments to the Treaty framework are not currently in place, Reclamation cannot assume that such programs will in fact be established in the future. However, insofar as some elements of the Basin States proposal have expressly contemplated Mexican participation in shortages, we suggest that some consideration of the potential benefits of Mexican participation in the NEPA process is warranted, since the implementation of the Seven States Agreement on which the Basin States Alternative is premised – most notably the proposed shortage policy and proposed policies for unilateral water exchanges – will already require consultation with Mexico and/or the adoption of a new Minute. Other opportunities for Mexican participation could be considered in the same diplomatic process. 97

As discussed in the white paper attached to the CBS submittal, *Taking ICS to Mexico*, significant benefits for U.S. water users, Mexican water users, and the environment could potentially be derived from extending proposed policies related to ICS, system efficiency improvements, and water exchanges to include water users in Mexico. Such a program could provide significant assistance in resolving difficult issues related to urban, agricultural, and environmental water supplies in Mexico, while opening enormous opportunities for both U.S. and Mexican water users to obtain water supplies via funding of irrigation efficiency improvements, the construction of urban water infrastructure, water supply replacement or enhancement, desalination, and other projects. 98

These credits could be used to firm up urban water supplies in both countries, engage in long-studied environmental restoration projects in the Delta, and increase flexibility in Mexico's agricultural sector – creating economic, environmental, and social benefits in both countries while offering the United States and Mexico a venue for cooperation in the otherwise contentious area of water management at the border. These opportunities would clearly help to offset the negative impacts to Mexico that might otherwise be associated with a shortage strategy.

Given the potential benefits, we urge Reclamation to leave the door open to such a program in the preferred alternative and the ROD, and include both an unassigned banking allotment and a broader ICS mechanism. 99

Individual Technical Corrections to the DEIS

p. 3-17 delete "to construct" from quoted material 100

p. 4-76 lines 13-19 appear out of place. Are they a repeat of p.4-41 lines 16-22? 101

p. 4-164 section 4.8.2.2 discussing NIB to SIB should refer to pulse flows below Morelos Dam rather than "excess" flows as ICS for delta would by definition be a dedicated flow for a beneficial use, and therefore not "excess." 102

p. 4-170 lines 15-17 statement re: volume of water passing Morelos being rare [*sic*] and unimportant for vegetation and wildlife is false. See our comments on the Drop 2 draft EA for documentation of the importance of these flows. 103

p. 4-170 line 39 why would CBS increase flows by 0.4 mafy? Is this due to incorrect assumption about M&I water? 104

p. 4-171 line 4 pulse flows every other year – incorrect for same reasons 105

p. 4-200 lines 15-16 pulse flows every other year- incorrect for same reasons 106

p. 4-203 lines 3-5 "These benefits were deemed moderate because flows in this reach are currently rare and any additional flow in this reach is assumed to be beneficial." By what criteria are these benefits deemed moderate rather than major? 107

p. P-86. Once corrected as noted above, figure P-61 should be labeled as "Flows Below Morelos Diversion Dam." 108

IV. Conclusion

Once again, we thank Reclamation for its extensive assistance in developing, modeling, and considering CBS for the DEIS, and ask that Reclamation incorporate our comments as it refines CBS and its environmental and socio-economic analyses for the Final EIS. We welcome the opportunity to meet with Reclamation to discuss these matters further if this would be of assistance in Reclamation's analysis.

We believe that the current NEPA process represents a significant potential turning point in the history of the Law of the River, one which offers significant opportunities for both water users and environmental values on the River – but which also carries with it significant economic, environmental, and diplomatic risks. 109 The Basin States Alternative, and the Seven States Agreement upon which it is built, represents a significant potential step forward for water management in the Lower Basin; however, in isolation it does not step far enough to ensure the protection of environmental values in the Lower Basin and Mexico and assist the development of an international agreement between the U.S. and Mexico that will be necessary to implement the States' proposed shortage policy. 110

Two components of CBS, the expansion of the ICS program to other users in the U.S. and Mexico, and the provision of a voluntary, compensated mechanism for shortage mitigation, are particularly critical in this regard, and we believe the analysis conducted to date strongly bears out the importance of these mechanisms. We strongly urge Reclamation to adopt these elements as a part of the preferred alternative in the Final EIS. 111

G-5

20

Thank you for your consideration of these comments. We look forward to continuing to work with Reclamation over the coming months as Reclamation moves to prepare its Final EIS and Record of Decision.

Sincerely,

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G-5

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Reponses to Comment Letter G-5

G-5-1

Your comment is noted.

G-5-2

Your comment is noted.

G-5-3

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment, as well as other public comments. Section H.6. of the Final EIS includes an additional assessment that considers the impacts of a compensated voluntary conservation program. This assessment indicates that the positive benefits of such a program will vary extensively and will depend on the type of program developed, the size and length of the program, the local and regional economics, and the participants.

G-5-4 and G-5-5

See response to Comment No. F-4-9.

G-5-6 through G-5-9

Your comment is noted. No change to the Final EIS was necessary.

G-5-10

Your comment is noted. No change to the Final EIS was necessary.

G-5-11 and G-5-12

Your comment is noted. No change to the Final EIS was necessary.

G-5-13

See response to Comment Nos. F-5-2 and F-5-5.

G-5-14

See response to Comment Nos. F-5-2 and F-5-5.

G-5-15

Reclamation concurs with this comment. However, as noted in Section 4.4 and Section 4.14, the total water delivery reductions that occur under the Conservation Before Shortage Alternative include both voluntary and involuntary reductions and the frequency and magnitude of these total reductions under the Conservation Before Shortage Alternative are comparable to those observed under the Basin States Alternative and the Preferred Alternative.

G-5-16

Your comment is noted. As noted in the response to Comment No. G-5-3, the assessment conducted by Reclamation in Section H.6 of the Final EIS indicates that the positive benefits of such a program will vary extensively and will depend on the type of program developed, the size and length of the program, the local and regional economics, and the participants.

G-5-17

Your comment is noted. Additionally, it is noted that under a compensated voluntary conservation program, the lands that would first likely be affected would be those that have the lowest productivity and/ or are less profitable. These lands would most likely be affected under both compensated, voluntary conservation or involuntary shortage since agencies that would be affected by involuntary shortages would also consider these same lands during a shortage as a source for dry year water transfers.

G-5-18

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment, as well as other public comments. In the assessment conducted by Reclamation (Section H.6 of the Final EIS), Reclamation determined that the per acre-foot payments to growers varied widely under a compensated voluntary conservation program. Other cost factors that would need to be considered in addition to the per acre-foot cost include: program administration, dust/weed control and other environmental mitigation, and other payments that may be needed to mitigate other third-party impacts.

G-5-19

As shown on Figure 4.4-2 and 4.4-3 in the Final EIS, the probability of water delivery reductions and the average shortage volumes is similar between the Conservation Before Shortage and the Basin States Alternative. The Preferred Alternative has somewhat lower probabilities of voluntary and involuntary shortage over the entire interim period when compared to the Basins States and Conservation Before Shortage alternatives.

G-5-20

See response to Comment No. F-4-9.

G-5-21 and G-5-22

This comment fails to accurately reflect the information published by Reclamation in the Draft EIS in Section 4.4.4.1 (page 4-82) and other places throughout the document. However, in light of the apparent confusion caused by this discussion in the Draft EIS, Reclamation has made editorial revisions to the Final EIS in Section 4.4.4.1 to avoid any confusion on this matter; specifically, language has been added in Section 4.4.4.1 that better explains the mechanism for voluntary versus involuntary water delivery reductions. To further distinguish these differences, involuntary and voluntary shortages are analyzed separately in several instances in the Final EIS to express the differences and respective effects, as appropriate.

G-5-23

Your comment is noted. As described in Appendix M of the Final EIS, it is unknown which entities might participate in the storage and delivery mechanism contemplated under several of the action alternatives. Further it is unknown at what levels they might participate, the specific water conservation projects that may be developed to create the water supply, and also where the conserved water will be used and when. Modeling assumptions with respect to the entities that might participate and their respective level of participation were used to determine potential effects of the storage and delivery mechanism on environmental resource, particularly to reservoir storage and river flows downstream of Lake Mead. See also responses to Comment Nos. F-5-2 and F-5-5

G-5-24

Your comment is noted. No change to the Final EIS was necessary.

G-5-25 and G-5-26

Your comment is noted. No change to the Final EIS was necessary.

G-5-27

Information presented in the Draft EIS has been modified in the Final EIS (see Section M.3.2, Appendix M) pursuant to this specific comment, as well as other public comments. Accordingly, the second heading in Table M-5 of the Final EIS has been modified to reflect this comment. Specifically, the description of the second set of flows has been changed and the word “environmental” has been deleted from the term – “Other Environmental Flows Below the NIB.” Also, language has also been added in this section that notes that “these second set of flows could be used by Mexico or the sponsor of the conserved water for varying purposes.”

G-5-28

The flows shown in Figure P-61 of the Draft EIS represents the probability of occurrence of any flows in excess of Mexico’s scheduled water deliveries. These include excess flows that occur when Lake Mead is in flood control release conditions, as well as flows associated with the storage and delivery mechanism. The CRSS model ends at NIB and a separate node was added next to the NIB to account for all flows that arrive in excess of Mexico's schedule deliveries. The model does not model how or where these flows would be used. The general assumption in the analysis is that these flows would pass the Morelos Diversion Dam. However, it is recognized that Mexico could divert any or all of these flows that arrive at the Morelos Diversion Dam and this would be done solely at their discretion at the quantities that they determine are appropriate.

G-5-29

Your comment is noted. No change to the Final EIS was necessary

G-5-30

Your comment is noted. No change to the Final EIS was necessary. The Basin States Alternative and the Preferred Alternative both include provisions for consultation when the Lake Mead water level falls below elevation 1,025 feet msl. For modeling purposes, it was assumed the 600 kafy shortages would continue down to the top of the Lake Mead dead pool elevation.

G-5-31 through G-5-33

Your comment is noted. No change to the Final EIS was necessary. See also responses to Comment Nos. F-5-2 and F-5-5.

G-5-34

Information presented in the Draft EIS has been modified in Section M.3.2. of the Final EIS pursuant to this specific comment, as well as other public comments. The description in Section M.3.2. was clarified to account for the flows as an additional delivery to Mexico.

G-5-35

Your comment is noted. No change to the Final EIS was necessary.

G-5-36

The Department of Interior or Reclamation currently does not have the authority to implement all facets of the funding proposal of the Conservation Before Shortage proposal and additional legislation would be necessary to gain such authority. As such, the viability of this funding proposal is not known at this time. Additionally, Reclamation it is beyond the scope of this EIS to analyze alternative funding strategies for any alternative or component of an alternative.

G-5-37

This comment fails to accurately reflect the information published by Reclamation in the Draft EIS in Section 4.11.2.6 and in other locations within Section 4.11. However, in light of the apparent confusion caused by this discussion in the Draft EIS, Reclamation has made editorial revisions to Section 4.11.2.6 of the Final EIS to affirm that a surcharge was not included in the economic analysis.

G-5-38

Your comment is noted. No change to the Final EIS was necessary.

G-5-39

Your comment is noted. No change to the Final EIS was necessary.

G-5-40 through G-5-43

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment, as well as other public comments. Accordingly, the content of the Final EIS has been modified to reflect this public input. For the Final EIS, a Preferred Alternative has been identified and evaluated and draft operational guidelines have been included in Appendix S.

G-5-44

The geographic scope identified for this EIS (Section 3.2) corresponds to the specific issues and potential effects associated with changes in the operations of Lake Powell and Lake Mead, as discussed and analyzed under the alternatives considered in this Final EIS (see Chapter 2).

G-5-45

Reclamation does not concur with this comment. The Draft EIS addressed this issue in Section 4.4 and Section 4.14.

G-5-46

Reclamation does not concur with this comment. The Draft EIS identified and addressed a wide of range of potential impacts to environmental resources within the affected area. The potential impacts were fully disclosed in the Draft EIS and clarifying information has been included in the Final EIS in response to public comment.

G-5-47 and G-5-48

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

G-5-49

Your comment is noted. No change to the Final EIS was necessary.

G-5-50

Your comment is noted. The interim nature of the guidelines is intended to provide an opportunity to evaluate how the guidelines work. In addition, opportunities for review of the effectiveness of the guidelines are anticipated to be available both throughout the proposed interim period and at intervals during the interim period. Such reviews would provide a basis for possible further federal actions and decisions at the end of the interim period. Reclamation anticipates that a review of the guidelines will be conducted at a time prior to the end of the interim that would allow the Department, and the public, to assess the effectiveness of the guidelines and to determine the most appropriate course of action for the post-interim period.

G-5-51

Your comment is noted. No change to the Final EIS was necessary. Please note that the CRSS salinity module is primarily used to model the effects of salinity control projects on the salinity numeric criteria locations (Below Hoover, Below Parker, and at Imperial Dam). While compliance with the differential required by Minute 242 is not modeled in CRSS, the compliance objectives are achieved by the daily and monthly operational decision that are made by the Yuma Area Office in the management of the Mexico deliveries and management of the drainage flows from the Yuma area.

G-5-52 and G-5-53

Your comment is noted. The United States will continue to undertake activities to comply with the provisions of Minute 242 and these activities will not be affected by the proposed federal action.

G-5-54 and G-5-55

See responses to Comment Nos. G-5-51 and G-5-52.

G-5-56 and G-5-57

Your comment is noted. The information requested is provided in Section 5.1.19 and Section 6.8 of the Final EIS.

G-5-58

Your comment is noted. No change to the Final EIS was necessary.

G-5-59

Your comment is noted. No change to the Final EIS was necessary.

G-5-60

Your comment is noted. No change to the Final EIS was necessary.

G-5-61

Your comment is noted. No change to the Final EIS was necessary.

G-5-62 through G-5-64

See responses to Comment Nos. F-5-2 and F-5-4.

G-5-65

See response to Comment No. F-5-18.

G-5-66

Reclamation does not concur with this comment. As noted in Section 4.3.9, none of the alternatives are expected to adversely affect the frequency or magnitude of excess flows to Mexico. See also response to Comment No. F-5-8.

G-5-67 through G-5-69

Your comment is noted. No change to the Final EIS was necessary. The guidelines and programs considered as part of the proposed federal action will enable the entities within the United States to manage the waters allotted to them pursuant to the Law of the River in a more effective manner. See also response to Comment No. F-5-22.

G-5-70 through G-5-74

Your comment is noted. No change to the Final EIS was necessary.

G-5-75 through G-5-85

See responses to Comment Nos. G-5-21 and G-5-23.

G-5-86

Your comment is noted.

G-5-87 through G-5-90

See response to Comment No. F-4-9.

G-5-91

Reclamation concurs with this comment. The Conservation Before Shortage Alternative was not eliminated from consideration even though Reclamation currently lacks the authority to implement all aspects of the alternative. See also response to Comment No. G-5-36.

G-5-92

The information requested is provided in the Draft EIS and the Final EIS. The text in Section 4.15.2 of the Final EIS states this was just one example of how the shortages would be distributed. The socioeconomic analysis in Section 4.14 of the Final EIS describes how additional shortages would affect communities throughout the affected environment.

G-5-93 through G-5-95

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment, as well as other public comments. For the Final EIS, a Preferred Alternative has been analyzed that provides for the maximum annual creation volume of 4.2 maf. The larger ICS provides the opportunity for future expansion of the program, with the potential for additional participants. See also response to Comment No. F-5-2.

G-5-96

Your comment is noted. No change to the Final EIS was required.

G-5-97 through G-5-98

See responses to Comment Nos. F-5-2 and F-5-5.

G-5-99

See response to Comment No. G-5-93.

G-5-100

Reclamation does not concur with this comment. The quoted material from the Colorado River Project Storage Act includes the words "to construct" as quoted in the Draft EIS in Section 3.3.2. However, after reviewing this comment, and considering public input, Reclamation has stricken the referenced words to avoid any confusion. This revision does not significantly or material change the statement or the impact analysis or results presented in the DEIS.

G-5-101

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment, as well as other public comments. The content of the Final EIS has been modified to reflect this public input and the referenced paragraph in Section 4.3.9 has been deleted and is no longer included in the Final EIS. This revision does not materially change the context of the paragraph or significantly change the impact analysis or results presented in the Draft EIS.

G-5-102

Your comment is noted. No change to the Final EIS was necessary.

G-5-103

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment, as well as other public comments. The referenced language in Section 4.8.3.7 has been deleted in the Final EIS.

G-5-104

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment. Section 4.8.3.7 of the Final EIS has been modified to reflect this public input. The volume with respect to the difference between the Conservation Before Shortage Alternative and the No Action Alternative is 0.35 maf and this difference occurs in year 2019. This revision does not significantly change the impact analysis or results presented in the Draft EIS.

G-5-105 and G-5-106

Information presented in the Draft EIS has been modified in Section 4.8.3.7 and Appendix M of the Final EIS pursuant to this specific comment, as well as other public comments. Section 4.8.3.7 and M.3.2 of the Final EIS has been revised to differentiate between the different flows that are provided in the Conservation Before Shortage Alternative. This revision does not significantly change the impact analysis or results presented in the DEIS since this revision only affects the description of these flows and not how the flows were modeled.

G-5-107

Your comment is noted. No change to the Final EIS was necessary. The benefits of the pulse flows below Morelos Dam associated with the Conservation Before Shortage Alternative were identified in the Draft EIS and Final EIS. These benefits were deemed moderate. These benefits were not deemed minor because the probability of significant flows would be greater under Conservation Before Shortage Alternative as compared to those under the No Action Alternative, and the river corridor in this reach allows overbank flooding at lower flows than upstream sections of the river. The benefits were not deemed major since a major benefit would be caused by a flow regime that was closer to pre-dam conditions where regular flows and overbank flooding likely occurred annually during spring runoff. These periodic pulse flows still remain distinct from the flows that existed under pre-dam conditions and therefore a major designation was not warranted.

G-5-108

Information presented in the Draft EIS has been modified in the Appendix P of the Final EIS pursuant to this specific comment, as well as other public comments. The title on the referenced figure has been changed to “Flows Below Morelos Diversion Dam.”

G-5-109 through G-5-111

Your comment is noted. No change to the Final EIS was necessary.

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Comments on Bureau of Reclamation Draft EIS
Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Prepared by: David L. Wegner
Prepared for: Glen Canyon Institute – 2609 Columbine Avenue, Durango, CO 81301
April 27, 2007

I. General Comments

The Draft EIS is the latest addition of water management related documents produced by the Bureau of Reclamation to address issues related the distribution of water from the Colorado River. This document and resulting management direction will add to the existing tomes on managing surplus water, the Long-Term Operating Criteria and the coordinated management of water between the upper and lower Colorado River Basin States. No one expects exciting reading or innovative thought, but the lack of addressing current state of climate and hydrology is troubling.

The Bureau is grossly missing the opportunity and responsibility to address potential future conditions for water management based on scientific advice from experts in water management and climate. Recent reports that point towards a much different hydrologic condition in the Colorado River Basin include:

National Research Council – February 2007 – reporting that future droughts will likely be more extreme and for longer periods of time.

Intergovernmental Panel on Climate Change – Climate Change 2007 – stating that droughts in the Southwest will be more extreme and calls on governments to 1
begin planning now for reduced water.

Recent Science article reporting the result of running 19 climate computer models and their indication of a worsening drying trend for the Southwest.

Tree-ring analysis clearly shows that climate and hydrology in the Colorado River basin are linked and that historically there have been long and extreme drought events.

To not admit that the system is changing quickly nor addressing appropriate water management contingencies is akin to the Corp of Engineers telling the people of New Orleans to not worry, the dikes are in great shape. Reclamation is better than that but unfortunately this document does not provide much hope, direction or acknowledgement of the fact that SW hydrology is changing.

Recent climate documentation is consistent in concluding that the future for the Colorado River Basin is for far less water. The analytical approach used in the DRAFT EIS has a
fatal flaw in that it assumes, based on a very short historic data set, that change will 2
balance out and therefore it is business as usual for the Bureau of Reclamation.

G-6

Climate change impacts will occur far sooner than the 2026 timeline outlined in the Draft EIS. The Colorado River Basin is entering a drought, one that continues the trend since water year 2000 (except for 2005) of below average water conditions. In the April 2007 announcement from the Upper Colorado River Basin Bureau of Reclamation lead hydrologist, *Water year 2007 is shaping up to be yet another year with below average inflow. The current projection for spring runoff into Lake Powell is only 50 percent of average. … Reservoir storage in Lake Powell and Lake Mead is currently 48 and 54 percent of capacity.* This sobering monthly report from the Bureau of Reclamation clearly identifies that conditions in the Colorado River Basin are changing quickly. It would stand to reason then that the Bureau of Reclamation should look at a much different hydrologic future than the one that they are using as the baseline for projecting future conditions.

Weather conditions for the Colorado River Basin and the Southwest are changing at a rate far faster than the historic record that the Bureau of Reclamation is using indicates. The Southwest has had significantly below-average rainfall since 1999. The prospect of a drier Southwest is clear and should not be ignored and to do so violates a basic trust that the citizens of this country have regarding government management of a precious resource. 3

II. Comments Related to Assumptions Utilized

The assumptions utilized in the DRAFT EIS are constrained by their lack of addressing some basic information. The entire premise of the DEIS is driven by the set of inflow conditions. The Bureau uses a very limited (1906-2004) historical data set of actual flows to define the input supply parameters for the model and analysis. Peer reviewed literature and a stable of climate scientists have pointed out that the historical parameters and data are not a scientifically credible way to address the future.

Historic Hydrology Utilized – Based on measured flows from 1906 – 2004. This range of flows does not cover the potential future lower flow conditions that will be found in the Colorado River Basin.

CRSS Model – limited application to addressing extreme conditions. Was developed and applied under a narrow set of operating constraints and inputs. 4

Glen Canyon Dam Elevation Ranges – does not address the concerns over water movement once the elevation of Lake Powell drops below minimum power pool. At that point control of releases will occur only through the river outlet tubes. 5

Upper Basin Depletions – uses a figure of 5.4 MAF when in fact the Upper Basin is proclaiming to want to deplete 6.0 MAF. This difference amounts to 3 MAF by the year 2030. 6

Input Volumes – the Bureau of Reclamation uses historic hydrology data (1906 to 2004) and assumes that 15 MAF will be available. Scientifically peer reviewed analysis performed and reported by the National Academy of Sciences indicate that at BEST CASE, no more 14.5 MAF should be used, and more likely the actual volume should be closer to 13.5 MAF. If everything else remains the same, 7

G-6

2

the Bureau of Reclamation's assumption that the flow will be 500,000 acre feet
higher than the long-term mean amounts to 5 MAF in ten years and 12.5 MAF in
25 years.

Impact due to climate change. On a best case approach we may see as little as
5% reduction in flow volumes, this would amount to an error in the Bureau's
input volume of 7.5 MAF in ten years and 18 MAF in 25 years. If the worse case
of 40% reduction in flow occurs this would lead to even larger error in the amount
of input volume to the system.

Ongoing Research – no mention is made of the impact of the proposed
operational impacts as related to the ongoing Grand Canyon Monitoring Program 8
and its proposed use of periodic flow releases to protect the resources of the
Grand Canyon. A slight mention is made of the Lower Colorado River
Multispecies Conservation Program but only in reference to its ongoing presence.
No discussion occurs as to how changing the operational patterns will be factored 9
into these important and ESA driven efforts.

Glen Canyon dam and Hoover dam operational constraints. Limited
discussion occurs as to the general management philosophy regarding the day to
day operational management of the two dams. Specific discussion as to critical
reservoir elevation limits (power pool, cavitation of generators from air
entrainment, use and limits of river outlet tubes, and operational constraints) is not 10
provided in a single section in the document.

Impacts to Basin Fund from reduced Lake Powell levels – a thorough
discussion needs to exist to what will happen to the revenue flow to the Basin 11
Fund as the elevation of Lake Powell drops and power generation is diminished.
What will this do to Westerns existing power contract rates (expect increases?),
capacity and energy amounts, and the Basin Fund which supports a multitude of 12
other water user and Bureau of Reclamation projects (i.e. subsidizes).

Impacts to Hydroelectric production. Discussion is limited on the impacts that
will likely occur to the financial balance of Western Area Power Administration if
hydropower is seriously constrained due to low reservoir elevation levels at Lake 13
Powell. While the report writers may not want to address the issues, it is
important that the potential worse case scenario of limited water available for
hydropower generation. What happens to the existing balance of payments for
the CRSP? What impacts occur to basin rate payers? 15 14

Identification of Priorities. It would seem logical that a clear process flow chart
should be identified in a SHORTAGE document that identifies what the process
would be in regards to meeting the priorities of water delivery. It would seem 16
pertinent that this process should be articulated and laid out so that there is a clear
identification of process and procedure.

III. Comments on Five Alternatives

The Bureau of Reclamation identifies five alternatives that they have assessed in the DEIS. These five evolved through a series of scoping and coordination meetings that the Bureau had with individuals, groups, and the seven Colorado River Basin States. The five alternatives include:

No action – business as usual

G-6

3

Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage

All five alternatives are addressed assuming the same management philosophy that has existed since the Long-Range Operating Criteria were agreed to. This philosophy assumes that Lake Powell and Lake Mead are operated as one unit, balancing releases based on the Law of the River constraints and a limited input supply data set.

Of the five alternatives, based on the historic set of assumptions, the most logical alternative is *Conservation Before Storage* as it utilizes set elevation targets in Lake Mead to direct specific water management actions. 17

However, based on the assumptions identified in Section I and the change that will occur in available water supply in the Colorado River Basin, we believe that an additional alternative should be evaluated that includes the following:

Shifting Storage from Lake Powell to Lake Mead. Under a lower flow volume scenario both Powell and Mead cannot and will not ever fill again under the historic hydrological rules articulated by Reclamation.

Storing water in Lake Mead will provide benefits to users of the Colorado River Basin by:

- Reducing evaporation. Maintaining one large reservoir instead of two will reduce the amount of water that evaporates off of the reservoir surface. Estimated water savings of 500,000 acre feet per year.
- Reduced loss of water migrating into the sandstone of Lake Powell basin. The granitic rock of Lake Mead basin does not draw as much water into the substrata. Result = increase in water. 18
- Maintain reservoir elevations of Lake Mead to continue electrical generation.
- Provide more normal flow regime in the Grand Canyon

Credit Upper Basin states with the amount of water flowing past the gaging station at Lees Ferry. We support the development of intentionally created surplus (Conservation Before Shortage Alternative) as a viable way to aggressively address water conservation with incentives.

Implement aggressive water conservation campaign throughout the Colorado River Basin.

IV. Comments on Methodology Used to Estimate a Range of Daily Glen Canyon Dam Releases

Only six annual Lake Powell release volumes were considered (7.00, 7.48, 8.23, 9.00, 9.50 mafy). 19 If climate scientists are correct, release volumes may approach 5 million acre feet per year. It would seem prudent to at least run scenarios that reflect the worse case conditions 20

Approach does not take into consideration the historical drought regimes that have historically occurred within the Colorado River Basin. 21

G-6

4

The CRSS methodology assumptions and input factors are limited resulting in a narrow set of comparison options. 22

V. Comments on Coordinated Operations on Lake Powell and Lake Mead

Lake Powell is the input for the majority of water to be distributed in the Lower Colorado River Basin.

Glen Canyon Dam operations are driven by a hierarchy of priorities, beginning with meeting the Colorado River Compact and ending with supporting recreation on the reservoir. Critical to upper basin water management is keeping the generators at Glen Canyon Dam spinning so that they generate electricity and revenue for the Upper Basin Fund and the support of other Bureau of Reclamation projects. The analysis provided by the Bureau of Reclamation indicated that they do not assume that Powell has a very high likelihood of ever dropping below the minimum power pool 23
elevation in Lake Powell. This is a gross underestimation of the likely impacts to be felt as result of lower inflow volumes to Powell due to climate change.

Colorado River Basin – System Management. Glen Canyon and Hoover dams are the largest facilities in the river basin, however management of a reduced supply of water and increasing environmental concerns demand that a system 24
wide EIS be developed to address and integrate the large range of issues and constraints that exist in the developed Colorado River system.

VI. Water Quality and Environmental Impacts

Affected Environment – <u>Water Quality</u>

- Temperature of Releases from Glen Canyon Dam do not take into account the full spectrum of thermal conditions that may exist as the reservoir level drops 25
  and seasonal limnology conditions change. It is highly likely that seasonal spikes in temperature will occur as warmer water in the reservoir is intercepted by the intakes (elevation 3470). No mention is made of the potential Temperature Control Device for Glen Canyon Dam that the Upper 26
  Colorado Region is currently reviewing.
- Dissolved Oxygen – In September 2006 and March of 2007 hypoxia events (release of low dissolved oxygen water) occurred at Glen Canyon Dam. These types of events will continue to occur at Glen Canyon Dam as the reservoir levels diminish and limnological conditions change. The DEIS 27
  indicates that this is an abnormal event and not likely to continue to occur. This is wrong – the probability will continue with potentially large impacts on the downstream environment.

Affected Environment – <u>Sediment</u>

- Lower reservoir levels in both Powell and Mead will expose significant 28
  sediment deposits in the delta areas. Remobilization of these sediments and the chemical residues trapped within them may pose a considerable risk to the 29
  aquatic environment in the reservoirs. Additional modeling under more

realistic reservoir conditions is required to predict future impacts and movement of sediment. 30

- Loss of storage capacity – no discussion occurs as to the reduction in reservoir storage capacity resulting from the input of sediment into the basins. 31 No reference is made to the ongoing reservoir sedimentation studies at neither Powell nor the historic work completed by the Denver Technical Service Center on sedimentation rates. 32 The Denver Technical Service Center also recently completed an assessment of bypassing sediment around Glen Canyon Dam. How will this work be integrated into the operational mix? 33

Affected Environment – <u>Special Status Species</u>

- Humpback Chub – no discussion on the impacts of variable flow and water quality conditions and their affects on the listed *gila cypha* (Humpback chub) in the Grand Canyon. 34 The Upper Colorado River Basin is currently engaged in a lawsuit over the impacts of flow releases on the Grand Canyon environment and the listed species. 35

Affected Environment – <u>Non-Native Species</u>

- Zebra and quagga mussle population expansion – no mention is made of the potential population impacts of zebra and quagga mussels in the Colorado River. 36 The lack of any discussion of these species and their potential impact on the water delivery system of the Colorado River is curious. 37 At least referencing work completed by the USGS would seem worthy. 38
- Striped Bass from Lake Mead - will there be an expansion of striped bass further into the Grand Canyon if the water temperatures warm due to modified Glen Canyon Dam operations and Lake Powell limnological conditions? 39

Affected Environment – Colorado River Delta and Mexico. While it is an interesting line of logic of why it is not within the context of the Bureau to acknowledge that a Colorado River delta exists, it would seem prudent that at least a short discussion on what the five alternatives might mean to the water flows would be appropriate. 40 Also no discussion is included about the potential for the Yuma Desalinization Plant coming on-line. 41 This will affect the water quality and delivery of water to Mexico. It should be mentioned. 42

Affected Environment – Recreation. Lower reservoir levels are exposing historic rapids and creating new rapids in the inflow areas of Powell and Mead. How will these river hazards be managed under the new lower elevation reservoir regime? 43

VII. Recommendations

Redo the hydrologic projects based on realistic future hydrologic conditions

Include an alternative that looks at managing the Colorado River reservoirs to focus on filling Lake Mead first and reducing evaporation and loss due to infiltration.

Recognize the range of actual hydrologic supply that is likely in the Colorado River Basin.

Include impacts to the Colorado River Delta and the Grand Canyon

Use the DEIS and NEPA process to look at a range of basin wide conservation measures 44

G-6

Recommend the development of a basin wide Colorado River EIS to address the integrated management of the entire plumbing system of the Colorado River. 45

Implement a clear and graphical identification of the process that will be followed should shortage occur and water deliveries are constrained. What process will be followed? How will priorities be defined? What will get shorted first – environment, junior holders, and tribes?

Include a complete list of water holders and their priorities. Put in a table and chart so that we can understand who will get water when shortages begin to occur. 46

G-6

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Reponses to Comment Letter G-6

G-6-1 through G-6-4

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

G-6-5

The information requested is provided in the EIS. The outlet works and the capacity limitations of the outlet tubes are discussed in Section B.2.11 of Appendix B of the EIS and these constraints are included in the CRSS model.

G-6-6

This comment fails to accurately reflect the information published by Reclamation in the Draft EIS and the Final EIS in Section 3.4.1. As noted in that section, the Upper Basin depletions are assumed to ramp up to 5.4 maf in 2060, excluding evaporation losses of approximately 574 kaf, resulting in a total depletion of approximately 6.0 maf.

G-6-7

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

G-6-8 and G-6-9

See response to Comment No. F-2-43.

G-6-10

The information requested is provided in the EIS. Appendix B, Colorado River System Facilities and Current River Systems Operations, From Lake Powell to SIB, which provides extensive descriptions on the yearly, monthly, daily, and hourly operations of the mainstream reservoirs, from Lake Powell to SIB.

G-6-11 and G-6-12

The information requested is provided in the Draft EIS. Section 4.11, Electrical Power Resources, describes the potential effects on energy resources, Western, and the basin funds.

G-6-13

Your comment is noted. Section 4.11 of the Final EIS describes the results the analyses that compare the differences between the alternatives on energy production. An evaluation of the financial condition of Western is outside the scope of this study.

G-6-14

Your comment is noted. No change to the Final EIS was necessary. Section 4.11.2.9 of the EIS notes that the proposed federal action could reduce the amount of money available to meet the intended use of the Basin Power Fund. The potential impacts to the fund are described in Section 4.11.2.5.

G-6-15

Reclamation does not concur with this comment. The different project power contractors and the retail power agencies all have different rate structures that include other cost factors such as transmission and distribution costs, peak power charges, administrative costs, taxes and franchise fees. Additionally, many retail agencies have access to other forms of power and this factors heavily into the melded rates that apply within their respective service areas. Because of all these cost factors, the retail rates that apply throughout the Colorado River Basin vary extensively. Given this and the fact that the change in average annual generation (from No Action) was generally less than 1 percent for the action alternatives, an evaluation of the potential impacts to rate payers within the numerous communities within the Colorado River Basin was determined to be unnecessary.

G-6-16

The information requested is provided in the EIS. Appendix E provides detailed tables that show the different water entitlement holders within each of the Lower Division states and their respective priorities. Section 3.4.6 of the EIS explains the modeling assumptions with regard to how the shortages are distributed between and within the Lower Division states. Additional detailed discussions on how the shortages are distributed using the Shortage Allocation Model as well as tables showing the output from this model, are presented in Appendix G. The tables in Appendix G also show the distribution of shortages to water users based on different total Lower Basin water delivery reduction volumes. In addition, draft guidelines for implementing the Preferred Alternative are included in the Final EIS as Appendix S.

G-6-17

Your comment is noted. No change to the Final EIS was necessary. All the alternatives have water management actions that are linked to specific reservoir water surface elevations. Table 2.8-2 and Table 2.8-3 of the EIS provide an overview and comparison of the operational elements and trigger elevations provided in the different alternatives.

G-6-18

Your comment is noted. No change to the Final EIS was necessary. The decommissioning of Glen Canyon Dam is outside the scope of this study,

G-6-19 through G-6-23

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

G-6-24

Your comment is noted. No change to the Final EIS was necessary. As described in Section 3.2 of the EIS, reservoirs located upstream of Lake Powell are operated independently of Lake Powell would not be affected by the proposed federal action.

G-6-25

This comment fails to accurately reflect the information published by Reclamation in the Draft and Final EIS in Section 4.5 and Appendix F. The CE-QUAL-W2 and GEMMS water quality models considered the changing water quality conditions (including temperature) at Lake Powell throughout the full range of operational elevations.

G-6-26

The information requested is provided in the EIS. Section 1.8.13 and Section 5.1.29.2 of the EIS which makes reference to the temperature control device proposed to be installed at Glen Canyon Dam and also the NEPA process that is being undertaken as part of the LTEP.

G-6-27

The information requested is provided in the EIS. Recurrences of low dissolved oxygen such as occurred in 2005 below Glen Canyon Dam may result from reservoir drawdown cycles under any of the alternatives, but as described in Section 4.5.5 the river reaerates after passing through rapids downstream of Lees Ferry.

G-6-28

Your comment is noted.

G-6-29

Your comment is noted. As noted in Section 4.5.5. of the EIS, quantified water quality impacts from reservoir sediment delta headcutting are not currently available.

G-6-30

Your comment is noted. No change to the Final EIS was necessary.

G-6-31 and G-6-32

Your comment is noted. No change to the EIS was necessary. The rate of sedimentation accumulation at Lake Powell has been decreasing over the past two decades. The sediment accumulation rate at Lake Powell was estimated to be approximately 85,000 afy in 1962, decreasing to 27,000 afy in 1986, a change of approximately 56 percent. This decrease is likely attributed to land-use controls, climatic conditions, and the construction of additional reservoirs upstream. Reclamation is investigating the use of newer technology and recently conducted a bathymetry survey to analyze the submerged topography at Lake Mead. Coupled with a GIS analysis of the exposed topography and comparison to past surveys, the sediment accumulation will be estimated. Analysis of that data is on-going.

G-6-33

Your comment is noted. The Denver Technical Service Center studies are outside the scope of this study.

G-6-34

The information requested is provided in the EIS in Section 4.8. Section 4.8 includes a description of how water quantity and quality impacts could impact the listed Humpback Chub (*Gila cypha*). This discussion included analysis of how potential temperature changes within the Grand Canyon could impact (1) the humpback chub and their non-native fish competitors, (2) several parasites that infect humpback chub, and (3) the main aquatic food sources in the Grand Canyon. In addition to this, Reclamation has added a discussion to the Final EIS regarding the effects of flow variations on native fish habitat for each alternative. Please refer to Chapter 4.8 of the Final EIS for further details of these analyses.

G-6-35

Your comment is noted. No change to the Final EIS was necessary.

G-6-36 through G-6-38

Information presented in the Draft EIS has been modified in the Final EIS (see Section 3.8) pursuant to this specific comment, as well as other public comments. Presently, zebra mussels are not definitely known to exist within the study area. Section 3.8 has been amended to note the presence of quagga mussels in Lake Mead, Lake Mojave, and Lake Havasu and the potential presence of zebra and/or quagga mussel populations in Lake Powell. However, the proposed federal action is not expected to have an effect on the presence or spread of quagga mussels within the study area greater than may occur under the No Action Alternative. This revision does not significantly change the impact analysis or results presented in the Draft EIS.

G-6-39

The information requested is provided in the EIS in Section 4.8. Although the Affected Environment section of the EIS does not provide a discussion on impacts, Reclamation did describe how temperature impacts could increase the likelihood of upstream migration of non-native fish into the Grand Canyon. Though not specifically mentioned, these non-native fish could include striped bass from Lake Mead.

G-6-40

Your comment is noted. No change to the Final EIS was necessary. As noted in Section 3.3.10 of the Draft EIS and the Final EIS, flows below Morelos Diversion Dam primarily result from flood control operations at Hoover Dam. The potential effects of the alternatives on those flows are presented in Section 4.3.9 of the Draft EIS and the Final EIS.

G-6-41 and G-6-42

The information requested is provided in the EIS. Section 4.2.7, notes that the modeling of the alternatives for the EIS assumes that the Yuma Desalting Plant is not operational over the modeling period. The water quality analyses described in Section 4.5 considered this and the findings of the analyses were that there will be no significant impact to the quality of the water delivered to Mexico at the NIB.

G-6-43

The information requested is provided in the EIS. As noted in Section 4.12.3.1, there would be no change in exposure to unsafe bloating conditions caused by changes in river elevations.

G-6-44

Your comment is noted. No change to the Final EIS was necessary. Basin wide conservation measures are outside the scope of this EIS.

G-6-45

See response to Comment No. G-6-24.

G-6-46

The information requested is provided in the EIS. Section 3.4 of the EIS provides a description of the apportionment of the waters of the Colorado River; Section 4.4 provides the results of comparative analyses of water deliveries under the different alternatives during Surplus, Normal, and Shortage conditions; Appendix E provides tables that show the Colorado River water users within each Lower Division state and that shows respective priorities within each state; and Appendix G provides a description of Shortage Allocation Model and provides tables that show the distribution of the shortages between the states and amongst the water users within each Lower Division state.

IRRIGATION & ELECTRICAL DISTRICTS
ASSOCIATION OF ARIZONA

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E-MAILED ONLY April 30, 2007

Regional Director, Lower Colorado River Region
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Boulder City, Nevada 89006-1470

Re: Comments on the Draft Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, 72 Fed.Reg. 9026, et seq. (February 28, 2007)

The following comments are submitted on behalf of the Irrigation & Electrical Districts Association of Arizona, a statewide association of 24 Members and Associate Members that contract for and receive power from Glen Canyon Dam, Hoover Dam, the Parker-Davis Project and the Navajo Generating Station. As such, our Members and Associate Members are directly impacted by the proposed Interim Guidelines.

The Irrigation & Electrical Districts Association of Arizona (IEDA) was founded in 1962 and represents the interests of its membership concerning federal hydropower resources generated on the Colorado River. Since 1962, IEDA has been intimately involved in the development of legislation, regulations, environmental analyses and other activities concerning power generation on the Colorado River.

IEDA wishes to compliment the Bureau of Reclamation on its thorough analysis of the resources subject of this DEIS and, specifically, with its analysis of hydropower resources and proposed impacts on those resources from implementation of any of the alternatives analyzed in the DEIS.

Having said that, however, we are mindful of the comments already submitted by the Colorado River Energy Distributors Association (CREDA), of which IEDA is a member, and the careful and specific analysis of necessary changes in the DEIS that those comments identify. We totally support those comments. 1

We wish to draw Reclamation's attention specifically to the economic analysis and forecast comments on page 2 of the CREDA comments. We do so because we feel one shortcoming of the DEIS is its failure to adequately appreciate the <u>future</u> value of peaking power from hydropower facilities managed by the Bureau of Reclamation on the Colorado River. As demand for electricity 2 3

G-7

SERVING ARIZONA SINCE 1962

Regional Director, Lower Colorado River Region
April 30, 2007
Page 2

continues to increase, demand for peaking power will increase also, perhaps even more rapidly than
demand for base load. There are numerous studies available that supply such forecasts in peer
reviewed analyses. Limitations on the use of Glen Canyon Dam especially as a peaking power
resource, and to a lesser extent Hoover Dam, will cause the utilities that contract for those resources 4
to seek other sources of peaking power. It is reasonable to assume that other hydropower resources
will also be fully committed and overcommitted, especially in a region-wide drought. Thus, the 5
alternative peaking power resources will come from fossil fuel sources. The DEIS does not 6
recognize this fact nor attempt to analyze the increase in fossil fuel electric power demand that will 7
be created when these Shortage Sharing Guidelines need to be implemented. Since Congress has
recognized the value of hydropower over a long history, in such provisions as Section 5 of the
Colorado River Storage Project Act of 1956, the final EIS needs to recognize this value also and to
recognize the increased demand on the fossil fuel portion of the regional generation supply that
utilization of the Shortage Sharing Guidelines will produce.

The final EIS also needs to recognize that there will be a concomitant increase in greenhouse gas 8
emissions from lesser availability of federal hydropower on the Colorado River. Since these
alternative generation resources are less nimble than hydropower, more of them will be required to
cover the same real time demand than a hydropower facility would otherwise supply. This factor
needs to be recognized in the final EIS as well.

The final EIS also needs to recognize the current status of contracting for the Parker-Davis resource. 9
Compare the statement at page 3-95, line 27, with the statement at page 4-235, lines 34 and 35. 10
Those conflicting statements will both need to be updated as Reclamation finalizes the EIS.

Finally, we note that CREDA believes that the collaborative process being undertaken by the Basin
States may continue to refine parameters of the Basin States alternative as described in the DEIS.
CREDA asks for further ability to comment on any such refinement. We are under the impression
that the refinement process that NEPA can recognize will be reflected in the comments submitted 11
during the comment period on the draft EIS and not thereafter. As Reclamation well knows, should
any significant change to the proposed alternatives be considered by Reclamation after the close of 12
the comment period, any such changes would be required to be resubmitted for public comment.
Given the timeline that Reclamation has announced for completion of this process, we anticipate
that that will not happen. However, should a significant change to any of the alternatives be
proposed for consideration, we will assume that Reclamation will reopen the comment period 13
before completing the Environmental Impact Statement process. Such action would be required to
maintain the integrity of the process.

Thank you for the opportunity to comment on this most important exercise.

Sincerely,

/s/

Robert S. Lynch
Counsel and Assistant Secretary-Treasurer

G-7

RSL:psr
cc: IEDA Members

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Reponses to Comment Letter G-7

G-7-1 and G-7-2

Your comments are noted.

G-7-3

Reclamation does not concur with this comment. As noted in Section 4.11 of the EIS the electrical energy prices used in the analysis were developed from both an hourly price forecast keyed to the Palo Verde Interchange and mean monthly reported price indices for the Palo Verde Interchange obtained from Dow Jones, Inc. These energy prices represent the best available data for evaluating impacts. We are not aware of an industry standard that provides for appreciating the future value of peaking power.

G-7-4 through G-7-8

Your comments are noted. No change to the Final EIS was necessary. While there may be a need for entities that contract for power from the Colorado River hydro powerplants to seek alternative peaking power sources in future years, the source of this power is uncertain. See also response to Comment No. G-3-15.

G-7-9

The information requested is provided in the Draft EIS. Please refer to Section 3.11.1.2 for a discussion on the status of power contracts associated with the Glen Canyon, Hoover, Parker and Davis powerplants.

G-7-10

Reclamation does not concur with this comment. The two referenced statements are correct. The Parker-Davis contracts are due to expire in 2008. As noted in Section 4.11 of the EIS, Western is currently negotiating the extension of these contracts.

G-7-11 through G-7-13

Your comments are noted.

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April 30, 2007

Regional Director, Lower Colorado Region
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Sent via email: strategies@lc.usbr.gov

Re: Comments on Draft Environmental Impact Statement for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Dear Regional Director,

Living Rivers/Colorado Riverkeeper and the Center for Biological Diversity submit the following as comments on the Draft Environmental Impact Statement for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (DEIS).

With this DEIS, it was hoped that the seven basin states and the Bureau of Reclamation (Reclamation) would take an important step in articulating the need for, and response to, the increasing likelihood that Colorado River water users will experience shortages. It was assumed that in this era of uncertainty surrounding Colorado River hydrology that Reclamation would hold true to its mission to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Unfortunately, the DEIS fell well short in meeting these expectations. 1

When the public hears the word "shortages," the term most commonly associated with this initiative, it wants to know how much, and the appropriate actions necessary to respond. While the DEIS has provided answers, the response leaves the public with little confidence that the principle agency responsible for managing the Colorado River water supplies has a full grasp of the problems now before it, nor a commitment to charting a path to overcome them. 2

- Baseline Conditions Not Properly Defined

The potential for shortages on the Colorado River have been mounting long before the emergence of the current drought. The over-allocation of water due to improper assumptions as to the Colorado River's mean inflow has reached the point where shortages, which never occurred in the past, will shortly be inevitable. Reclamation is

G-8

Regional Director, Lower Colorado Region
April 30, 2007
Page 2

repeating the same mistake by using a 15.0 million acre-feet (maf) mean inflow projection well above the paleo-climate reconstruction estimates of 13.0-14.7 maf. If the observed flows of 14.2 maf of the past 50 years were to be used as a guide, the Basin States proposal would be of little value, and Upper Basin water users would be destined to restrict their consumption to meet their delivery requirements to the Lower Basin. 3

- Climate Change Does Not Exist?

Reclamation's modeling excluded any analysis of the potential for the region's rising temperatures to further impact future streamflow. Study after study from the nation's leading research centers now point to reduced flows on the Colorado River in the years ahead: ranging from 10 percent over the next century to upwards of 50 percent by 2050. As the National Research Council reported in February, while there may be uncertainty as to the magnitude of change, flows on the Colorado River are expected to reduce. Even the most modest reduction in flows, five percent over the 53-year forecast period, would create shortages far in excess of what the DEIS has contemplated. 4

- Conservation Measures Undefined

While a program for banking conserved water in Lake Mead is contained in the Basin States proposal, this program appears speculative as to the level of participation, or how it assures a decreasing reliance on Colorado River water commensurate with the level of shortages Nature may impose. 5

We fully recognize the dilemma faced by Reclamation in developing this DEIS. Had it undertaken a thorough evaluation, addressing the range of uncertainty regarding mean streamflow and climate, the Basin States initiative would have looked far too meager a response to warrant much consideration. However, Reclamation's principle mission, especially during these uncertain hydrologic times, should be to present as unbiased and as clear picture of what the future might be, not what a select group of politicians and/or special interests want it to look like. 6

1. Baseline Conditions Not Properly Defined

Reclamation must present a clear picture to the public of the real challenge facing Colorado River water users. The system's over-allocation is now creating an imbalance that requires shortages to become the norm, not rare events that may result from extended dry periods. These are not problems necessitating detailed study to understand nor sophisticated computer models to simulate, yet Reclamation neglects to offer such critical background information to the pubic. 7

As illustrated in Table 1, employing Reclamation's own assumptions, in 2008 it is projected that the Colorado River will provide an operating surplus of just 2.7% (400,000 af), shifting to an annual net shortage of 3.3% (-490,000 af) by 2060. This latter figure is little different from the extensive results offered by Reclamation's own model discussed in Chapter 4, Section 4 of the DEIS. 8

G-8

Regional Director, Lower Colorado Region
April 30, 2007
Page 3

Table 1
Colorado River Water Balance

	2008	2060
Inflows		
Mean Inflows at Lees Ferry	15.03	15.03
Gains between Glen Canyon Dam and Hoover Dam	0.77	0.77
Gains below Hoover Dam	0.50	0.50
Total System Inflows	16.30	16.30
Outflows		
Upper Basin depletions	**(4.54)**	**(5.43)**
Lake Powell evaporation	(0.56)	(0.56)
Lake Mead evaporation	(0.80)	(0.80)
Lower Basin & Mexico consumption	(9.00)	(9.00)
Evaporation and operational losses below Hoover Dam	(1.0)	(1.0)
Net System Balance	0.40	(0.49)

8

Although this imbalance is what is now driving the Basin States to develop a plan for shortages, nowhere in the DEIS are such basic issues and mathematics surrounding the system's over-allocation addressed. It is not the drought that is forcing this EIS. Nor is it the potential intervention by the Secretary of Interior should Lake Mead fall below 1,025 msl as stated in the Purpose and Need. These are all secondary to the main issue: the Colorado River has reached its limit, yet plans are underway to take more water.

It's vital that Reclamation ensures the public is fully aware of this dynamic, since it illustrates how sensitive the system has now become to changes in inflow, and thus how critically important inflow assumption are for Colorado River planning purposes. 9

Reclamation, however, has avoided any frank discussion on the likelihood of, or impacts resulting from, a reduction in the forecasted mean inflow of 15.0 maf used in its modeling. Reclamation offers the public only this, "However, 99-year record period is a relatively short time frame, and it is possible that future flows may include periods of wet or dry conditions that are outside of all the possible sequences seen in the historical record."

This is an amazingly cavalier attitude since Reclamation knows better than most how foolhardy reliance on merely observed streamflow records can be. History has already proven that mistakes in forecasting future mean streamflow on the Colorado can lead to major problems down the road. It is precisely such a misadventure that is behind the imbalance the system now experiences. This DEIS is underway now because those who signed-off on the Colorado River Compact of 1922 mistakenly believed in their mean Lees Ferry streamflow calculations of 16.4 maf. In allocating just 15 maf, they assumed a nearly ten percent buffer. A buffer we've longtime known is not there. Scientists concur that the period used by Compact drafters was the wettest in the past 1,200 years, and have also concluded the 20th century to be one of the wettest overall. Knowing this, it

G-8

Regional Director, Lower Colorado Region
April 30, 2007
Page 4

seems imprudent to assume future flows will necessarily be so benevolent.

As the National Research Council (NRC) stated in its recent report, "Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability," relying on gage data alone is a somewhat antiquated practice.

> *"For many years, scientific understanding of Colorado River flows was based primarily on gaged streamflow records that covered several decades. Recent studies based on tree-ring data, covering hundreds of years, have transformed the paradigm governing understanding of the river's long-term behavior and mean flows. These studies affirm year-to-year variations in the gaged records. They also demonstrate that the river's mean annual flow—over multi-decadal and centennial time scales, as shown in multiple and independent reconstructions of Colorado River flows—is itself subject to fluctuations."* 10

The studies the NRC authors refer to all estimate a long-term mean streamflow at Lees Ferry below the 15.0 maf mean uses by Reclamation in the DEIS.

Table 2
Reconstructions of Colorado River
Mean Flows at Lees Ferry

Author (year)	Reconstruction Period	MAF
Stockton and Jacoby (1976)	1511/12/20-1961	13.0 – 14.15
Michaelsen et al. (1990)	1568-1962	13.8
Hidalgo et al. (2000)	1493-1962	13.0
Woodhouse et al. (2006)	1490-1997/98	14.1 – 14.7

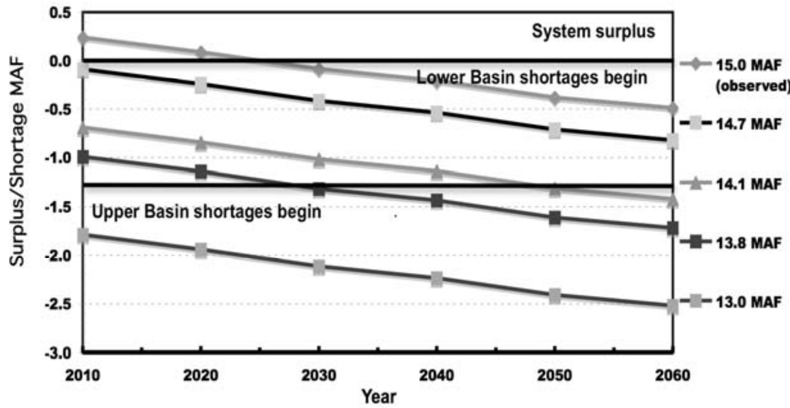
These paleoclimatic reconstructions illustrate that it is not only possible, but growing evidence suggests that the observed mean streamflow being used by Reclamation is too high. Surprisingly, nowhere in the DEIS is this fundamental assumption addressed, merely the disclaimer that the model may misrepresent the future because of its reliance on the observed record.

Here again, a sophisticated model is not necessary to illustrate the significant impacts changes in mean streamflow would have on the imbalance growing in the system. Figure 1 uses the information from Tables 1 and 2 to estimate the net annual shortages Colorado River water users will experience should the mean inflow be less than 15.0 maf Reclamation projects. Figure 1 also illustrates how, should future flows drop to 14.1 maf annually, shortages will likely occur in both the Upper and Lower Basins—not just the Lower Basin as forecasted in the DEIS. Furthermore, this 6.2 percent reduction in the mean streamflow is sufficient to generate average annual shortages right now in excess of the 400,000 – 600,000 af shortage policy at the heart of the Basin States alternative. Evaluating a reduction of this magnitude is hardly inappropriate as it is very close to the observed mean of 14.2 maf from 1950 to the present. 11

G-8

Regional Director, Lower Colorado Region
April 30, 2007
Page 5

Figure 1
Anticipated Average Annual Colorado River Surplus/Shortages
Under Observed Record and Selected Reconstructed Mean Inflows



To its credit, Reclamation does provided some alternative flow sequences summarized in Appendix N. However, no analysis was performed on the potential impacts should the observed mean streamflow prove inaccurate in projecting future Colorado River flows. Two of the three scenarios used relied on the observed record to simulate flows with greater variability, but not significant reductions in mean flow volumes. The third alternative sequence, Direct Paleo, used Woodhouse data with a mean of 14.6 maf. This offered a glimpse into the type of sensitivity analysis that should be undertaken on the full range of reconstructed streamflow estimates. The likelihood of shortages rose from 70 to 80 percent in 2060, with shortages in excess of 2 maf five percent of the time—shortages not forecasted using the observed mean of 15.0 maf. To these changes Reclamation offers just the following commentary on the Direct Paleo results. 12

> *"The Direct Paleo scenario underestimates the observed mean, as expected, because this paleo reconstruction has a lower mean (14.6 million acre-feet [maf]) than the observed period (15.0 maf). …The Direct Paleo is able to generate much lower flows that observed, approximately 3.7 maf lower five percent of the time. It was expected the Direct Paleo would generate lower flows than observed as these are characteristic of Lees Ferry streamflow reconstructions." Pages N-4/5)*

To limit such an important discussion to known statistical differences without any background as to why these differences exist, and that surrounding them is a whole body of work that suggests that Reclamation is over-estimating the mean annual flow, is not only misleading, but wholly inappropriate given the issues at stake should Reclamation's assumptions be wrong. 13

As Table 2 illustrates, Reclamation's choice of reconstruction data with an annual mean of 14.6 maf is at the top end of the mean flow estimates by paleo-reconstruction

G-8

Regional Director, Lower Colorado Region
April 30, 2007
Page 6

researchers. While the data used for its Direct Paleo scenario is among the most recent, the National Research Council further notes there is not yet consensus on which reconstruction may be most appropriate for planning purposes. Therefore, Reclamation must not limit its discussion of alternative hydrologic sequencing to merely a brief analysis of one reconstruction data set. It must fully analyze the full range of variability advanced by researchers so that both Reclamation and the public can be sufficiently informed to evaluate the alternatives for the proposed action. 14

2. Climate Change Does Not Exist?

Even more alarming than Reclamation's unwillingness to objectively address what constitutes an appropriate historical mean streamflow, is the agency's policy to wholly ignore the recommendations of climate scientists who are warning with increasing regularity of the inevitability of reduced Colorado River flows in the decades ahead. 15

The most recent alert arrived this month in the April edition of *Science Magazine*. The Lamont Doherty Earth Observatory of Columbia University forecasts that drier climatic conditions are already taking hold in the Southwest. Droughts similar to what the region is now experiencing will become more common, and the respites in between will generate less precipitation than in the past. 16

> *" Here we show that there is a broad consensus amongst climate models that this region will dry significantly in the 21st Century and that the transition to a more arid climate should already be underway. If these models are correct, the levels of aridity of the recent multiyear drought, or the Dust Bowl and 1950s droughts, will, within the coming years to decades, become the new climatology of the American Southwest."*

In the National Research Council's report released six weeks earlier it was emphasized that the trend toward rising temperatures in the Colorado River basin will continue, thus further stressing water supplies.

> *"Any future decreases in Colorado River streamflow, driven primarily by increasing temperatures, would be especially troubling because the quantity of water allocations under the Law of the River already exceeds the amount of mean annual Colorado River flows. This situation will become even more serious if there are sustained decreases in mean Colorado River flows. Results from these numerous hydroclimatic studies are not unanimous, and all projections of future conditions contain some degree of uncertainty. Nevertheless, the body of climate and hydrologic modeling exercises for the Colorado River basin points to a warmer future with reductions in streamflow and runoff."*

To illustrate this range of forecasts one need look no further than the two most recent papers released that address the Colorado River specifically. Both used models contained in the Intergovernmental Panel on Climate Change (IPCC), 4th Assessment released in February. 17

In Christensen, et al. 2007, University of Washington, it was found that mean results from eleven models generated reductions of annual streamflow at Lees Ferry from eight to eleven percent toward the end of the century: "Although our results show somewhat 18

G-8

Regional Director, Lower Colorado Region
April 30, 2007
Page 7

smaller (ensemble mean) reductions in runoff over the next century than in previous studies (Christensen et al, 2004 in particular), the reservoir system simulations show nonetheless that supply may be reduced below current demand which in turn will cause considerable degradation of system performance."

In Hoerling, et al., 2006, NOAA Earth System Research Laboratory, where 12 models were employed, a much more dramatic changes to the mean flow at Lees Ferry was forecasted: "Relative to the 1990-2005 mean flow of 13 maf, the 42-run average projects a 25 percent decline in streamflow during 2006-2030, and a 45 percent decline during 2035-2060." 19

In 2005, Milly, et al., NOAA Geophysical Fluid Dynamics Laboratory, 12 models contained in the IPCC 4th Assessment were also used to assess future Colorado River flows. The results projected reductions in the Colorado River flows from 10 to 30 percent by 2050. 20

In the face of such mounting evidence, Reclamation remains steadfast in using its 15.0 maf observed mean streamflow to evaluate proposed alternatives designed to address shortage conditions. However, if the projections contained in the findings of any of the above researchers prove accurate, such conditions would dramatically, if not entirely eliminate, the viability of the proposed alternatives to cope with the scale of shortages Nature may deliver during Reclamation's forecast period.

As illustrated in Table 3 and Figure 2 below, assuming the most modest projections of just a 5 percent increase over the next 50 years, the Colorado River system will begin to force shortages in both the Upper and Lower Basins by 2060. Albeit crude, the results of such calculations are not inconsistent with past research. As Nash et.al, reported in 1993, a 5 percent reduction on Colorado River flows would indeed begin to stress the Upper Basin's ability to meet its Colorado River Compact obligations. 21

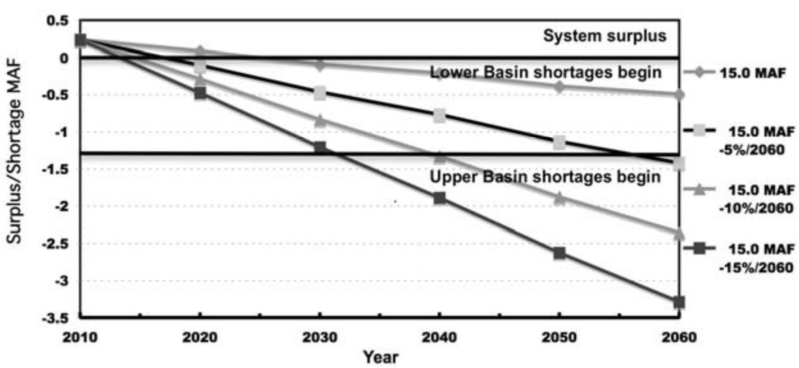
G-8

Regional Director, Lower Colorado Region
April 30, 2007
Page 8

Table 3
Estimated Impact of Inflow Reductions
On Colorado River Water Balances in 2060
Using 15.03 maf Observed Mean Streamflow

	Reduction			
	0%	-5%	-10%	-15%
Inflows				
Mean Inflows at Lees Ferry	15.03	14.28	13.53	12.78
Gains between Glen Canyon Dam and Hoover Dam.	0.77	0.73	0.69	0.65
Gains below Hoover Dam	0.50	0.48	0.45	0.43
Total System Inflows	16.30	15.49	14.67	13.86
Outflows				
Upper Basin depletions	(4.54)	(5.43)	(5.43)	(5.43)
Lake Powell evaporation	(0.56)	(0.59)	(0.62)	(0.64)
Lake Mead evaporation	(0.80)	(0.84)	(0.88)	(0.92)
Lower Basin & Mexico consumption	(9.00)	(9.00)	(9.00)	(9.00)
Evaporation and operational losses below Hoover Dam	(1.00)	(1.05)	(1.10)	(1.15)
Total System Losses	(15.90)	(16.91)	(17.03)	(17.14)
Net System Balance	(0.40)	(1.42)	(2.36)	(3.29)

Figure 2
Estimated Impact of Inflow Reductions on Colorado River Shortages 2010- 2060
Using 15.03 maf Observed Mean Streamflow



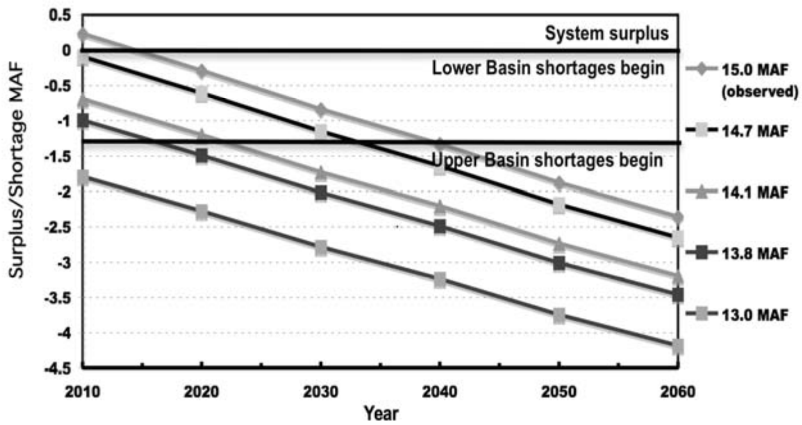
These estimated shortages are all calculated assuming Reclamation's 15.0 maf streamflow. As noted above, there is significant evidence that suggest that reliance on the observed record my significantly over-estimate the system's ability to avoid shortages. Moreover, as the Hoering analysis illustrated, models themselves rely on

G-8

Regional Director, Lower Colorado Region
April 30, 2007
Page 9

different mean streamflows when making their forecasts. As such, it's instructive to also examine how shortage conditions may change depending on the mean streamflow the climate change reduction factor are applied to. Figure 3 illustrates how a 10% reduction in flows attributed to climate change would impact the same reconstructed streamflow estimates from Figure 1.

Figure 3
Estimated Impact on Colorado River Shortages 2010- 2060
Assuming a 10% Inflow Reduction to Observed, and Selected Reconstructed Mean Inflows



While nobody yet knows if any of the scenarios outlined in Figures 2 and 3 above will pass by Lees Ferry in the coming decades, all estimates are well within the range of projections that have been made by climate researchers to date. Needless to say, all forecast shortages well beyond the range contemplated by the DEIS.

For Reclamation to project future Colorado River shortages while ignoring such overwhelming evidence is of an error of magnitude far greater than mistakes made by those who framed the Compact 85 years ago. Then, just a few people were asking that caution be exercised given the limited data at hand. Now society is faced with the reverse. Most people recognize the need for caution given the volumes of data available encouraging it, yet Reclamation alone chooses to embark on a path of risk, blind to the flashing lights along the way.

3. The Conservation Unknown

The majority of the DEIS evaluates plans for when and how to reduce flows from Lake Mead should certain shortage conditions exist. What is virtually ignored are the steps the Lower Basin should be taking to reduce its reliance on this water as these shortages gradually become a permanent condition due to increased Upper Basin consumption and the potential continuation of the downward trend in overall system inflows. 22

G-8

Regional Director, Lower Colorado Region
April 30, 2007
Page 10

Admittedly, given the limited level of initial shortages forecasted by Reclamation for the interim period, the DEIS likely assumes that such shortages are of a magnitude well within the abilities of the Lower Basin states to absorb without creating additional noise 23
in the system. However, even under Reclamation's rather optimistic predictions of inflows, shortages of more than .5 MAF will become commonplace. Arizona in particular will be facing reductions nearly every year.

More importantly, should Colorado River inflows continue to reflect the kind of downturn many researchers are predicting, a nearly persistent state for Lower Basin reductions would quickly materialize. 24
Furthermore, should those forecasts suggesting more severe reductions in streamflow prove accurate, the Upper Basin too may be forced to permanently adjust its consumption.

The DEIS's only attention to the water conservation issues pertaining to the Basin States Alternative, is through a mechanism allowing the Basin States to bank water in Lake Mead for release at a later date. However, as the DEIS notes, the actual use of this program is vague to say the least.

> *"At this time, it is unknown which entities might participate in a Lake Mead mechanism that* 25
> *allows the storage and delivery of conserved system and non-system water. Furthermore, the timing and magnitude of the storage and delivery of conserved water is unknown." (Page M-1.)*

Furthermore, as is illustrated in the specimen worksheet reproduced in Table M-3, it is unclear if the kinks of the program have been ironed out. The worksheet shows 26
California accumulating over 3 maf of water in Lake Mead, whereas the assumptions state California's maximum allowable accumulation is 1.5 maf.

While a potentially valuable concept, the lack of any discussion as to how this, or any other program, will cause those Lower Basin water users most exposed to shortage 27
situation to reduce their reliance on Colorado River water, illustrates an ongoing lack of foresight by the Lower Basin states. As summarized in Section 1 above, these shortages have been a known problem resulting from the river's over-allocation. The Lower Basin's reluctance to address this problem is evidence by the political background 28
spawning the Basin States proposal, and ultimately this DEIS. Moreover, the Lower Basin's unwillingness to advance a more far-reaching alternative, which recognizes the 29
scale of potential shortages discussed above, further reveals its resistance to planning for what it has known for decades would be coming.

Therefore, the Department of Interior must require from the Basin States, as a pre-condition to any changes in dam operations, a detailed action plan outlining how they 30
will reduce their consumption of Colorado River should shortages of the range discussed above materialize. It's not enough to assume that junior water rights holders will happily accept such cuts on a regular basis. Colorado River water users must resolve disputes in advance of shortages occurring, so that federal resources, including 31
the courts, are not forced to do it for them.

In developing their plans, the Basin States and Reclamation should examine the

G-8

Regional Director, Lower Colorado Region
April 30, 2007
Page 11

tremendous water losses evaporating off the surfaces of Lakes Powell and Mead, 32
averaging 1.36 maf annually. Much of the water in both these reservoirs could be stored 33
underground in aquifers already plumbed into the Colorado River system.

It's ironic that as the climate heats up, and evaporation rates increase, the states of 34
Arizona and California, which have extensive capacity in their Colorado River
groundwater recharge facilities, would advocate storing "conserved" water in Lake
Mead where more losses will undoubtedly occur. The DEIS should therefore examine
how the proposed "Lake Mead storage and delivery of conserved system and non- 35
system water" program can be shifted to more efficient storage reservoirs underground.
Such storage would also avoid the potential loss associated with Mead banking should 36
Reclamation be forced to spill excess water for flood control purposes through Hoover
Dam

Conclusion

Thirty million people now rely on Colorado River water to be delivered to their homes, 37
a number which is increasing despite the fact river flows are decreasing. Much of the
Southwest economy relies on this water, therefore will experience serious repercussions
should shortages materialize that are beyond the magnitude forecasted in this DEIS.

The men who met at Bishops Lodge in 1922 created this problem by allocating more water than the Colorado River had historically provided. Reclamation now appears destined to perpetuate this error by again assuming there is more water in the river than paleo-reconstruction experts now advise. Moreover, Nature is in the process of imposing major changes on the Colorado River that no amount of computer modeling can hide.

We therefore urge Reclamation and the Basin States to take a step back and revisit the 38
assumptions that went into this process so they better reflect the changing world
around them. Only then can some *real* alternatives for dealing with the *real* shortages
problems be developed, analyzed and presented to the public. The longer Reclamation 39
and the Basin States delay attending to all this, the fewer the options, the more
contentions the atmosphere, and the more costly the solutions become.

Lastly, recognizing the importance of this issue, Living Rivers/Colorado Riverkeeper 40
would appreciate the opportunity to offer additional comments to Reclamation and this
DEIS process. We understand that other interveners intend to submit comments beyond 41
today's published deadline and that Reclamation has agreed to incorporate them in the
Final EIS. Please notify us as to the final deadline after which no additional comments 42
will be accepted on this DEIS.

Sincerely,

John Weisheit, Living Rivers, Conservation Director
Michelle Harrington, Center for Biological Diversity, Rivers Program Director

G-8

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Reponses to Comment Letter G-8

G-8-1 and G-8-2

Your comment is noted.

G-8-3 and G-8-4

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

G-8-5

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

G-8-6

Your comment is noted. No change to the Final EIS was necessary

G-8-7 through G-8-14

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

G-8-15 through GS-8-21

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

G-8-22

The information requested is provided in Section 3.4 and Section 4.4. of the EIS. Most states, regional agencies, local agencies, and communities have already or are in the process of preparing water resources management plans and or drought management plans that address varying water demand and water supply management issues.

G-8-23

Information presented in the Draft EIS has been modified in the Final EIS pursuant to this specific comment, as well as other public comments. Section 4.4 of the Final EIS has been expanded to include a discussion on the probability and magnitude of future multi-year shortages.

G-8-24

Your comment is noted.

G-8-25

Your comment is noted. No change to the Final EIS was necessary. The proposed storage and delivery mechanism is one of the four operational elements that comprise the proposed federal action. The proposed mechanism will increase the flexibility the Lower Division states have to meet future water use needs from Lake Mead, particularly during low reservoir and shortage conditions. Section 2.3.3 and Appendix S describe the operational details of the Basin State's Alternative ICS mechanism

G-8-26

This comment fails to accurately reflect the information published by Reclamation in the Draft EIS in Appendix M and other locations in the Final EIS. Table M-3 in Appendix M of the EIS provides the assumed accumulation and delivery schedules for conservation activities under the Basin States' Alternative These schedules are used in modeling the ICS mechanism under the Basin States' Alternative. The model assumes a running account of the water being accumulated and delivered and limits the amount of water that can be accumulated to the maximum volumes that are noted in Table M-2 (Basin States Alternative Volume Limitations of ICS)..

G-8-27 and G-8-28

See response to Comment No. G-8-22.

G-8-29

Your comment is noted. The action alternatives consider a range of shortage strategies for the Lower Basin and he analyses also considered how these water delivery reductions would be distributed to the Lower Division states as well as to users within these states. Additionally, Reclamation has evaluated the potential impacts of these potential future water delivery reductions. The implementation of the proposed federal action is intended to provide a higher degree of certainty of the volumes of potential water deliveries that may available under different reservoir conditions. This higher degree of certainty will enable the Basin States and other Colorado River water users to better plan and prepare for future reductions in water deliveries.

G-8-30 and G-8-31

Your comment is noted. No change to the Final EIS was necessary. The Basin State's Alternative is based on their consensus proposal of February 2006 as revised by their comments submitted in response to the Draft EIS in April 2007. The April 30, 2007 letter transmitting the Basin State's proposal to the Secretary notes that the Basin States have set aside contentious issues and agreed to a comprehensive set of detailed operating guidelines for the Colorado River during the proposed interim period.

G-8-32

Information presented in the Draft EIS has been modified in the Final EIS (see Appendix P) pursuant to this specific comment, as well as other public comments. Evaporation at Lake Powell and Lake Mead is simulated in CRSS by multiplying the monthly average reservoir surface area by monthly evaporation coefficients. A description of the methodology and the monthly evaporation coefficients is provided in Appendix A. A comparison of the mean and median evaporation volumes for Lake Powell and Lake Mead for the No Action Alternative and the action alternatives is provided in Appendix P. This revision does not significantly change the impact analysis or results presented in the Draft EIS.

G-8-33 through G-8-36

Your comment is noted. Local water user agencies, such as the Metropolitan Water District of Southern California, and the Arizona Water Bank are already utilizing storage in groundwater aquifers to optimize their available surface water supplies. The proposed federal action would not limit these activities, but rather would enhance the tools available to lower basin waters users to meet their water use needs from Lake Mead in the future.

G-8-37 through G-8-39

Reclamation has considered a wide range of potential hydrological conditions and a wide range of potential water delivery reductions in the analyses in this EIS. The proposed guidelines will be interim in nature and are intended to provide the river operators and managers experience in the operation the Colorado River system under low reservoir conditions. This valuable experience is intended to provide information that can be used to plan for future conditions beyond the interim period.

G-8-40 through G-8-42

Your comment is noted. Reclamation did not extend the comment period on the Draft EIS

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CREDA

Colorado River Energy Distributors Association

ARIZONA
Arizona Municipal Power Users Association

Arizona Power Authority

Arizona Power Pooling Association

Irrigation and Electrical Districts Association

Navajo Tribal Utility Authority
(also New Mexico, Utah)

Salt River Project

COLORADO
Colorado Springs Utilities

Intermountain Rural Electric Association

Platte River Power Authority

Tri-State Generation & Transmission Association, Inc.
(also Nebraska, Wyoming, New Mexico)

Yampa Valley Electric Association, Inc.

NEVADA
Colorado River Commission of Nevada

Silver State Power Association

NEW MEXICO
Farmington Electric Utility System

Los Alamos County

City of Truth or Consequences

UTAH
City of Provo

South Utah Valley Electric Service District

Utah Associated Municipal Power Systems

Utah Municipal Power Agency

WYOMING
Wyoming Municipal Power Agency

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April 25, 2007

Bureau of Reclamation
Attention: BCOO-1000
PO Box 61470
Boulder City, Nevada 89006-1470

VIA EMAIL: strategies@lc.usbr.gov

The Colorado River Energy Distributors Association (CREDA) appreciates the opportunity to provide comments on the Bureau of Reclamation's (Reclamation) draft environmental impact statement on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (DEIS) (72 Fed.Reg. 9026-9028, February 28, 2007). In the event there is an extension of the comment period, CREDA may supplement these comments at an appropriate later date. CREDA offers some general background and perspectives, followed by specific comments on the DEIS.

CREDA Background

CREDA's mission is "To preserve and enhance the availability, affordability, and value of Colorado River Storage Project facilities while promoting responsible stewardship of the Colorado River System." CREDA is a non-profit, Colorado corporation, also authorized to do business in Arizona, which was formed in 1978 as an association of non-profit entities who are long-term contractors for resources of the Colorado River Storage Project (CRSP). CREDA represents its members by working with Reclamation and the Western Area Power Administration (WAPA) regarding issues related to the CRSP. CREDA members serve over four million consumers in both Upper and Lower Colorado River basin states: Arizona, New Mexico, Nevada, Colorado, Utah and Wyoming. CREDA members include joint action agencies, state agencies, political subdivisions, tribal utility authorities, municipalities, rural electric cooperatives and irrigation and electrical districts. CRSP contractors pay all the power costs of the CRSP, which includes construction (with interest), operation, maintenance and replacements, transmission, environmental and approximately 95% of the irrigation costs. CREDA has also been a representative of contractors who purchase federal power on the Glen Canyon Dam Adaptive Management Work Group (AMWG) since its inception. CREDA and its members have a direct and specific interest in this process.

CRSP Background

In 1956, the CRSP was initiated to provide storage facilities for the Upper Basin states so that they could meet their obligations under the Colorado River Compact. The CRSP was authorized in the Colorado River Storage Project Act of 1956 (P.L. 485, 84th Cong., 70 Stat. 50), as a multi-purpose federal project. The Act defined project purposes as flood control, water storage for irrigation, municipal and industrial purposes and generation of electricity. The CRSP includes hydropower generation facilities at the Aspinall Unit (three dams with hydropower facilities), Flaming Gorge Dam and Glen Canyon Dam. Glen Canyon Dam is the largest hydropower generating feature of the CRSP, comprising approximately 70%

G-9

of the generation resource of the Salt Lake City Area Integrated Projects (SLCA/IP).

Glen Canyon Dam and Hydropower Considerations

Glen Canyon Dam, located near Page, Arizona, includes eight generators, with the nameplate generating capacity of 1,296,000 kW[1] and reservoir storage capacity of 27,000,000 acre feet (to elevation 3,700)[2]. Lake Powell and Glen Canyon Dam are critical to the workings of the Law of the River, the Colorado River Compact and the Upper Colorado River Basin Compact, particularly in times of drought.

Reclamation currently operates Glen Canyon Dam to allow for hydrologic conditions, water rights, minimum stream flows, powerplant capacities, and reservoir elevation goals. "In addition to the water delivery purpose, another authorized purpose of Glen Canyon Dam is to generate hydroelectric power".[3] However, that purpose has been significantly constrained since the early 1990's, with the initiation of interim operating criteria, and continuing with the October 1996 Record of Decision (ROD)[4] which called for a Modified Low Fluctuating Flow (MLFF) operating regime, which ultimately resulted in the constraint of hydropower generation levels (maximum and minimum generation/flow and limits on up and down ramps) in favor of downstream resource concerns.

"Energy is the lifeblood of the U.S. economy. As our economy continues to grow, so too will the demand for abundant, affordable and reliable sources of energy."[5] Commenting on positive economic indicators, Federal Reserve Board Chairman Alan Greenspan cited the "chronic concern" that rising energy prices could threaten the nation's economic recovery. Greenspan called the positive indicators "scant comfort" and pointed out that all projections point to an "uncertain future."[6] Over the past 25 years, electrical demand in the West rose at nearly twice the rate of the population growth (140% vs. 71%), with the population expected to increase another 54% by the year 2030.[7] Now is not the time to further reduce or continue to unnecessarily restrict generating capacity at Glen Canyon Dam. Hydropower has been labeled the "most successful form of renewable energy."[8] It provides the only way to "store" electricity (in the form of water) for later use. Hydropower has many advantages over other power sources, including the ability to start quickly and adjust to rapid changes, including black start capability, during times of high energy demand and regional system disturbances. Since the power system in the West operates in an integrated manner, any time the load increases or decreases, a regulating generator must sense that change and immediately respond. Glen Canyon generation provides that capability. If Glen Canyon generation is further constrained by maximum and minimum flow and ramp rate releases, this flexibility and resource diversity is reduced. Reduced generation capability also requires the use of other less environmentally desirable resources, which can also raise the cost to consumers due to the need to replace the hydropower resource that is no longer available. 1 2

In 2005, CREDA wrote to then-Interior Secretary Gale Norton expressing a multitude of concerns regarding CRSP generation, drought and Basin Fund issues. A copy of that letter is attached hereto and CREDA requests Reclamation give consideration to the points contained in that communication in this DEIS process. ***Hydropower generation impacts, although addressed in detail in the DEIS, should be added as one of the "three important considerations" in this DEIS.***[9] 3 4

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[1] http://www.usbr.gov/power/data/sites/glencany/glencany.html
[2] http://www.usbr.gov/dataweb/dams/az10307.htm
[3] 71 Fed.Reg. 74558, December 12, 2006
[4] http://www.usbr.gov/uc/rm/amp/pdfs/sp_appndxG_ROD.pdf
[5] House Resources Committee Press Release, January 20, 2004.
[6] Testimony of Chairman Alan Greenspan, *Federal Reserve Board's semiannual Monetary Policy Report to the Congress,* Before the Committee on Financial Services, U.S. House of Representatives, February 11, 2004.
[7] Energy Information Administration, Annual Energy Outlook 2006 with Projections to 2030, http://www.eia.doe.gov/oiaf/aeo/electricity.html (Feb. 2006)
[8] Report of the Energy Policy Development Council, May, 2001 at 5-19.
[9] DEIS, p.2-1.

G-9

Bureau of Reclamation
April 25, 2007

CREDA offers the following specific comments on the DEIS, organized by Section title, then by page number and line numbers where appropriate).

Purpose and Need

1) P.1-24, l.4-8: This paragraph references Beach Habitat Building Flow (BHBF) releases, but in terms of the Purpose and Need of the DEIS, the relevancy is not clear. Based on clarifying discussion at the April 3 comment forum, we understand the reference to "triggering criteria" refers to the spill avoidance criteria, (Appendix A.5.6), NOT the sediment criteria used in the 2004 BHBF. By way of background, at the December 6, 2006 AMWG meeting, there was significant discussion and concern 5
expressed about the lack of a science plan for a BHBF, and the need to consider more than just "hydrologic triggering criteria." In addition, at the April 2, 2007 Technical Work Group (TWG) meeting, it became clear that there is not yet a BHBF science plan that has been vetted/approved by the TWG and the AMWG. CREDA recommends this paragraph be deleted, or in the alternative clarified that the only reference to BHBF specifically refers to the modeling assumption explained in Appendix A regarding spill avoidance.

Affected Environment

1) P.3-19, l.15: Where reference is made to Glen Canyon Dam operations, it should be clear that operations are pursuant to the Law of the River (and not just reference to the Grand Canyon Protection Act of 1992). 6

2) P.3-19, l.21-23: Reference later in the DEIS is made to Reclamation's Long-Term Experimental Plan[10]; CREDA recommends these lines be revised to reflect "pending the outcome of the LTEP….", as opposed to stating that "future daily and hourly released are expected to continue to be made according to … 1996 … ROD…". 7

3) P.3-48, l.2-6: See also comment on Purpose and Need above regarding BHBF. CREDA recommends these lines be deleted. 8

4) P.3-95, l.26: CREDA recommends this line be rewritten as follows: "Firm power contracts for resources of the Salt Lake City Area Integrated Projects (SLCA/IP), of which Glen Canyon is one of the resources, terminate in 2024,"…. 9

5) P.3-99, l.1-2: Clarification should be added to indicate that the Secretary is *authorized* (not mandated) to use CRSP power revenues to fund the Glen Canyon Adaptive Management Program,[11] hence, funding for this program does not fall within the same obligation level as the other listed programs. 10

6) P.3-99, l.3-4: Clarification should be added to the reference to funding of the Endangered Fish Recovery Implementation Program. Annual base funding is provided solely by power revenues, it is not "cost shared." 11 In addition, no later than 2008, the Secretary is obligated to provide a report to Congress on the status of the use of power revenues for base funding, containing a recommendation regarding the need for continued base funding after fiscal year 2011. 12 The utilization of power revenues for annual base funding shall cease after the fiscal year 2011, unless reauthorized by Congress; except that power revenues may be continued to be utilized to fund the operation and maintenance of capital projects and monitoring."[12] 13

7) P.3-99, l.14-16: The DEIS should be very clear in that "A change in the amount of available capacity or energy *WILL* affect "the revenue… to the Basin Fund, the rates charged to power *and water* customers, *and could impact repayment to the Treasury and the support of environmental programs funded by Basin Fund revenues.* 14

Environmental Consequences

1) P.4-79, l.27-29: Seasonal, daily and hourly flows will continue to be managed in accordance with the Law of the River, not the AMP. 15

2) P.4-241, l.24-29: Certainly "total loss of electrical power generation" would have a substantial impact on the Basin Fund, power rates, repayment, and environmental program funding. 16

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[10] DEIS, section 5.1.28

[11] Grand Canyon Protection Act of 1992, section 1807

[12] P.L. 106-392, Section 3(d)(2)

G-9

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Bureau of Reclamation
April 25, 2007

However, it should be noted that these impacts don't occur ONLY with the complete loss of power generation. Although "the action alternatives generally have a minor impact on the *economic value* of electrical power generation", impacts associated with declining Basin Fund levels can be significant (see comment 7) above). 16

Alternatives/Recommendations

1) CREDA supports the consensus process being undertaken by the Basin States in the development of the Basin States (BS) alternative. 17 We also understand the States are continuing to refine parameters of that alternative, and there is the potential that underlying assumptions may be adjusted, so we request the ability to comment further should that alternative change. 18

2) Consistent with the position CREDA has taken in the past regarding the use of Basin Fund power revenues for "non-power" programs (see attached), and consistent with the stepped levels of shortage contained in the BS alternative, CREDA recommends that Reclamation fund the "non-power" programs from appropriated dollars (*not* CRSP Basin Fund power revenues) in stepped increments tied to the BS shortage levels. 19 For instance, if a shortage of 400kaf is declared, one-third of the "non-power" program annual costs would be funded through appropriations. If a shortage of 500kaf is declared, two-thirds of those annual costs would be funded through appropriations. If a shortage of 600kaf is declared, 100% of those annual costs would be funded through appropriations. This approach would not require legislation to implement.

3) From a public policy perspective, CREDA believes it inappropriate to assess power customers with a surcharge to "subsidize" water conservation projects as recommended in the Conservation Before Storage (CBS) alternative. 20

Thank you for the opportunity to comment on this DEIS.

Sincerely,

/s/ Leslie James

Leslie James
Executive Director

Cc: CREDA Board

G-9

4

Bureau of Reclamation
April 25, 2007

CREDA

Colorado River Energy Distributors Association

April 25, 2005

ARIZONA
Arizona Municipal Power Users Association

Arizona Power Authority

Arizona Power Pooling Association

Irrigation and Electrical Districts Association

Navajo Tribal Utility Authority
(also New Mexico, Utah)

Salt River Project

COLORADO
Colorado Springs Utilities

Intermountain Rural Electric Association

Platte River Power Authority

Tri-State Generation & Transmission Association, Inc.
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Colorado River Commission of Nevada

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Farmington Electric Utility System

Los Alamos County

City of Truth or Consequences

UTAH
City of Provo

Strawberry Electric Service District

Utah Associated Municipal Power Systems

Utah Municipal Power Agency

WYOMING
Wyoming Municipal Power Agency

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Honorable Gale Norton, Secretary
Department of the Interior
VIA FAX

Dear Secretary Norton:

It is our understanding that on or about April 26, 2005, the seven Colorado River Basin States may submit to you comments regarding whether the runoff forecast warrants an adjustment to the release amount from Lake Powell for water year 2005. We are writing to alert you to another drought related issue that the Colorado River Energy Distributors Association (CREDA) believes requires your immediate attention.

CREDA is a non-profit Colorado corporation comprised of Colorado River Storage Project (CRSP) firm electric service customers in the states of Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming. CREDA members are all non-profit entities, including joint action agencies, state agencies, political subdivisions, tribal utility authorities, municipalities, rural electric cooperatives and irrigation and electrical districts. CREDA members represent the majority of the CRSP customers and serve over four million consumers. CREDA initiated a dialogue over a year ago with the Bureau of Reclamation (Bureau), Western Area Power Administration (Western) and state water interests to consider drought impacts to power production and the Upper Colorado River Basin Fund (Basin Fund). CREDA participates in the Annual Operating Plan stakeholder process, the Glen Canyon Adaptive Management Work Group and the Upper Basin Endangered Fish Recovery Program, as well as the annual work program review process with Western and the Bureau.

Section 7 of the CRSP Act of 1956 requires that the "hydroelectric powerplants and transmission lines…be operated…so as to produce the greatest practicable amount of power and energy that can be sold at firm power and energy rates…". Section 5 of that Act established the Basin Fund and requires that all revenues collected in connection with the operation of the CRSP and participating projects be credited to that Fund.

Due to the on-going drought, the Basin Fund -- which finances repayment of the federal investment in power facilities and operation, maintenance and replacement (OM&R) activities at Glen Canyon Dam and the other power facilities of the CRSP – is close to insolvency. Unless immediate action is taken, the Basin Fund will not be able to cover annual OM&R expenses, repay the capital costs of the power features of the CRSP or fund three important non-power programs now funded by power revenues: the Colorado River Salinity Control Program, the Glen Canyon Adaptive Management Program and the Endangered Fish Recovery Programs of the Upper Colorado River and San Juan Basins. The costs associated with these non-power programs are nearly $20 million per year.

CREDA is deeply concerned the Basin Fund may not have sufficient revenues to cover the annual OM&R costs of the CRSP and to repay the capital costs of the project. We are also concerned that, if the Fund is depleted, the non-power programs currently funded with CRSP power revenues will go unfunded, to the detriment of many interests in the Upper Basin states.

CRSP customers have already borne the financial brunt of the ongoing drought. Just two years ago, a 17% rate increase was imposed. In addition, beginning October 1, 2004, energy reductions of 26% were imposed. And the comment and consultation process for yet another rate increase (24%) just closed last week, with the increase to take effect October 1, 2005. And yet, funding for these non-power programs has continued with no reduction, which has in part created a severe cash flow situation in the Basin Fund. Ongoing

G-9

Bureau of Reclamation
April 25, 2007

rate increases could render the CRSP resources uneconomic, with customers having no choice but to pass those increased costs on to their consumers. For most of the CRSP customers, particularly the 55 Native American customers who became CRSP customers on October 1, 2004, this cost would be prohibitive and would defeat any potential benefit the federal resource is intended to provide.

CREDA urges the Department of the Interior to immediately seek appropriations for the non-power programs now financed with Basin Fund revenues. Further, CREDA believes that future use of revenues from the Basin Fund for non-power purposes should be limited to those situations where the use of power revenues is mandated by law, not when such use is merely permitted. For example, the Glen Canyon Adaptive Management Program authorizes, but does not mandate, the use of CRSP power revenues for program funding. Similarly, the Endangered Fish Recovery Program legislation requires the Bureau and the Western to seek appropriations in times of financial need. To the best of our knowledge, neither the Bureau nor Western has requested such appropriations, despite the congressional directive. Furthermore, these programs are for the benefit of an entire population, and should be funded as such, not by a restricted pool of recipients of federal hydropower.

CREDA also urges the Department to seek appropriations to fund OM &R at CRSP facilities when the Basin Fund is not adequate to cover these costs. Consideration could be given to the establishment of a "trigger", such as when the Bureau's 24-month hydrology indicates minimum power pool conditions at Lake Powell.

Our review of the legislative history of the CRSP indicates no one contemplated, or could have been reasonably expected to contemplate, this drought situation and the ensuing economic and financial impacts to CRSP power customers. This situation deserves immediate attention and assistance.

I am enclosing a copy of a Drought White Paper that CREDA prepared in March of this year, which provides additional information about these critical issues. Also enclosed is a resolution passed by the Colorado River Water Users Association in December 2004, supporting our request.

We would also like the opportunity to discuss these issues with you or your staff at your earliest convenience.

Sincerely,

/s/ Leslie James

Leslie James
Executive Director

Cc: CREDA Board
John Keys III
Michael Hacskaylo
AZ, CO, NV, NM, UT, WY Congressional Delegations

G-9

Bureau of Reclamation
April 25, 2007

DROUGHT IN THE COLORADO RIVER BASIN

THE COLORADO RIVER STORAGE PROJECT (CRSP)

The CRSP was authorized in the Colorado River Storage Project Act of 1956 (P.L. 485, 84th Cong., 70 Stat. 50), as a multi-purpose federal project. The Act defined project purposes as flood control, water storage for irrigation, municipal and industrial purposes and the generation of electricity. Recreation and environmental mitigation and protection were added as project purposes later, but were not added to all of the features that make up the CRSP.

The CRSP power features include five dams and associated generators, substations, and transmission lines. Glen Canyon Dam is located near Page, Arizona and is by far the largest of the CRSP projects. Glen Canyon consists of eight generators for a total of about 1300 MW, which is more than 76% of the total CRSP generation. Flaming Gorge Dam is on the Green River, a major tributary of the Colorado River, and is located near Vernal, Utah. Flaming Gorge has three units producing about 132 MW of generation. The Aspinall Unit includes three dams and generating plants along the Gunnison River near Gunnison, Colorado. Blue Mesa is the first dam on the river and has two units producing about 97 MW. Morrow Point is the second dam in the series and consists of two generators producing a total of 146 MW. Crystal is the final dam and has one 32 MW generator.

COLORADO RIVER ENERGY DISTRIBUTORS ASSOCIATION (CREDA)

CREDA's mission is "To preserve and enhance the availability, affordability, and value of Colorado River Storage Project facilities while promoting responsible stewardship of the Colorado River System." CREDA is a non-profit corporation, which was formed in 1978 as an association of entities who are long-term contractors for resources of the CRSP. CREDA works on behalf of its members with the Bureau of Reclamation (Bureau) and the Western Area Power Administration (WAPA) regarding issues related to the CRSP. CREDA members serve over 4 million consumers in six states: Arizona, New Mexico, Nevada, Colorado, Utah and Wyoming. CREDA members include joint action agencies, state agencies, political subdivisions, tribal utility authorities, municipalities, rural electric cooperatives and irrigation and electrical districts.

CRSP contractors pay all the power costs and approximately 95% of the irrigation costs of the CRSP, which includes construction (with interest), operation, maintenance and replacements, transmission, environmental and irrigation assistance. Beginning October 1, 2004, 55 tribes and pueblos became CRSP contractors under 20 year contracts.

DROUGHT IN THE COLORADO RIVER BASIN

The Colorado River Basin is in its sixth consecutive year of drought. In the 100 years of record keeping by the Bureau, there have never been six consecutive years of drought. Lake Powell is at its lowest level since 1969 at 3556 feet, which is 144 feet from full pool. It is approaching minimum power generation level. If this year's hydrology mirrors the past two years, this level could be reached as soon as February 2006. If minimum power generation level is reached, there will be little CRSP generation available to the CRSP contractors. This will have significant economic consequences for the CRSP contractors and the customers they serve, as well as for a number of other non-power programs that are funded with CRSP power revenues.

THE UPPER COLORADO BASIN FUND AND DROUGHT IMPACTS

The Basin Fund is a revolving fund maintained by CRSP power revenues. The Basin Fund is the source of CRSP project repayment, including: repayment of the capital investment with interest, operation, maintenance and replacement expense, 95% of the irrigation investment, Bureau and WAPA employee salaries (about $80 million annually). In addition, the Fund has been the source of funding for other "non-power" programs:

G-9

*Approximately $18 million for the Colorado River Salinity Control Program;
*$179,577,774 for the Glen Canyon Adaptive Management Program;
*$40,399,329 for the Upper Colorado River Basin and San Juan Basin Endangered Fish Recovery Programs.

The programs listed above total about $20 million per year.

In addition, due to reduced generation levels from the CRSP resource, WAPA has had to purchase power on the open market to meet its contractual requirements. This year alone, they have spent $50.5 million from the Upper Colorado Basin Fund for replacement power. In order to maintain a sufficient Basin Fund level, in October 2003, WAPA reduced energy deliveries to its customers by 26%. Each customer has had to "make up" the shortfall on its own. WAPA has also begun an approximate 24% rate increase process.

CREDA has worked with WAPA to develop a program as part of the rate process that would allow some customers to procure their own supplemental power instead of through WAPA. This would shift some of the Basin Fund risk from WAPA to the customers by allowing each customer to decide how the shortfall in CRSP generation should be made up.

Since 1998, the Basin Fund has been at risk of deficiency due to reduced generation levels, market price conditions and expenditures for environmental testing. CRSP customers have experienced increased rates and reduced energy deliveries. In the event generation ceases at Glen Canyon Dam, the CRSP rate would have to increase fourfold, which would also be approximately double the cost of energy that could be procured on the open market.

CREDA members, all non-profit entities, have no option other than to pass those costs on to their consumers. For most of the CRSP customers, particularly the 55 new Native American customers, this cost would be prohibitive, and would defeat any potential benefit the CRSP resource may provide to those customers.

NON-POWER RELATED PROGRAMS SHOULD BE FUNDED BY APPROPRATIONS, NOT CRSP CUSTOMERS

CREDA is concerned that, when generation is ceased or close to being ceased at Glen Canyon Dam, an effort will be made to require CRSP power users to fund the non-power programs described above. This would, in effect, be a subsidy from the electric consumers in six Western states to all the parties that benefit from the Salinity Control, Adaptive Management and Endangered Species Recovery programs on the river.

Instead, the non-power programs should seek appropriations from Congress to fund activities when the Basin Fund is depleted. Further, the Basin Fund should be limited to "the basics", namely, those costs that are mandated by law to be repaid by the Fund. The Glen Canyon Adaptive Management Program authorizes, but does not mandate, the use of CRSP power revenues for program funding. The Endangered Fish Recovery Programs legislation requires the Bureau and WAPA to seek appropriations in times of financial need.

From a public policy standpoint, these programs are intended to benefit the environment, which is in the public interest, and therefore should be funded by appropriations. Providing appropriations for these programs would assist in maintaining the Basin Fund's solvency.

G-9

Bureau of Reclamation
April 25, 2007

APPROPRIATIONS RECOMMENDATIONS

CREDA suggests that Congress immediately:

Provide funding for Glen Canyon Adaptive Management Program costs by appropriations to Section 8, CRSP Act. (approx. $9 M annually) – see GCPA Sec. 1807; CRSPA Sec. 5;

Provide funding for the Upper Colorado River and San Juan Endangered Fish Recovery Programs by appropriations to Section 8, CRSP Act (approx. $6M annually) – see (3)(d)(1) of S. 2339; and

Provide funding for the Colorado Basin Salinity Control Program costs assigned to CRSP power revenues (approx. $2 M annually)

Further, CREDA suggests that when the Bureau's 24-month hydrologic study indicates there will be no power generation at Glen Canyon Dam OR if the Secretary of the Interior implements an annual release amount of less than 8.23MAF, Congress provide appropriations, to be repaid by CRSP at the end of the repayment period, without interest, to fund the operation, maintenance, and replacement expenses of the Bureau and WAPA assigned to the Colorado River Storage Project (approximately $80 million annually). Congress should also require a report to Congress if the hydrologic trigger is met. Funding would be discontinued when Lake Powell's level reaches the level agreed to by the states for 602(A) storage.

G-9

Bureau of Reclamation
April 25, 2007

Adopted by CRWUA December 17, 2004

Resolution No. 2005-19

DROUGHT IMPACTS ON THE COLORADO RIVER STORAGE PROJECT

The United States Bureau of Reclamation (USBR) and the Western Area Power Administration (Western) should implement cost-cutting measures and strategies to improve the status of the Upper Colorado River Basin Fund and stabilize the Colorado River Storage Project (CRSP) power rate, and to work in partnership with the CRSP customers to develop an operational, financial, and rate-setting strategy that addresses the drought situation, creates a sustainable cash flow and maintains a viable power rate.

The Colorado River Water Users Association encourages the passage of federal legislation that would make available non-reimbursable appropriations to the USBR and Western; to ensure ongoing funding of CRSP operations and other required annual funding obligations.

Position Statement
Drought Impacts on the Colorado River Storage Project
(Resolution No. 2005-19)

The federal CRSP hydropower and delivery systems were authorized by Congress to provide a wide range of significant benefits to millions of citizens in the West, including:

- Flood Control
- Irrigation
- Municipal water supply
- Interstate and international compact water deliveries
- Lake and stream recreation
- Blue ribbon trout fisheries
- River regulation
- Economic development
- Fish and wildlife propagation and mitigation
- Power generation and transmission

The Colorado River Basin is entering its sixth year of drought conditions. Lake Powell water storage is at the lowest since it filled in 1980, and is approaching the level where power generation will cease.

Funding for repayment of federal investment in the CRSP storage features and participating irrigation projects, and the operation and maintenance of the CRSP facilities and staff of the U.S. Bureau of Reclamation (USBR) and the Western Area Power Administration (Western) is provided through power revenues maintained in the Upper Colorado River Basin Fund.

A portion of the costs associated with the Colorado River Salinity Control program, the Glen Canyon Adaptive Management Program and the Upper Basin Endangered Fish Recovery Programs are funded through the Upper Colorado River Basin Fund.

A combination of reduced generation from the CRSP, costs associated with environmental programs and experiments, and wholesale power market conditions have resulted in unstable, non-sustainable cash flow conditions in the Upper Colorado River Basin Fund. The effective CRSP power rate is increasing while resource deliveries are declining.

As hydrologic conditions improve after the current severe ongoing drought that has plagued the Colorado River Basin and most of the western United States for the past five years, the Bureau of Reclamation should do its utmost to build reservoir conservation storage back to pre-drought conditions in each of the reservoirs which it manages.

G-9

Reponses to Comment Letter G-9

G-9-1 and G-9-2

Your comment is noted. No change to the Final EIS was necessary.

G-9-3

Your comments are noted. Seeking federal appropriations to replace Basin Fund revenues for non-power programs and Operation, Maintenance and Replacement of CRSP facilities is outside the scope of this study.

G-9-4

The information requested is provided in the EIS. Please refer to the opening paragraph of Section 4.11 of the EIS identifies the issues addressed in the analyses of potential impacts to the electrical power resources.

G-9-5

Your comment is noted. No change to the Final EIS was necessary. Section 1.8.1 of the EIS is a summary description of the Operation of Glen Canyon Dam Final EIS and Record of Decision. This and other references cited in Section 1.8 cover other previous federal actions that are of relevance to this EIS.

G-9-6

The information requested is provided in Section 3.3.2 of the EIS.

G-9-7

Information presented in the Draft EIS has been modified in the Final EIS (See Section 3.2.2.) pursuant to this specific comment, as well as other public comments. This revision does not change the impact analysis or results presented in the DEIS.

G-9-8

See response to comment G-9-5.

G-9-9

Your comment is noted. No change to the Final EIS was necessary.

G-9-10 through G-9-14

Your comments are noted. No change to the Final EIS was necessary.

G-9-15

The information requested is provided in Section 3.3.2 of the EIS.

G-9-16

Your comment is noted. No change to the Final EIS was necessary. Section 4.11.2.9 of the EIS notes that the proposed federal action could reduce the amount of money available to meet the intended use of the Basin Power Fund. The potential impacts to the fund are described in Section 4.11.2.5.

G-9-17 and G-9-18

Your comment is noted.

G-9-19

See response to Comment No. G-9-3.

G-9-20

Your comment is noted. No change to the Final EIS was necessary.

Comments Submitted By State Agencies

This section contains comment letters submitted by the following state agencies:

- S-1 New Mexico Interstate Stream Commission
- S-2 Colorado Water Conservation Board, State of Colorado
- S-3 State of Wyoming, State Engineer's Office
- S-4 Arizona Department of Water Resources
- S-5 Nevada State Clearinghouse
- S-6 State of Utah, Department of Natural Resources
- S-7 Colorado River Board of California
- S-8 Seven Basin States Representatives (Arizona, California, Colorado, Nevada, New Mexico, Utah, Wyoming)
- S-9 Southern Nevada Water Authority and Colorado River Commission of Nevada

NEW MEXICO INTERSTATE STREAM COMMISSION

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FOLDER I.D
KEYWORD

April 30, 2007

Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City, Nevada 89006-1470

Via Fax (702-293-8156) and First-Class Mail

The New Mexico Interstate Stream Commission offers the following comments on the Bureau of Reclamation's
February 2007 Draft Environmental Impact Statement on Colorado River Interim Guidelines for Lower Basin
Shortages and Coordinated Operations for Lake Powell and Lake Mead. These comments are in addition to
those made in the submittal of the seven Basin States. The State of New Mexico supports the Basin States' 1
recommendation that is described in the comment letter submitted by the seven Basin States and dated April 30,
2007, as the preferred alternative for the Final Environmental Impact Statement and the Record of Decision on 2
this matter. We recommend that the EIS be revised as necessary to reflect the seven Basin States' 3
recommendation, including the terminology and provisions included therein.

Page 1-15, line 1, through page 1-19, lines 6; page 3-31, lines 12-19; and page 3-32, lines 10-11. The
descriptions of compact and decree apportionments and of mainstream and tributary uses should be more 4
accurately stated.

Page 2-13, lines 5-27. Conservation and storage in Lake Mead of water for consumptive uses or for
environmental purposes in Mexico should be tied to resolution of other international issues affecting 5
management of Colorado River Basin waters. In addition, at this time, there is no international agreement, or
other guarantee, that water purchased for environmental purposes in Mexico would indeed be used for 6
environmental purposes. Also, the funding mechanisms and the purchase prices for implementing voluntary
conservation programs in the amounts suggested by the Conservation Before Shortage alternative are uncertain. 7
The conservation targets may not be achievable on a voluntary basis.

Page 3-11; and page 3-84, line 14, through page 3-85, line 8. The Navajo Nation in northeastern Arizona also 8
has an annual allocation of water from the Central Arizona Project. In addition, an allocation of 14,000 acre-
feet per year of new consumptive use from the Gila River system within the State of New Mexico requires the
exchange delivery of an equivalent amount of water from the Central Arizona Project for use by downstream 9
water users on the Gila River in Arizona.

S-1

Bureau of Reclamation
April 30, 2007
Page 2

Page 3-32, lines 1-4. The Upper Basin depletion schedules do include average annual evaporation losses from 10
most reservoirs, including Navajo Reservoir. The depletion schedules shown in Figure 3.4-1, however, may not
include Colorado River Storage Project reservoir evaporation at Lake Powell, Flaming Gorge Reservoir and the 11
Aspinall Unit that is shared among the Upper Division states.

Page 4-8, lines 7-9. The EIS should clarify the physical and operational parameters associated with installation 12
of the Southern Nevada Water Authority's third intake.

Page 4-9, lines 3-4. The EIS should include a disclaimer that while the modeling assumes that the United States
will not operate the Yuma Desalting Plant, the use of this modeling assumption does not represent any 13
determination by Reclamation or the United States as to whether the plant will or will not be operated in the
future.

Page 4-51, line 7, through page 4-52, line 1. The text is not consistent with Figure 4.3-23 and Figure 4.3-24,
which both indicate that the Lake Mead water surface drops below 1000 feet elevation in 2025 and 2026 under 14
the Basin States alternative.

Page 4-174, lines 2-25. At high storage levels in Lake Powell, water in storage inundates a waterfall on the San 15
Juan River that otherwise provides an effective barrier to fish movement up the river. Also, bluehead sucker 16
and flannelmouth are common in the San Juan River.

Page A-3, line 2, through page A-4, line 9; and page A-6, lines 5-7. The modeling on which the EIS relies
should reflect for Navajo Reservoir operations the preferred alternative in the April 2006 Final Environmental 17
Impact Statement and June 2006 Record of Decision on Navajo Reservoir Operations. Under the Navajo
Reservoir Operations ROD, the minimum and maximum releases from Navajo Dam are 250 cfs and 5,000 cfs,
respectively, and seasonal Navajo Dam releases to the San Juan River are based on the San Juan River Basin 18
Recovery Implementation Program's flow recommendations for the San Juan River below Farmington so as to
provide for habitat needs of populations of Colorado pikeminnow and razorback sucker.

Page A-11, lines 1-5. The following opinion is provided should the Secretary in the future conduct a review of 19
the algorithm for determining 602(a) storage requirements for Lake Powell. The active storage in Navajo
Reservoir should not be considered in determining whether the 602(a) storage requirement is met. During
extended drought, Navajo Reservoir storage is drawn down to meet water use demands of contractors and may
not be available for delivery to Lee Ferry either physically or without impairing contract uses in New Mexico.
About ¾ of New Mexico's Upper Basin uses are serviced from the Navajo Reservoir water supply. Using 20
Navajo Reservoir storage for release in the 602(a) storage algorithm does not protect Upper Basin uses in New
Mexico.

Page C-1, Table C-1. The State of New Mexico's most recent schedule of anticipated Upper Basin depletions is
appended to the Bureau of Reclamation's May 2006 Draft Hydrologic Determination, and indicates depletions 21
of up to about 642,000 acre-feet per year within New Mexico. Upon the Secretary of the Interior's approval of
the Hydrologic Determination, the New Mexico depletions should be revised accordingly. 22

Page N-3, lines 17-29. The EIS should include a brief statement of potential shortcomings of the Direct Paleo 23
technique consistent with such statements included for other techniques.

S-1

Bureau of Reclamation
April 30, 2007
Page 3

Thank you for the opportunity to comment on the DEIS.

Sincerely,

John R. D'Antonio, Jr., PE
Secretary

Copy: Scott Balcomb
Rod Kuharich
Dennis Strong
Patrick Tyrrell
Herb Guenther
Gerry Zimmerman
Richard Bunker
Pat Mulroy

S-1

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Reponses to Comment Letter S-1

S-1-1

Your comment is noted. No change to the Final EIS was necessary.

S-1-2

Your comment is noted. No change to the Final EIS was necessary.

S-1-3

Your comment is noted. Modifications, as appropriate, have been made to the Final EIS.

S-1-4

Your comment is noted. The EIS provides a general description of the Law of the River solely for the purpose of providing background to the readers.

S-1-5

Your comment is noted. No change to the Final EIS was necessary.

S-1-6

See the general response to the comments received from the Government of Mexico and the specific responses to Comment Nos. F-5-17 and F-5-18.

S-1-7

Your comment is noted. No change to the Final EIS was necessary. As noted in Section 2.4.5 of the Draft EIS, the viability of the funding proposal provided in the Conservation Before Shortage proposal is not known at this time. For purposes of environmental impact analysis, and to analyze the full impacts of this alternative, it was assumed that the voluntary conservation targets would be achieved.

S-1-8

Your comment is noted. No change to the Final EIS was necessary. To clarify, the Arizona Water Settlements Act (AWSA) provides that the Secretary shall retain 6,411 af of Central Arizona Project water for use for a future water rights settlement agreement approved by an Act of Congress that settles the Navajo Nation's claims to water in Arizona. Reference to this water was included in Section 3.10.6 of the Draft and Final EIS.

S-1-9

Your comment is noted. No change in the Final EIS was necessary. To clarify, pursuant to the AWSA, the Secretary shall offer, with appropriate approvals, to contract with users in New Mexico for up to an annual average of 14,000 af from the Gila River, subject to deliveries of Colorado River water to downstream Gila River users in Arizona to replace any diminution in flows. As discussed in Section 4.4.1.1, the Shortage Allocation Model (used to distribute shortages to individual entitlement holders within the CAP) was consistent with the ASWA. However, for the comparative analysis performed for this EIS, not all potential future ASWA water transactions were included in this modeling.

S-1-10 and S-1-11

Your comment is noted. The statement has been clarified in Section 3.4.1 to inform the reader that the Upper Basin depletion schedules as shown in Figure 3.4-1 and detailed in Appendix C do not include evaporation losses only for the CRSPA reservoirs and for the Navajo Reservoir. It should also be noted that although the schedules submitted by New Mexico include the evaporation losses for Navajo Reservoir, those losses are not included as input to the CRSS model since the model computes the evaporation loss for Navajo Reservoir at each time step during the simulation.

S-1-12

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. G-1-31.

S-1-13

Your comment is noted. No change to the Final EIS was necessary. Section 4.2.7 of the Draft EIS and the Final EIS contains language that clarifies the modeling assumptions regarding operation of the Yuma Desalting Plant. Also see response to Comment No. F-4-9.

S-1-14

Reclamation concurs with this comment. Section 4.3.4 in the Final EIS and Figure 4.3-23 and Figure 4.3-24 (re-numbered to Figure 4.3-24 and Figure 4.3-25 respectively in the Final EIS) have been revised.

S-1-15

Reclamation concurs with this comment. The Final EIS (Section 4.8.4) has been modified to include additional discussion and analysis regarding the probability of the waterfall at the San Juan inflow area being exposed, and its potential effects on native fish species.

S-1-16

Your comment is noted. No change to the FEIS was necessary. The geographic scope of the EIS does not include the San Juan River above Lake Powell.

S-1-17 and S-1-18

Your comment is noted. No change to the Final EIS was necessary. The geographic scope of the EIS does not include the San Juan River above Lake Powell. However, the simulation of reservoirs above Lake Powell is necessary to accurately simulate inflow to Lake Powell. The operation of Navajo Reservoir is simulated in the Colorado River Simulation System (CRSS). The CRSS does not include the revised operation of Navajo Reservoir under the 2006 Navajo Reservoir Operations ROD (2006 Navajo ROD). However, in the CRSS, the operation of Navajo Reservoir on an annual time-step closely matches the operation under the 2006 Navajo ROD. A separate model which simulates the San Juan River and Navajo Reservoir which incorporates the 2006 Navajo ROD was used to make this comparison. Incorporation of the 2006 Navajo ROD in CRSS would result in some minor inter-annual changes to Lake Powell storage from those simulated by the CRSS.

S-1-19 and S-1-20

Your comment is noted. No change to the Final EIS was necessary.

S-1-21 and S-1-22

Your comment is noted. As discussed in Section 3.4.1 of the Final EIS, the depletion schedules for the Upper Basin states used in the EIS were developed by each Upper Basin state and approved for transmittal to Reclamation by the Upper Colorado River Commission (Commission). Reclamation will continue to work with the Commission and the Basin States and other stakeholders to update these depletion schedules as appropriate.

S-1-23

Your comment is noted. Additional information has been provided in the Final EIS (Appendix N).

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STATE OF COLORADO

Colorado Water Conservation Board
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Bill Ritter, Jr.
Governor

Harris D. Sherman
Executive Director

Rod Kuharich
CWCB Director

Dan McAuliffe
Deputy Director

April 30, 2007

Honorable Dirk Kempthorne, Secretary
Department of the Interior
1849 C. Street, NW
Washington, D.C. 20240

Re: State of Colorado Comments on *Draft Environmental Impact Statement Regarding Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions*.

Dear Secretary Kempthorne:

The State of Colorado thanks you for the opportunity to comment on the *Draft Environmental Impact Statement for Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions* (the "DEIS") released by the Bureau of Reclamation (the "Bureau") on February 28, 2007.[1]

The importance to Colorado of its namesake river cannot be overstated. The Colorado River and its tributaries supply over a third of Colorado's water needs and provide water to nearly 60 percent of the States' population. Originating as snowfall high in the Colorado mountains, Colorado River water is put to agricultural use on Colorado's eastern plains, central valleys, and western mesas; municipal use in cities from Fort Collins to Denver to Colorado Springs to Durango to Grand Junction; and industrial use at manufacturing facilities, mines, ski resorts, and oil and gas production facilities across the State. Moreover, because no major rivers flow into Colorado, Colorado must satisfy all its water demands from sources within the State. The Colorado River is simply an irreplaceable resource for Colorado. The State's past, present, and future are directly tied to the Colorado River.

The significance of the Colorado River to Colorado is reflected in the Colorado River and Upper Colorado River Basin Compacts, which grant Colorado the largest allocation of Colorado River System water of all the Upper Division States and the second largest allocation of Colorado River Water of all the Basin States. Due to its location at the headwaters of the Colorado River, Colorado must depend upon this allocation not only to meet its present needs, but also to provide for its future development. Indeed, it was precisely for the purpose of preserving its right to

[1] Publication of the Draft EIS, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (hereinafter "DEIS") was announced at 72 Fed. Reg. 9026 (February 28, 2007).

future development of Colorado River water that Colorado entered into the Colorado River and
Upper Colorado River Basin Compacts.

Given this relationship with the Colorado River, Colorado clearly has a substantial interest in the
efficient management and wise administration of the Colorado River System and System
reservoirs. The Colorado River System and its reservoirs must be administered and managed in a
manner that meets the needs of the Colorado River basin states without jeopardizing Colorado's 1
significant, legally protected rights to the waters of the Colorado River, or compromising its
ability to serve the present uses and future needs of Colorado citizens. It is in the interest of
protecting the rights and needs of its citizens that Colorado submits these Comments.

The State of Colorado's Comments consist of two parts. First, Colorado joins in the Basin
States' Combined Comments, Recommendations, and Proposed Guidelines (the "Basin States'
Comments"), submitted under separate cover. Colorado strongly believes that the Basin States' 2
Alternative, as described in the DEIS and clarified and implemented by the Basin States'
Comments, sets forth the appropriate mechanism for interim management of the Colorado River
System through 2025. As is more fully explained in the Basin States' Comments, the Basin
States' Alternative best addresses the issues raised by the proposed federal action (the "Action"), 3
as described in the DEIS and the Bureau's March 2006 Scoping Summary Report. Accordingly,
Colorado joins the Basin States in requesting that you adopt the Basin States' Alternative, as
implemented through the Basin States' Proposed Guidelines, as the preferred alternative in the 4
Final Environmental Impact Statement and Record of Decision.

Second, the State of Colorado submits the following general Comments to the DEIS to address concerns specific to Colorado. These individual State Comments are not intended to suggest any disagreement with the Basin States' Comments, or to call into question Colorado's support for the Basin States' Alternative. Rather, they are intended to identify and suggest means of addressing issues of unique interest to Colorado.

These Comments are as follows:

- **Affected Geographic Region.** The DEIS defines the geographic region affected by the
Action as Lake Powell and the River below Lake Powell. The DEIS analyzes the effects of
the Action only within this geographic region.[2] However, decisions made regarding
management of Lakes Mead and Powell also could potentially affect the geographic region
upstream of Lake Powell after 2025. Decreased or increased storage in Lake Powell could
affect storage levels in other Upper Basin reservoirs, and thus increase or decrease the risk 5
that Upper Division States would have to curtail their uses of Colorado River water in order
to satisfy the Upper Basin's obligations under Article III(d) of the Colorado River Compact.
In addition, curtailment in the Upper Division or shortages in the Lower Division could 6
potentially impose cumulative impacts on other geographic regions.

  Notwithstanding these facts, because Colorado believes it unlikely that Upper Division curtailment will be necessary during the interim period of 2008 through 2025, Colorado does not, at this time, object to the limited description of the affected geographic region set forth in the DEIS; provided, however, that said description is understood to be applicable only to

---

[2] For example, the DEIS describes the affected geographic region as Lake Powell and the Lower Basin at pages including, but not necessarily limited to: p. 1-7, lines 5-7; p. 3-3, lines 1-24; p. 4-81, lines 37-39.

Flood Protection • Water Project Planning and Finance • Stream and Lake Protection
Water Supply Protection • Conservation Planning

S-2

the interim period. Beginning in 2026, the potential risk of Upper Division curtailment will 7
increase substantially due to increased development in the Upper Basin. Accordingly,
Colorado believes the description in the DEIS of the geographic region affected by the
Action will be invalid by the expiration of the interim period, and that it will be necessary at 8
that time to reexamine management of Lakes Powell and Lakes Mead.

- **Expiration of Guidelines.** Expiration of the Guidelines in 2025 is critical toward 9
Colorado's support of any preferred alternative. Continued operation of Lake Powell in a
manner consistent with the proposed Action after 2025 may prove highly disadvantageous to
Colorado. Moreover, as noted above, the assumptions upon which any proposed Action is 10
chosen will no longer be valid after 2025.

The DEIS correctly recognizes that the Guidelines implementing the Action will be interim
in nature, and will remain in effect for determinations to be made through 2025 regarding
water supply and reservoir operating decisions through 2026. However, the DEIS does not
clearly state what default operating criteria will be relied upon after that date.[3] As stated in 11
the Basin States' Comments, the DEIS should explain that at the conclusion of the effective
period of the Guidelines, the modeled operating criteria are assumed to revert to the
operating criteria used to model baseline conditions in the final EIS for the Interim Surplus
Guidelines dated December 15, 2000 (i.e., modeling assumptions are based upon a 70R
strategy for the period commencing January 1, 2026 (for preparation of the 2027 AOP)).
These operating criteria would utilize the present 602(a) algorithm for calculating 602(a)
storage requirements for releases from Lake Powell. As is more fully explained below, it is
extremely important to Colorado that the Bureau continue to operate Lake Powell in a
manner that serves the interests of the Upper Division States, and that sufficient storage be 12
maintained in Lake Powell to protect Colorado's and the other Upper Division States' current
and projected future uses. Accordingly, Colorado would object to any operating criteria that
would alter any of the assumptions in the present 602(a) algorithm, and specifically objects 13
to the proposed review of the 602(a) algorithm proposed in Arizona's DEIS comments and
scoping comments.

- **Consultation with Basin States in 2020**. As mentioned above, Colorado believes it
important that the DEIS identify default criteria for operating Lakes Mead and Powell after
2025. However, because of the importance of the management of Lakes Mead and Powell to
the overall operation of the Colorado River System, Colorado believes it preferable for the
Bureau to identify and develop new Guidelines for the management of Lakes Mead and
Powell and the administration of the Colorado River System before the interim Guidelines
developed through this process have expired. To ensure such action is taken, Colorado
recommends that the Final Environmental Impact Statement and Record of Decision require
the Bureau to initiate future consultation with the Basin States and other interested parties no
later than 2020 to identify and implement appropriate management mechanisms for the 14
Colorado River System following expiration of the proposed Action and implementing
Guidelines. The Basin States Proposed Guidelines includes language that would require the
Bureau to initiate such consultation.

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[3] For example, the DEIS omits identification of what will happen after expiration of the proposed interim action in 2025 at pages, including but necessarily not limited to pp. ES-2, lines 6-13 and 1-1, lines 21-26.

S-2

- **Coordinated Operations of Lakes Powell and Mead.** Several of the proposed alternatives in the DEIS, including the Basin States Alternative, call for a more coordinated operation of Lakes Powell and Mead in hopes of more efficiently managing the Colorado River System during the interim period. Under this coordinated operation, releases from Lake Powell may vary based upon levels in both Lake Powell and Lake Mead, in the interest of limiting shortages in the Lower Division, as well as reducing the risks of Upper Division curtailment. Colorado has agreed to this approach toward reservoir management during the interim period as described in the Basin States' Alternative and implemented through the Basin States' Proposed Guidelines.

  However, in adopting a preferred alternative for managing Lower Basin shortages as a result
  of this or any future process, the Department of Interior and Bureau of Reclamation must not
  lose sight of the primary purpose for which Lake Powell was originally constructed: "to 15
  initiate the comprehensive development of the water resources of the Upper Colorado River
  Basin . . . making it possible for the States of the Upper Basin to utilize, consistently with
  provisions of the Colorado River Compact, the apportionment made to and among them in
  the Colorado River Compact and the Upper Colorado River Compact, respectively. . . ."
  Colorado River Storage Project Act of 1956 (43 U.S.C. § 620). Accordingly, pursuant to the
  Colorado River Storage Project Act, any system for coordinated operations of Lakes Mead
  and Powell must not subordinate the need for Upper Basin storage to the interest of limiting 16
  Lower Division shortages.

  The Basin States Alternative maintains consistency with the Colorado River Storage Project
  Act by imposing a minimum 602(a) storage level in Lake Powell of 14.85 million acre-feet, 17
  which amount is then adjusted upwards annually. Colorado would strongly object to any
  proposed alternative that does not similarly protect Upper Basin storage. Specifically,
  Colorado would strongly object to any action, such as the proposed "Water Supply
  Alternative," which violates the statutorily mandated requirement that sufficient storage be 18
  maintained in Lake Powell to protect future Upper Division development, or that otherwise
  ignores, alters or amends the current mechanisms used to determine sufficient storage in
  Lake Powell.

- **Mexican Treaty Shortage Issues.** Colorado agrees with the other Basin States that the issue
  of how and under what circumstances the United States will reduce the water allotted to
  Mexico under Article 10(a) of the Mexican Water Treaty of 1944 must be addressed in order 19
  for the Bureau to develop a comprehensive program for administering the Colorado River
  System and managing the Colorado River System reservoirs. Colorado believes that the
  United States should reduce the quantity of water allotted to Mexico in any year the
  Secretary reduces the water available for consumptive use pursuant to Art. II(B)(3) of the 20
  Consolidated Decree.

  However, Article III(B)(3) reductions are not the exclusive circumstances determining
  whether the United States should reduce the amount of water allotted to Mexico under the 21
  1944 Treaty. Other conditions may also arise that are reflective of extraordinary drought in 22
  the Colorado River System under Article 10 of the Treaty. Resolution of the timing and
  extent of reductions in the water allotted to Mexico has the potential to affect interests in both 23
  the Upper and Lower Colorado River Basin.

S-2

Flood Protection • Water Project Planning and Finance • Stream and Lake Protection
Water Supply Protection • Conservation Planning

The DEIS states that this issue will be resolved through discussions with Mexico by the
International Boundary Waters Commission in consultation with the Department of State.[4]
Because of the importance of this issue to both the Upper and Lower Division States,
Colorado believes that all the Basin States must be consulted on and included in these 24
discussions.

- **Definition of Colorado River System.** The Colorado River Compact provides a very
specific definition of the Colorado River System. The DEIS appears to be somewhat
inconsistent in its use and definition of this term. Specifically, the DEIS sometimes confuses
the concepts of the Colorado River System, Colorado River System water, and the Colorado 25
River Mainstem.[5] Colorado requests that the Bureau attempt to avoid such inconsistencies in
its Final Environmental Impact Statement and Record of Decision.

- **Definition of Consumptive Use.** In summarizing the apportionments of the use of
Colorado River water to the Basin States, the DEIS states that "[t]he apportionments of the
Basin States are generally presented in terms of consumptive use, which consists of
diversions minus return flows."[6] The DEIS thus appears to make the legal assertion that the 26
"diversions minus returns flows" definition of consumptive use is applicable to the
allocations of all of the Basin States under the Law of the River.

  Such a legal assertion would be incorrect. Although the Supreme Court relied upon this
"diversions minus return flows" definition in portions of *Arizona v. California*, the Supreme
Court stressed that in so doing it was not interpreting the Colorado River Compact.
Moreover, the "diversions minus return flows" definition of consumptive use is not present in
the Colorado River Compact. Pursuant to Article VI of the Upper Colorado River Basin 27
Compact, "consumptive use" in the Upper Basin is defined as "man-made depletions of
virgin flow at Lee Ferry."

  The State of Colorado would accept the DEIS' general definition of "consumptive use" for
the limited purpose of analyzing impacts of the proposed federal action within the identified
geographic scope. However, the limited purpose of this definition should be made clear. 28
The DEIS should not include statements that could be misinterpreted as interpretations of the
Law of the River.

- **Off-stream Storage as Beneficial Use.** The DEIS affirmatively states that "consumptive use
by a Lower Division state includes delivered water that is stored off-stream for future use by
that state or another state."[7] The accuracy of this sentence has not been established as a 29
matter of law, and is potentially contrary to or inconsistent with the Colorado River Compact
and other elements of the Law of the River. The support for this statement is likely derived
from the 1999 Offstream Storage Rules, which states that "[t]he Secretary will account for
the water that is diverted and stored by a storing entity as consumptive use in the Storing
State for the year in which it is stored." (A "Storing State" is defined as a Lower Division

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[4] For example, the DEIS explains that all necessary action will be conducted through the IBWC and the Department of State at pages including, but not necessarily limited to, p. 1-18, lines 9-11.

[5] For example, the DEIS confusingly interchanges the identification and description of mainstem activities and facilities with the phrase "Colorado River System" at pages including, but not necessarily limited to, pp. 1-9, lines 33-35; 1-18, lines 12, 29-38; and title of Appendix B.

[6] *See e.g.,* DEIS at p. 1-11, lines 5-7.

[7] *See e.g.,* DESI at p. 1-15, lines 29-31.

S-2

State in which water is stored off the mainstream.") However, a decision by the Secretary to account for water in some fashion is not a judicial determination that offstream storage is a consumptive use. Because this sentence raises questions of Compact interpretation among 30
the Basin States, and is unnecessary to the DEIS analysis, Colorado recommends that it be deleted.

- **Intentionally Created Surplus.** Colorado fully supports the Intentionally Created Surplus and Developed Shortage Supply programs outlined in the DEIS and more fully described in 31
the Basin States' Comments. Intentionally Created Surplus and Developed Shortage Supply water stored in Lake Mead benefits the Lower Division by providing a storage vessel and mechanism for delivering additional water to the Lower Division States, and benefits the Upper Division by increasing levels in Lake Mead. These increased Lake Mead storage levels reduce the amount of water that must be released from Lake Powell for equalization and balancing purposes. Accordingly, instead of mentioning that ICS will be created "during this NEPA process,"[8] Colorado recommends, consistent with the Basin States Comments, that the Final Environmental Impact Statement and Record of Decision expressly adopt 32
Guidelines that permit the creation of Intentionally Created Surplus and Developed Shortage Supply, and provide that this water be accounted in Lake Mead for purposes of equalization and balancing from Lake Powell.

- **Status of Existing Interim Surplus Guidelines.** The DEIS states that "[t]he proposed federal action would modify the substance of the existing Interim Surplus Guidelines (ISG), published in the Federal Register on January 25, 2001 (66 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026."[9] As explained in the Basin States' Comments, the Basin States recommend that the Final Environmental Impact Statement and Record of Decision adopt the 33
Basin States' combined Proposed Guidelines and that the Basin States Proposed Guidelines replace, rather than merely modify and extend, the existing Interim Surplus Guidelines.

- **Disclaimer**. The DEIS identifies and describes numerous elements of the Law of the River. Because the individual Basin States may disagree as to the definitive interpretation of specific aspects of the Law of the River, and the NEPA process is not intended to provide a definitive interpretation of the law, the State of Colorado recommends, consistent with the Basin States' Comments, that the Final Environmental Impact Statement and Record of Decision include appropriate disclaimer language to allow the various interested stakeholders 34
to refrain from disputing or contesting the general characterizations of the Law of the River in the DEIS. Precedent for such disclaimer language can be found in past Annual Operating Plans promulgated by the Bureau of Reclamation and authorized by the Secretary of the Interior. Similar to that language, the disclaimer in the FEIS and ROD should provide:

  > Nothing in this (insert "FEIS" or "ROD" as appropriate) is intended to interpret specific provisions of the Law of the River, including, but not limited to: the provisions of the Colorado River Compact (45 Stat. 1057), The Upper Colorado River Basin Compact (63 Stat. 31), The Utilization of Water of the Colorado and Tijuana Rivers and of the Rio Grande, Treaty Between the United States of America and Mexico (Treaty Series 994, 59 Stat. 1219), the United States/Mexico agreement in Minute 242 of August 30, 1973,

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[8] *See e.g.* DEIS at p. 2-2, lines 20-24.

[9] *See e.g.*, DEIS at p. ES-2, lines 27-31. *See also,* DEIS at pages including, but not necessarily limited to: ES-6, line 28; 2-2, lines 27-28; 2-11, line 3; 3-31, line 10; 4-94, line 12; Glo.6 (ISG).

(Treaty Series 7708; 24 UST 1968), the Decree entered by the Supreme Court of the United States *Arizona v. California, et. al*. (376 U.S. 340), as amended and supplemented, The Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Adjustment Act (54 Stat. 774; 43 U.S.C. 618a), The Colorado River Storage Project Act (70 Stat. 105; 43 U.S.C. 620), The Colorado River Basin Project Act (82 Stat. 885; 43 U.S.C. 1501), The Colorado River Basin Salinity Control Act (88 Stat. 266; 43 U.S.C. 1951), The Hoover Power Plant Act of 1984 (98 Stat. 1333), The Colorado River Floodway Protection Act (100 Stat. 1129; 43 U.S.C. 1600), or The Grand Canyon Protection Act of 1992 (Title XVIII of Public Law 102-575, 106 Stat. 4669).

- **Reservation of Rights.** The Basin States' Comments include as attachments several agreements to which Colorado is not a party. Colorado supports the submission of these attachments as necessary and important to the implementation of the Basin States' Alternative. However, Colorado was not a party to many of these agreements, and does not necessarily agree with all legal and factual recitations made therein. By supporting the Basin States' Comments and attachments, and by agreeing to the submission of these documents as necessary to the implementation of the Basin States' Alternative, Colorado does not intend to waive any disagreements it may have with legal and factual recitations made without its participation or approval. 35

Finally, Colorado may have other concerns with specific factual and/or legal assertions in the DEIS. However, these assertions do not appear to materially alter the analysis in the DEIS. In addition, in the course of reviewing the voluminous amount of material included within the DEIS, Colorado may have overlooked other inaccurate factual and/or legal assertions. Colorado's failure to raise such concerns in these Comments, or to correct what it believes to be inaccurate assertions, shall not be construed as an admission with respect to any factual or legal issue, or a waiver of any of rights for the purposes of any future legal, administrative, or other proceeding.

Rod Kuharich
Director
Colorado Water Conservation Board

cc: Robert W. Johnson, Commissioner, U.S. Bureau of Reclamation
Rick Gold, Regional Director, U.S. Bureau of Reclamation, Upper Colorado Regional Office
Jayne Harkins, Acting Regional Director, U.S. Bureau of Reclamation, Lower Colorado Regional Office
Larry Walkoviak, Deputy Regional Director, U.S. Bureau of Reclamation, Lower Colorado Regional Office
Regional Director, Lower Colorado Region, Bureau of Reclamation, c/o BCOO-1000
Scott Balcomb, Esq.
Jim Lochhead, Esq.

S-2

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Reponses to Comment Letter S-2

S-2-1

Your comment is noted. No change to the Final EIS was necessary.

S-2-2

Your comment is noted. No change to the Final EIS was necessary.

S-2-3

Your comment is noted. No change to the Final EIS was necessary.

S-2-4

Your comment is noted. No change to the Final EIS was necessary.

S-2-5

Your comment is noted. No change to the Final EIS was necessary. The proposed federal action would be in effect for an interim period (2008 through 2026). To disclose any potential impacts after the interim period, the resource analyses have been conducted from 2008 through 2060.

S-2-6

Your comment is noted. No change to the Final EIS was necessary.

S-2-7

Your comment is noted. No change to the Final EIS was necessary.

S-2-8

Your comment is noted. No change to the Final EIS was necessary.

S-2-9

See response to Comment No. S-2-5.

S-2-10

Your comment is noted. No change to the Final EIS was necessary.

S-2-11

Your comment is noted. No change to the Final EIS was necessary. The proposed federal action would be in effect for an interim period (2008 through 2026). To disclose any potential impacts after the interim period, the resource analyses have been conducted from 2008 through 2060.

For modeling purposes, it was assumed that the operation under all action alternatives would revert to the modeling assumptions used for the No Action Alternative (Section 4.2.7 of the Draft EIS and the Final EIS). The modeling assumptions used for the No Action Alternative are detailed in Section 2.2.2 and Appendix A of the EIS.

S-2-12

Your comment is noted. No change in the Final EIS was necessary.

S-2-13

Your comment is noted. No change in the Final EIS was necessary.

S-2-14

Your comment is noted. The draft guidelines included in the Final EIS (Appendix S) include a provision for a formal review to evaluate the effectiveness of the guidelines prior to December 31, 2020.

S-2-15

Your comment is noted. No change in the Final EIS was necessary.

S-2-16

Your comment is noted. No change in the Final EIS was necessary.

S-2-17

Your comment is noted. No change in the Final EIS was necessary.

S-2-18

Your comment is noted. No change in the Final EIS was necessary.

S-2-19 through S-2-22

See responses to Comment Nos. F-5-2 and F-5-5.

S-2-23

Your comment is noted. No change in the Final EIS was necessary.

S-2-24

Your comment is noted. No change in the Final EIS was necessary.

S-2-25

Reclamation concurs with this comment. The terms “system water” and “non-system water” have been defined in the glossary and modifications have been made to the Final EIS as appropriate.

S-2-26 through S-2-28

Your comment is noted. The Final EIS was modified (Section 1.7.2 and Section 3.4) to clarify the use of the term “consumptive use” in this EIS.

S-2-29 and S-2-30

Your comment is noted. The Final EIS was modified (Section 1.7.2.2) to clarify the accounting of water stored off-stream in the Lower Basin.

S-2-31

Your comment is noted. No change to the Final EIS was necessary.

S-2-32

Your comment is noted. Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that discuss the administration of Intentionally Created Surplus (ICS).

S-2-33

Your comment is noted. No change to the Final EIS was necessary.

S-2-34

Your comment is noted. Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that includes a section titled “Authority and Disclaimer”.

S-2-35

Your comment is noted. No change to the Final EIS was necessary.

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State Engineer's Office

HERSCHLER BUILDING, 4-E CHEYENNE, WYOMING 82002
(307) 777-7354 FAX (307) 777-5451
seoleg@state.wy.us

DAVE FREUDENTHAL
GOVERNOR

PATRICK T. TYRRELL
STATE ENGINEER

April 30, 2007

Honorable Dirk Kempthorne
Secretary of the Interior
Department of the Interior
1849 C. Street, NW
Washington, D.C. 20240

Re: Wyoming's Comments on *Draft Environmental Impact Statement Regarding Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions*

Dear Secretary Kempthorne:

Thank you for the opportunity to comment on the *Draft Environmental Impact Statement for Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions* (72 Fed. Reg. 9026-9028) (February 28, 2007) (hereinafter "DEIS"). The Wyoming State Engineer's Office, on behalf of the State of Wyoming, would like to take this opportunity to offer comments on the DEIS. Importantly, Wyoming supports the comments made jointly by
the Seven Basin States (hereinafter the Basin States' Comments) that were sent to you under 1
separate cover.

We in Wyoming strongly believe the Basin States' Alternative, as described in the February 2007 DEIS (and as further elaborated upon through the recommendations made in the Basin States' Comments) provides the most suitable and acceptable mechanism for interim
Colorado River System management through the end of calendar year 2025. The Basin States' 2
Alternative provides the best solutions to the issues raised by the proposed federal action described in the Bureau's March 2006 Scoping Summary Report and February 2007 DEIS. The Basin States' Alternative best meets critical elements of the purpose and need statement set forth in the DEIS. Accordingly, the State of Wyoming joins the other Basin States in requesting that
you adopt the Basin States' Alternative, as implemented through the Basin States' Proposed 3
Guidelines, as the preferred alternative in the Final Environmental Impact Statement and Record of Decision.

In addition, the State of Wyoming provides within this letter our individual State comments. We wish to make it clear that these additional comments neither contradict nor

S-3

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Secretary of the Interior Dirk Kempthorne
April 30, 2007
Page 2

disagree with the Basin States' Comments or in any manner diminish our support for the Basin States' Alternative. These individual State comments are as follows:

- **Coordinated Operations of Lakes Powell and Mead.** The Basin States' Alternative in the DEIS would modify the operation of both Lake Powell and Lake Mead through instituting a greater level of reservoir coordination during the interim period, effectuating criteria where releases from Lake Powell may vary based upon levels in both Lake Powell and Lake Mead. This would be done to help meet the objective of delaying the onset of water shortages in the Lower Division States and to minimize their extent and duration, while, at the same time, to maximize the Upper Division States' protection provided by having Lake Powell storage available to release so as to meet the Colorado River Compact non-depletion requirement at
Lee Ferry. The "Basin States' Alternative" will provide for more efficient and responsive
operation of the system reservoirs for the benefit of both the Upper and Lower Basins. For 4
this reason, Wyoming is willing to accept the compromise that allows additional Lake Powell releases to Lake Mead at higher reservoir levels – which are offset by reduced Lake Powell releases at lower levels.

  Under the Basin States' Alternative, reservoir storage levels in both Lakes Mead and Powell will serve as trigger points used in calculating annual Lake Powell release amounts. Nonetheless, it is vitally important that the Department of Interior and Bureau of Reclamation not lose sight of the statutory basis for the construction of Glen Canyon Dam and Lake Powell as set forth in the Colorado River Storage Project Act of 1956 (43 U.S.C. § 620) (CRSP Act). This keystone facility was originally constructed: "to initiate the comprehensive development of the water resources of the Upper Colorado River Basin ... making it possible for the States of the Upper Basin to utilize, consistent with provisions of the Colorado River Compact, the apportionment made to and among them in the Colorado
River Compact and the Upper Colorado River Compact, respectively ..." The Basin States'
Alternative maintains consistency with the CRSP Act by imposing a minimum storage level 5
in Lake Powell of 14.85 million acre-feet, which amount is then adjusted yearly. The State
of Wyoming could not accept coordinated Lakes Mead and Powell operations that ignore the 6
CRSP Act's mandates or create undue detriments to or subordination of the need for Upper
Basin storage in the interest of limiting Lower Division shortages.

- **Expiration of Interim Shortage Guidelines in 2025.** Expiration of the Guidelines in 2025 7
is an important aspect of Wyoming's support of any preferred alternative. We believe it will be necessary and desirable to re-examine management of Lakes Powell and Mead. The Basin States' Alternative proposes the initiation of that examination process prior to the end of the Interim Period. The DEIS recognizes that the Guidelines implementing the Action will be interim in nature, and will remain in effect for determinations to be made through 2025 for
water supply and reservoir operating decisions through 2026. However, the DEIS does not 8
clearly state what default operating criteria will be relied upon after that date. We urge the
Department of the Interior to ensure (consistent with the Basin States' Comments), that the
FEIS and particularly the Record of Decision clearly state that at the conclusion of the 9
effective period of the shortage guidelines, the modeled operating criteria are assumed to
revert to the operating criteria used to model baseline conditions in the December 2000 Final

S-3

2

Secretary of the Interior Dirk Kempthorne
April 30, 2007
Page 3

EIS for the Interim Surplus Guidelines (i.e., operations are modeled as if system operations revert to a 70R strategy for the period commencing January 1, 2026 (for preparation of the 2027 AOP)).

- **Consultation with Basin States in 2020**. As stated above, the State of Wyoming strongly advocates that the Record of Decision specify default criteria for operating Lakes Mead and Powell after 2026. This should be done to assure that in the absence of a satisfactory agreement to do otherwise that the Upper Division States' interests are protected. The Basin States' Alternative specifies that the Bureau of Reclamation and the Basin States collectively identify and develop new Guidelines for the management of Lake Powell and Lake Mead prior to the expiration of the interim shortage guidelines. Accordingly, we request that the Final EIS and Record of Decision specify that the Bureau will initiate future consultation with the Basin States and other interested parties no later than December 31, 2020 to identify
and implement appropriate management mechanisms for the Colorado River System 10
following the Interim Period. The Basin States' Comments include language that would require the Bureau to initiate such consultation – and we urge the adoption of the Basin States' Proposed Guidelines.

- **Mexican Treaty Shortage Issues.** Colorado River shortages will be shared with Mexico, but how, when and to what extent are critically important and sensitive issues that must be
addressed for the Bureau of Reclamation to develop a comprehensive program for 11
administering the shortage guidelines during the Interim Period. There is unanimous consensus among the Basin States that the United States should reduce the quantity of water
allotted to Mexico under Article 10(a) of the 1944 Treaty in any year the Secretary reduces 12
the water available for consumptive use pursuant to Art. II (B)(3) of the Consolidated Decree in *Arizona v. California*. It is also the case that Article II (B)(3) reductions are not the only
or sole mechanism to ascertain whether the United States should reduce the amount of water 13
allotted to Mexico under the 1944 Treaty. The matter of equitably computing how much Mexico's water deliveries would be curtailed has been modeled in the DEIS, however, the DEIS states that this issue will be resolved through discussions with Mexico by the International Boundary Waters Commission in consultation with the Department of State.

We wish to offer two important comments in regards to these important issues. It
must be recognized that other conditions (beyond Article II(B)(3) reductions) may arise that 14
are reflective of "extraordinary drought in the Colorado River System" under Article 10(a) of the Treaty. Secondly, for the reason that resolution of the issues associated with imposition
of water delivery shortages upon the Republic of Mexico has the potential to affect interests 15
in both the Upper and Lower Colorado River Basins, it is critically important that all the
Basin States be consulted in these discussions. 16

- **Definition of "Colorado River System" and "consumptive use."** The Colorado River Compact provides a very specific definition of the "Colorado River System." The DEIS
appears to be somewhat inconsistent in its use and definition of this term. Specifically, the 17
DEIS sometimes confuses the concepts of the "Colorado River System," "Colorado River System water," and the "Colorado River Mainstem." We urge you to direct the Bureau of

S-3

Reclamation to make every attempt to avoid such inconsistencies in the Final EIS and in preparing the Record of Decision for your execution.

Similarly, the DEIS contains language summarizing the apportionments of the use of Colorado River water to the Basin States which states that "[t]he apportionments of the Basin States are generally presented in terms of consumptive use, which consists of diversions minus return flows." This is an oversimplification and generalization that is inapplicable to apportionments made to the Upper Basin States. 18 Article VI of the Upper Colorado River Basin Compact defines "consumptive use" in the Upper Basin as "man-made depletions of virgin flow at Lee Ferry." The "diversions minus return flows" definition of consumptive use is not present in the Colorado River Compact. 19 In *Arizona v. California*, the Supreme Court of the United States explicitly noted the definition used therein was not intended to interpret the Colorado River Compact. The Final EIS should be clear in stating it is providing and using a limited purpose definition.

- **Intentionally Created Surplus.** The Intentionally Created Surplus and Developed Shortage Supply programs outlined in the DEIS and more fully described in the Basin States' Comments are supported by the State of Wyoming. 20 We recognize that Intentionally Created Surplus and Developed Shortage Supply water stored in Lake Mead benefits the Lower Division. The direct benefit to the Upper Division is through increasing the Lake Mead water storage level – which reduces the amount of water that must be released from Lake Powell for equalization and balancing purposes. Wyoming again urges that the Final EIS and Record of Decision expressly adopt shortage guidelines consistent with the Basin States' Alternative that permit the creation of Intentionally Created Surplus and Developed Shortage Supply.

- **Status of Existing Interim Surplus Guidelines.** As explained in the Basin States' Comments, the Basin States recommend that the Final Environmental Impact Statement and Record of Decision adopt the Basin States' combined Proposed Guidelines and that the Basin States Proposed Guidelines replace, rather than merely modify and extend, the existing Interim Surplus Guidelines. 21

- **Submission of Parties' Documents.** The Basin States' Comments have several attachments including side agreements in which the State of Wyoming has had no involvement. We again reiterate our strong support for implementation of the Basin States' Alternative in the Department of Interior's forthcoming Record of Decision, but wish to point out that since we are not a party to those side agreements that we are not necessarily in agreement with all of the statements or interpretations of the Law of the River that are found in them. 22 We do agree the side agreements are appropriately part of the Basin States' Comments and are necessary to the implementation of the Basin States' Alternative; but we reserve the right to disagree with certain legal and factual recitations made in those side agreements in the future should it be determined to be in our State's best interest to do so.

- **Disclaimer**. Since the NEPA process is not intended to provide a definitive interpretation of the Law of the River, we suggest it would be entirely appropriate and would serve a useful 23

S-3

Secretary of the Interior Dirk Kempthorne
April 30, 2007
Page 5

purpose for the Final EIS and Record of Decision to include an appropriate disclaimer akin to the language included in the Annual Operating Plans for the Colorado River System that 23 are promulgated by the Bureau of Reclamation and authorized by the Secretary of the Interior.

Attached to this letter are a few additional specific comments concerning the DEIS document. Thank you for the opportunity to submit, and for your consideration of, these comments. Should I be able to answer any questions, please don't hesitate to contact me.

With best regards,

Patrick T. Tyrrell
Wyoming State Engineer
Wyoming Commissioner,
Upper Colorado River Commission

PTT:js

cc: Seven Colorado River Basin States' Representatives
Upper Colorado River Commission Executive Director Don Ostler
USBR Upper Colorado Regional Director Rick Gold

S-3

State of Wyoming's Specific Comments on the U.S. Bureau of Reclamation's Draft Environmental Impact Statement: *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

Page 1-13, lines 8-9: "Documents which are generally considered as part of the Law of the River include, but are not limited to …" It may be useful for the DEIS to state the basis for making this statement, e.g., in whose judgment is the list of documents included in Table 1.7-1 considered to be inclusive of the elements of the Law of the River? 24

Page 1-15, lines 29-31: "Consumptive use by a Lower Division state includes delivered water that is stored off-stream for future use by that state or another state." The DEIS needs to be more careful in distinguishing between Secretarial decisions (or proposals for how water would be accounted for once interim shortage guidelines have been proposed and promulgated) to account for water as opposed to making statements that are based on judicial determinations in *Arizona v. California* or make Compact interpretations on matters where there are differences of opinion among the Basin States. This sentence is one example of a number of instances where imprecise wording has been used, as pointed out in our comment letter. 25

Page 3-31, lines 28-31: The depletion projects for the Upper Basin States were actually developed by each of the Upper Basin States and were considered and approved for transmittal to other entities by the Upper Colorado River Commission. Updating or modification of those depletion projections was made in consultation with the Upper Basin States by Reclamation and the States. 26

Page 3-35, line 8: There is a word missing before the parenthetical phrase "(consumptive use)" in this line. 27

Page 3-43, line 26: It is not clear why the DEIS is relying upon a 2002 report by the Colorado River Basin Salinity Control Forum when the 2005 edition of the subject report is available and could have been used for this purpose and referenced. The references section (see page Ref-4) lists only the 2005 report though the text on this page reflects the 2002 publication date. 28

Page 3-44, lines 11-13: The distinction is not altogether clearly made that the salinity criteria are average annual flow-weighted values, whereas the comparison being made in this sentence is to a daily value that is not reflective of either the annual-averaging or flow-weighting procedures that would be needed for a valid comparison. Daily observed salinity concentration values are being compared in Figure 3.5-1 to a flow-weighted average annual salinity criteria figure of 723 mg/l. 29

Page 3-98, lines 3-4: The correct name of the program being referenced at this place in the text is the "Upper Colorado River Endangered Fish Recovery Program." 30

Page 3-100, line 32: There is a typo in this line where the sentence begins: "Changes in drops in the elevation …" 31

S-3

Page 3-101, lines 26-27: The cost of power would be for the water pumps that are components within the intakes operated by the SNWA. 32

Page 4-3, lines 31-32: The DEIS could be made clearer here noting that the period 2008 to 2026 includes the year 2026. 33

Page 4-6, line 23: The words “possible sequences” should be changed to read “observed sequences” to more accurately communicate the statement that is being made. The historic record is indicative of what has been observed as opposed to what has been possible during the period during which records have been collected. 34

Pages 4-8 and 4-9, lines 31 through 37 and lines 1-2 on the next page: These statements with regard to replacement of the bypassed water should be clarified to more explicitly state what is being done and the timeline for accomplishing definite action. As written, the statements are vague and do not help to educate the reader. 35

Page 4-9, lines 30-33: The sentence found here concerning consultation with Mexico is completely lacking in stating when the subject consultation will or would occur. 36

Page 4-17, line 9: A typo is found in this line where the intent is to state “90th” rather than “90^{t}h.” 37

Page 4-231, line 18: Lake “Powell” is misspelled in this line. 38

Page 5-7, line 34: The agreement referenced in this sentence was struck early in 2006 as opposed to “early in 2007.” 39

S-3

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Reponses to Comment Letter S-3

S-3-1

Your comment is noted. No change to the Final EIS was necessary.

S-3-2

Your comment is noted. No change to the Final EIS was necessary.

S-3-3

Your comment is noted. No change to the Final EIS was necessary.

S-3-4

Your comment is noted. No change to the Final EIS was necessary.

S-3-5

Your comment is noted. No change to the Final EIS was necessary.

S-3-6

Your comment is noted. No change to the Final EIS was necessary.

S-3-7

See response to Comment No. S-2-11.

S-3-8 and S-3-9

See response to Comment No. S-2-11.

S-3-10

See response to Comment No. S-2-14.

S-3-11 through S-3-15

See responses to Comment Nos. F-5-2 and F-5-5.

S-3-16

Your comment is noted. No change to the Final EIS was necessary.

S-3-17

See response to Comment No. S-2-25.

S-3-18 and S-3-19

See responses to Comment Nos. S-2-26 through S-2-28.

S-3-20

Your comment is noted. No change to the Final EIS was necessary.

S-3-21

Your comment is noted. No change to the Final EIS was necessary.

S-3-22

Your comment is noted. No change to the Final EIS necessary.

S-3-23

See response to Comment No. S-2-34.

S-3-24

See response to Comment No. S-1-4.

S-3-25

See response to Comment No. S-2-29.

S-3-26

Reclamation concurs with this comment. The text in Section 3.4.1 has been revised accordingly.

S-3-27

Reclamation concurs with this comment. The text in Section 3.4.4 has been revised accordingly.

S-3-28

Reclamation concurs with this comment. The text in Section 3.5.1 has been revised accordingly.

S-3-29

Reclamation concurs with this comment. The text in Section 3.5.1 has been revised accordingly.

S-3-30

Reclamation concurs with this comment. The text in Section 3.11.6.1 has been revised accordingly.

S-3-31

Reclamation concurs with this comment. The text in Section 3.11.7.1 has been revised accordingly.

S-3-32

Reclamation concurs with this comment. The text in Section 3.11.7.3 has been revised accordingly.

S-3-33

Reclamation concurs with this comment. The text in Section 4.2.2 has been revised accordingly.

S-3-34

Your comment is noted. Section 4.2 was modified to include additional information and provide additional clarity. The referenced sentence does not exist in the Final EIS.

S-3-35

See response to Comment No. F-4-9.

S-3-36

Your comment is noted. No change to the Final EIS was necessary.

S-3-37

Reclamation concurs with this comment. The text in Section 4.3.2 has been revised accordingly.

S-3-38

Reclamation concurs with this comment. The text in Section 4.11.2.5 has been revised accordingly.

S-3-39

Your comment is noted. Section 5.1 was modified and the referenced sentence does not exist in the Final EIS.

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ARIZONA DEPARTMENT OF WATER RESOURCES
3550 North Central Avenue, Phoenix, Arizona 85012
Telephone 602 771-8426
Fax 602 771-8681

April 30, 2007

Janet Napolitano
Governor

Herbert R. Guenther
Director

Honorable Dirk Kempthorne
Secretary of the United States Department of the Interior
1849 C. Street, NW
Washington, D.C. 20240

Re: Arizona Department of Water Resources Comments Regarding the *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

Dear Mr. Secretary:

The Arizona Department of Water Resources (ADWR) submits the following comments to the *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement* (February 2007). By Arizona statute, ADWR is the state agency within Arizona that is authorized and assigned the responsibility to consult, advise and confer with the Secretary of Interior regarding matters dealing with the operation of the mainstem of the Colorado River.

Arizona relies on Colorado River water for municipal and industrial use along the River and in Central Arizona; as well as for agricultural use in both areas. As you are aware, Arizona will be impacted by shortage water supply reductions more than any other Lower Basin State. There have historically been significant differences among the seven Colorado River Basin states concerning important elements of the Law of the River. Hydrological conditions on the River require that the Secretary, in consultation with the Basin states, adopt shortage guidelines. The process for adoption of such guidelines could have been the occasion for each of the Basin states to assert its legal positions—resulting in extended litigation and years of uncertainty for Colorado River water users. The seven states chose, instead, to seek agreement on shortage guidelines and guidelines for the management of Lakes Mead and Powell for an interim period of nineteen years, and to reserve their legal positions for later resolution if necessary. 1

Arizona worked diligently with the other Basin states to achieve agreement on the Basin States' Preliminary Proposal recommended to you on February 3, 2006. Since that time, and following the publication of the Draft EIS, Arizona has continued to work closely with the other states to refine and improve the Basin States' Preliminary Proposal and to develop one set of comments to the Draft EIS on behalf of all of the states ("Basin States' Comments"). The Basin states are submitting the Basin States' Comments, together with the Basin States' Proposal, which includes the Basin States' Agreement, Proposed Interim Guidelines for Colorado River Operations, Draft Forbearance Agreement and Arizona-Nevada Shortage Sharing Agreement ("Basin States' Proposal") under separate cover. Arizona has joined in and strongly supports the Basin States' Comments and Proposal. 2

Arizona submits the following additional comments to supplement and buttress the Basin States Comments and to address concerns specific to Arizona.

647306.06

S-4

Honorable Dirk Kempthorne
April 30, 2007
Page 2 of 7

<u>Supplemental Comments in Support of the Basin States' Proposal:</u>

<u>Reclamation Should Adopt the Basin States Alternative as the Preferred Alternative</u>

Reclamation should adopt the Basin States Alternative because it is the compromise alternative developed by
the Governor's Representatives of the seven Colorado River Basin States, and, for the reasons stated in the 3
Basin States' Comments, it is the best of the five alternatives analyzed in the Draft EIS. The Basin States
Alternative would provide more benefits to Arizona than the No Action Alternative, and is acceptable to all 4
of the states that will be directly affected by its implementation. The Basin States Alternative addresses the
issues identified during the Environmental Impact Statement (EIS) scoping process, and it can be 5
implemented immediately upon issuance of the Record of Decision.

Each of the other four alternatives analyzed in the Draft EIS fails to adequately address the issues identified 6
during scoping. The No Action Alternative is unacceptable for several reasons. First, it fails to address the
Secretary's objectives because it does not include shortage guidelines for the Lower Basin. In addition, the 7
No Action Alternative does not comply with existing law, as explained in Arizona's November 28, 2005 8
scoping letter.[1]

The Water Supply Alternative reflects the traditional strategy for managing reservoir systems in the West—
i.e., shortages are declared only when water is physically unavailable for delivery. The DEIS indicates that
there would likely be no shortages to Arizona during the interim period under this alternative. However,
there would also be less water retained in storage in Lake Powell under the Water Supply Alternative, and it 9
lacks consensus Basin States' support.

While the analysis of the No Action and Water Supply alternatives is important because they expand the
range of analyzed impacts, neither includes negotiated criteria for the coordinated operation of Lake Powell 10
and Lake Mead, or specific guidelines for the implementation of future water supply reductions in the Lower 11
Colorado River Basin under defined shortage conditions. Nor do these two alternatives allow for the
intentional creation of surplus in Lake Mead by a Lower Colorado River Mainstream contractor and release
of the surplus for use within the state that intentionally created the surplus, with the forbearance of the other 12
Lower Division States.

With regard to the other two alternatives, substantive changes to the Law of the River would be required in
order to implement either the Conservation Before Shortage (CBS) or the Reservoir Storage Alternative. 13

The CBS Alternative includes the intentional creation of surplus and release of the surplus from Lake Mead
contained in the Basin States Alternative, but it depends upon a funding mechanism that does not currently 14
exist. According to Reclamation, "The viability of the Conservation Before Shortage program funding
proposal is not known at this time. Reclamation currently does not have the authority to implement all facets
of this proposal and additional legislation would be necessary to gain such authority."[2] The CBS Alternative 15
also proposes to allow Mexico to participate in an ICS program. Together with the other Basin States,

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[1] See note 4, *infra*, and accompanying text.
[2] Draft EIS, Section 2.4.5, page 2-13.

647306.06

S-4

Honorable Dirk Kempthorne
April 30, 2007
Page 3 of 7

Arizona supports the concept of Mexican participation in an ICS mechanism at some time in the future. An 16
international framework and agreement would be a necessary prerequisite to the adoption of an ICS-type 17
water management program for Mexico. Arizona stands ready to participate in discussions with Mexico, the
U.S. federal government, and the other Basin States with regard to the development of such a framework. 18

Finally, the only remaining alternative, the Reservoir Storage Alternative serves a valuable purpose by
allowing analysis of a broad range of impacts in the EIS, but it contains provisions that impound water for 19
power generation and recreation to the detriment of downstream agricultural and domestic uses. This is
prohibited by Article IV (b) of the Colorado River Compact (Compact) which clearly states that "Subject to
the provisions of this compact, water of the Colorado River System may be impounded and used for the 20
generation of electrical power, but such impounding and use shall be subservient to the use and consumption
of such water for agricultural and domestic purposes and shall not interfere with or prevent use for such
dominant purposes."

Also, the shortage criteria proposed in the Reservoir Storage Alternative doubles the maximum shortage 21
reduction proposed in the Basin States Alternative. This is unacceptable to Arizona. The shortage criteria in
the Basin States Alternative were adapted from criteria developed by the Director's Shortage Sharing 22
Workgroup in Arizona. The Workgroup met for almost two years to develop a recommendation regarding
the appropriate implementation strategy and volume of shortage reductions. This recommendation was later
refined by the subsequent Arizona-Nevada Shortage-Sharing Agreement, executed on February 9, 2007 23
(Shortage-Sharing Agreement) between Nevada and Arizona apportioning lower basin shortages between the
two states.

<u>Mischaracterization of Intentionally Created Surplus</u>

The Draft EIS characterizes Intentionally Created Surplus ("ICS") as a water management mechanism for 24
storage and delivery of conserved and/or non-system water. This is not a correct description of ICS as it is
used in the Basin States' Proposal. ICS is characterized in the Basin States' Proposal as a category of
Surplus water under the provisions of Article II(B)(2) of the Consolidated Decree in *Arizona v. California*, 25
just as Domestic Surplus under the Interim Surplus Guidelines is a category of Surplus water. The Basin
States, CBS and Reservoir Storage Alternatives each include a provision for the development of ICS. The
Consolidated Decree allocates Surplus water among Arizona (46%), California (50%) and Nevada (4%). A 26
state may forbear its use of Surplus water, which would allow the Secretary to allocate the apportioned but
unused surplus to another state pursuant to Article II(B)(6). The Draft EIS describes the creation of ICS for
each of the above referenced alternatives, but fails to describe the required forbearance that would make that 27
water available for the intended use. Reclamation should, in the Final EIS, accurately describe ICS as a
category of Surplus, include a description of the forbearance necessary for the delivery of ICS to the entity
that created the Surplus, and, in the Record of Decision, adopt guidelines for the creation and delivery of ICS 28
as set forth in the Proposed Interim Guidelines contained in the Basin States' Proposal.[3]

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[3] Attached to this Arizona Comments Letter as Exhibit 1 is "Changes to DEIS Volume I and Appendix M to Conform to Basin States Proposal re Intentionally Created Surplus" to conform the DEIS to the Proposed Interim Guidelines contained in the Basin States' Proposal.

647306.06

S-4

Honorable Dirk Kempthorne
April 30, 2007
Page 4 of 7

Comments Addressing Concerns Specific to Arizona

Default Operating Criteria After Termination of Interim Guidelines

For the most part, the Interim Guidelines that would be adopted upon adoption of a ROD consistent with the
Basin States Alternative will terminate in 2026, and could, under certain circumstances, terminate prior to
2026. The Draft EIS does not clearly set forth the default operating criteria for Lakes Powell and Mead that 29
would apply upon termination of the Interim Guidelines. Before utilizing the present 602(a) storage
algorithm for calculating 602(a) storage requirements for releases from Lake Powell, the Secretary should
conduct a complete review of Section 602(a) of the Colorado River Basin Project Act of 1968 in consultation 30
with the Basin States and consider Arizona's comments concerning the validity of the use of the present
602(a) algorithm, as stated in Arizona's scoping comments submitted November 28, 2005 as a part of this
NEPA process.[4]

Colorado River Compact Deliveries

Article III(d) of the Compact defines the minimum, ten-year release requirement from the Upper Basin to the
Lower Basin, in addition to the releases required by Articles III (c) and (e). The Basin States Alternative
describes reservoir operations to balance the contents of Lake Powell and Lake Mead, with varied Powell
releases based on water surface trigger elevations for the reservoirs. Nevertheless, Arizona will continue to 31
monitor the ten-year releases in order to evaluate compliance with Article III (d) of the Compact. Even
during the proposed interim period, gauging whether the experimental interim release schedule actually
causes less than 75 MAF of flow at Lee Ferry in a ten-year period will help to determine the effectiveness of 32
the proposed guidelines. The information also might be a factor in adjusting Powell releases within the
agreed range during the proposed interim period, and may demonstrate the need for adjustment of the
proposed release schedule after consultation with the Basin States and the Secretary.

Shortage Criteria

The *Director's Shortage Sharing Workgroup Recommendation, October 24, 2006 (Revised) Final*,[5] describes
a method to distribute Arizona shortage reductions between the CAP and equivalent priority mainstream 33
Colorado River water users. The assumptions regarding the distribution of shortage reductions between 34
Arizona and Nevada have since been defined, as reflected in the Shortage-Sharing Agreement.[6] Arizona
water users will be impacted by shortage water supply reductions more than any other Lower Basin State. 35
Reclamation should consider the Director's Shortage Sharing Workgroup Recommendation and the 36
Shortage-Sharing Agreement with Nevada when adopting a preferred alternative.

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[4] Letter from Herbert R. Guenther to Robert W. Johnson, November 28, 2005, pp. 1-2, attached as Exhibit 2.
[5] Attached as Exhibit 3.
[6] The Arizona-Nevada Shortage-Sharing Agreement, February 9, 2007, is attached to the Basin States' Comments as part of the Basin States' Proposal.

647306.06

S-4

Honorable Dirk Kempthorne
April 30, 2007
Page 5 of 7

Analysis of the Impact of Multiple, Consecutive-Year Colorado River Shortages in Arizona

The Draft EIS includes the following statement: "Key to the impact analysis is the assumption that the most conservative way to estimate impacts is to assume that, if a shortage occurs, farmers would react by fallowing irrigated lands."[7] This is an adequate approach for analyzing shortage reductions expected to last for a single year. However, we disagree with the assumption that this approach captures the expected 37
impact for multiple, consecutive-year shortage reductions. Since fourth priority agricultural water users in Mohave County, Arizona have no reasonably available replacement water supply, a long-term shortage will 38
likely result in the permanent loss of production for some lands. Within the CAP service area, where groundwater is available as a replacement water supply, agricultural producers will have additional costs for 39
the rehabilitation or replacement of irrigation wells as well as additional hydropower costs to pump groundwater.

Arizona has analyzed the likelihood of multiple year Colorado River shortage reductions, using Reclamation's data.[8] Modeling for the No Action Alternative indicates a 44 percent probability of five or more years of consecutive shortage during the interim period (2008 through 2026) and a 95 percent probability from 2027 through 2060. Under the Basin States Alternative the probability of consecutive 40
shortage years is less, but still significant, with a 29 percent probability of five or more years of consecutive shortage during the interim period and a 96 percent probability between 2027 and 2060. Reclamation should consider the socioeconomic and other impacts to both agricultural and municipal water users of multiple, consecutive-year shortages.

The Draft EIS further concludes that "No permanent change in land uses would occur under any of the alternatives because shortages would be of a temporary nature and agricultural lands would likely not be 41
permanently removed from production."[9] Arizona disagrees with this conclusion. Under all alternatives analyzed in the Draft EIS, multiple year shortage reductions are possible. Reclamation should consider the impacts of prolonged shortage and address the impacts in the Final EIS.

Analysis of Shortage Impacts in Arizona

Fourth priority mainstream uses (agricultural and municipal) in Arizona will be reduced proportionately as soon as the first Colorado River water supply reductions are implemented. The Draft EIS does not describe the adverse impacts to fourth priority mainstream municipal Colorado River water users. Future estimated shortage reductions to mainstream users, including Lake Havasu City and Bullhead City, run as high as 30 42
percent of entitlement. Shortage reductions will also reduce the Cocopah Indian Tribe's fourth priority entitlement as well as agricultural water uses in the Mohave Valley. Under Reclamation's current interpretation of Article V accounting under the Consolidated Decree in *Arizona v. California*, there is no locally available, non-Colorado River water supply to offset these shortage reductions.

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[7] Draft EIS, Section 4.14.1.2, page 4-263.
[8] Data taken from Reclamation's DEIS CRSS Model Output data files NA.Short.cy.xls and BS.Short.cy.xls. ADWR analyzed the data found in these files to determine the duration of shortages. The graphed results are shown in Exhibit 4.
[9] Draft EIS, Section 4.14.2, page 4-270.

647306.06

S-4

Honorable Dirk Kempthorne
April 30, 2007
Page 6 of 7

The Draft EIS analyzes a range of shortage reductions from 200,000 acre-feet to 2,500,000 acre-feet. The
impact analysis generally assumes increased impacts from increased volumes of shortage. While it is
reasonable to assume that adverse impacts increase as shortage reductions increase, this approach fails to 43
acknowledge that there has never before been a declared shortage of Colorado River water, and there will be
adverse impacts to a variety of water users in Arizona when the first shortage reductions are implemented.

The Final EIS should recognize Arizona's shortage planning measures and investments over the last decade. 44
It should also acknowledge the additional costs of demand reduction programs already in place that would be
operative during shortage reductions. Arizona cities have already invested millions of dollars to develop
shortage water supplies and to implement demand reduction programs. The Arizona Water Banking
Authority has spent more than $106 million to store water to supplement municipal supplies during times of 45
shortage. Such measures should be included in the analysis of the impacts of shortage.

Conclusion

Adoption of the Basin States Alternative would initiate an opportunity for nineteen years of peace on the 46
River. The outstanding differences among the seven basin states over various aspects of the Law of the
River would be set aside for this interim period while a new, agreed method for managing the Colorado
River and new shortage criteria are implemented. By the year 2020, the Secretary and the Basin States will
have had enough experience with these interim procedures to allow informed and productive consultation 47
concerning River management and shortage guidelines for the period after 2026. If an alternative other than
the Basin States Alternative were to be adopted, the compromises encompassed in the Basin States' Proposal 48
would not be preserved and differences among the states would not be deferred.

Arizona strongly recommends that the Secretary choose the Basin States Alternative as the preferred alternative in the FEIS and adopt a ROD with the guidelines and criteria necessary to implement the Basin States Alternative in substantial conformance with the carefully negotiated Basin States' Proposal.[10]

Sincerely,

Herbert R. Guenther

Attachments

1. Exhibit 1: Changes to DEIS Volume I and Appendix M to Conform to Basin States' Proposal re Intentionally Created Surplus.
2. Exhibit 2: Letter from Herbert R. Guenther to Robert W. Johnson, November 28, 2005.

[10] Attached as Exhibit 5 are additional technical corrections by the State of Arizona regarding the Draft EIS that are self-explanatory and therefore not discussed in the body of this letter..

647306.06

S-4

3. Exhibit 3: Director's Shortage Sharing Workgroup Recommendation, October 24, 2006 (Revised) Final
4. Exhibit 4: Arizona Multiple Consecutive Year Shortage Graphs.
5. Exhibit 5: ADWR technical corrections to DEIS.

c: Robert W. Johnson, Commissioner, U. S. Bureau of Reclamation
Rick Gold, Regional Director, U. S. Bureau of Reclamation, Upper Colorado Regional Office
Jayne Harkins, Acting Regional Director, U. S. Bureau of Reclamation, Lower Colorado Regional Office
Larry Walkoviak, Deputy Regional Director, U. S. Bureau of Reclamation, Lower Colorado Regional Office

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S-4

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EXHIBIT 1

Changes to DEIS Volume I and Appendix M to Conform to Basin States' Proposal re Intentionally Created Surplus

S-4

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The purpose of the proposed federal action is to: 1) improve Reclamation's management of the Colorado River by considering tradeoffs between frequency and magnitude of reductions of water deliveries, and considering the effects on water storage in Lake Powell and Lake Mead, and on water supply, power production, recreation, and other environmental resources; 2) provide mainstream United States users of Colorado River water, particularly those in the Lower Division states, a greater degree of predictability with respect to the amount of annual water deliveries in future years, particularly under drought and low reservoir conditions; and 3) provide for the creation and delivery of intentionally created surplus ("ICS") water in Lake Mead.

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ES.1.2 Proposed Federal Action

The proposed federal action includes the adoption of specific interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead. These interim guidelines would remain in effect for determinations to be made through 2025 regarding water supply and reservoir operating decisions through 2026 and would provide guidance each year in development of the Annual Operating Plan for Colorado River Reservoirs (AOP). This proposed federal action considers four operational elements that collectively are designed to address the purpose and need for the proposed federal action.

The interim guidelines would be used by the Secretary to:

- Determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) below 7.5 million acre-feet (maf) (a "Shortage") pursuant to Article II(13)(3) of the United States Supreme Court in the case of Arizona v. California, 547 U.S. (2006) (Consolidated Decree);

- Define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;

- Establish the conditions for the creation and delivery, pursuant to applicable federal law, of intentionally created surplus water in Lake Mead for use within the Lower Division states to increase the flexibility of meeting water use needs from Lake Mead; and

- Determine those conditions under which the Secretary may declare the availability of ICS and other surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing Interim Surplus Guidelines (ISG), published in the Federal Register on January 25, 2001 (66 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026.

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ES.1.3 Geographic Scope

The geographic region that could potentially be affected by the proposed federal action begins with Lake Powell and extends downstream along the Colorado River floodplain to the Southerly International Boundary (SIB) with Mexico. In addition to the potential impacts that may occur within the river corridor, the alternatives may also affect the water supply that is available to

643132.05

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S-4

specific Colorado River water users in the Lower Basin. The following water agency service areas are also included in the appropriate affected environment discussions:

- Arizona water users, particularly the lower priority water users located in the Central Arizona Project service area;
- The Southern Nevada Water Authority service area; and
- The Metropolitan Water District of Southern California service area. Figure ES-1 shows the geographic scope for the Draft EIS.

ES.1.4 Alternatives

Five alternatives are considered and analyzed in the Draft EIS. The alternatives consist of a No Action Alternative and four action alternatives. The four action alternatives are: Basin States Alternative, Conservation Before Shortage Alternative, Water Supply Alternative, and Reservoir Storage Alternative. The action alternatives reflect input from Reclamation staff, the cooperating agencies, stakeholders, and other interested parties.

Reclamation received two written proposals for alternatives that met the purpose and need of the proposed federal action, one from the seven Colorado River Basin States (Basin States) and another from a consortium of environmental non-governmental organizations (NGO). These proposals were used by Reclamation to formulate two of the alternatives considered and analyzed in the Draft EIS (Basin States Alternative and Conservation Before Shortage Alternative, respectively). A third alternative (Water Supply Alternative) was developed by Reclamation and a fourth alternative (Reservoir Storage Alternative) was developed by Reclamation in coordination with the NPS and Western. The alternatives were posted on Reclamation's website (http://www.usbr.gov/lc/region/programs/strategies.html) on June 30, 2006.

Reclamation has not identified a preferred alternative in the Draft EIS. The preferred alternative will be identified following public comments on the Draft EIS and will be expressed in the Final EIS. The preferred alternative may be one of the specific alternatives described below or it may incorporate elements or variations of these alternatives.

Summary descriptions of the No Action Alternative and the four action alternatives considered in the Draft EIS are provided below and in Table ES-l.

643132.05

3

S-4

TABLE ES-1

Matrix of Alternatives

Alternatives	Shortage Guidelines to reduce deliveries from Lake Mead (elevations in feet msl)	Coordinated Reservoir Operations (Lake Mead & Lake Powell) (elevations in feet msl)	Intentionally Created Surplus	Interim Surplus Guidelines for deliveries/releases from Lake Mead
No Action	• Determination made through the AOP process, absent shortage guidelines • Reasonably represented by a two-level shortage strategy – probabilistic protection of Lake Mead elevation 1,050 and absolute protection of Lake Mead elevation 1,000	• Minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required • Operation at low reservoir levels reasonably represented by a 8.23 maf release from Lake Powell down to Lake Powell dead pool	• No guidelines for creation and delivery of ICS. r	• No modification or extension of the ISG which end in 2016 • After 2016, determination made through the AOP process, absent surplus guidelines; reasonably represented by the spill avoidance (referred to as the 70R Strategy)
Basis States	• Shortages (i.e., reduced deliveries) of 400,500 and 600 kaf from Lake Mead at elevations 1,075, 1,050, and 1,025 respectively • Initiate efforts to develop additional guidelines for shortages if Lake Mead falls below elevation 1,025 (Note: includes consultation with Basin States	• Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization release are required • Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevation at Lake Powell and Lake Mead	• Guidelines for the creation and delivery of ICS for augmentation by extraordinary conservation , system efficiency, tributary conservation and importation of non system water • Maximum total ICS in Lake Mead of 2.1 maf • System assessment of 5 percent of ICS	• Modification of ISG to eliminate Partial Domestic Surplus conditic • Extension of the modified guidelines through 2026
Conservation Before Shortage	• Shortages are implemented in any given year when necessary to keep Lake Mead above SNWA's lower intake at elevation 1,000 (absolute protection of elevation 1,000)	• Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required • Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevation at Lake Powell and Lake	• Guidelines for the creation and delivery of different volumes of ICS tied to Lake Mead elevation • Guidelines for the creation Storage and delivery of ICS for augmentation by extraordinary conservation ed, system efficiency, tributary	• Modification of ISG to eliminate Partial Domestic Surplus conditio • Extension of the modified guidelines through 2026

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S-4

Alternatives	Shortage Guidelines to reduce deliveries from Lake Mead (elevations in feet msl)	Coordinated Reservoir Operations (Lake Mead & Lake Powell) (elevations in feet msl)	Intentionally Created Surplus	Interim Surplus Guidelines for deliveries/releases from Lake Mead
		Mead	conservation and importation of system and/or non system water • Water for environmental uses • Maximum total ICS greater than 4.2 maf • System assessment of 5 percent of ICS	
Water Supply	• Release full annual entitlement amounts until Lake Mead is drawn down to dead pool (elevation 895)	• Minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required • Balancing if Lake Powell is below elevation 3,575 or Lake Mead is below elevation 1,075	• No guidelines for creation and delivery of ICS	• Extension of the existing ISG through 2026
Reservoir Storage	• Shortages (i.e. reduced deliveries) of 600, 800, 1,000 and 1,200 kaf from Lake Mead at elevations 1,100, 1,075, 1,050, and 1,025 respectively	• Minimum objective release of 8.23 maf from Lake Powell if Lake Powell is above elevation 3,595 unless storage equalization releases are required • 7.8 maf release from Lake Powell between Lake Powell elevations of 3,560 and 3,595 • Balancing below Lake Powell elevation of 3,560	• Guidelines for the creation Storage and delivery of ICS for augmentation by extraordinary conservation ed, system efficiency, tributary conservation and importation of system and/or non system water • Maximum total ICS of 3.05 maf • System assessment of 10 percent of ICS.	• Permissive provisions of existing ISG terminate in 2007, and during period from 2008 to 2026, surplus determinations are limited to Quantified and Flood Control Conditions.

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5

S-4

ES.1.4.1 No Action Alternative

The No Action Alternative provides a baseline for comparison of each of the action alternatives. The No Action Alternative represents a projection of future conditions that could occur during the life of the proposed federal action without an action alternative being implemented.

Pursuant to the Long-Range Operating Criteria (LROC), the Secretary makes a number of determinations at the beginning of each operating year through the development and execution of the AOP, including the water supply available to users in the Lower Basin and the annual release from Lake Powell. However, the LROC currently does not include specific guidelines for such determinations. Furthermore, there is no actual operating experience under very low reservoir conditions, i.e., there has never been a shortage determination in the Lower Basin. Therefore, in the absence of specific guidelines, the outcome of the annual determination in any particular year in the future cannot be precisely known. However, a reasonable representation of future conditions under the No Action Alternative is needed for comparison to each action alternative. The modeling assumptions used for this representation are consistent with assumptions used in previous environmental compliance documents for the ISG, the Colorado River Water Delivery Agreement, and the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). However, the assumptions used in the No Action Alternative are not intended to limit or predetermine these decisions in any future AOP determination.

ES.1.4.2 Basin States Alternative

The Basin States Alternative was developed by the Basin States and proposes a coordinated operation of Lake Powell and Lake Mead that would minimize shortages in the Lower Basin and avoid risk of curtailments of Colorado River water use in the Upper Basin. This alternative includes shortages to conserve reservoir storage; coordinated operations of Lakes Powell and Mead determined by specified reservoir conditions; guidelines for the creation and delivery of intentionally created surplus through extraordinary conservation, system efficiency, tributary conservation and importation of non-system water in the Lower Basin; and a modification and extension of the ISG through 2026.

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Deleted: a mechanism for the storage and delivery of conserved system and non-system water in Lake Mead

ES.1.4.3 Conservation Before Shortage Alternative

The Conservation Before Shortage Alternative was developed by a consortium of NGOs. The Conservation Before Shortage Alternative includes voluntary, compensated reductions (shortages) in water use to minimize involuntary shortages in the Lower Basin and avoid risk of curtailments of Colorado River water use in the Upper Basin. This alternative includes voluntary shortages prior to involuntary shortages; coordinated operations of Lakes Powell and Mead determined by specified reservoir conditions; an expanded system for the creation and delivery of intentionally created surplus through extraordinary conservation, system efficiency, tributary conservation and importation of non-system water in the Lower Basin, including water for environmental uses; and a modification and extension of the ISG through 2026.

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ES.1.4.4 Water Supply Alternative

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The Water Supply Alternative maximizes water deliveries at the expense of retaining water in storage in the reservoirs for future use. This alternative would reduce water deliveries only when insufficient water to meet entitlements is available in Lake Mead. When reservoir conditions are relatively low, Lakes Powell and Mead would share water

("balance contents"). This alternative does not include any guidelines for the creation and delivery of ICS. The existing ISG would be extended through 2026.

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ES.1.4.5 Reservoir Storage Alternative

The Reservoir Storage Alternative was developed in coordination with the cooperating agencies and other stakeholders, primarily Western and the NPS. This alternative would keep more water in storage in Lake Powell and Lake Mead by reducing water deliveries and by increasing shortages to benefit power and recreational interests. This alternative includes larger, more frequent shortages that serve to conserve reservoir storage; coordinated operations of Lakes Powell and Mead determined by specified reservoir conditions (more water would be held in Lake Powell than under the Basin States Alternative); and an expanded system for the creation and delivery of intentionally created surplus through extraordinary conservation, system efficiency, tributary conservation and importation of non-system water in the Lower Basin. The existing ISG would be terminated after 2007.

Deleted: mechanism for the storage and delivery of conserved system and non-system water in Lake Mead

ES.2 Summary of Potential Environmental Effects

ES.2.1 Methodology

Hydrologic modeling of the Colorado River system was conducted to determine the potential hydrologic effects of the alternatives. The modeling provides projections of potential future Colorado River system conditions (i.e., reservoir elevations, reservoir releases, river flows) for comparison of those conditions under the No Action Alternative to conditions under each action alternative. Due to the uncertainty with regard to future inflows into the system, multiple simulations were performed in order to quantify the uncertainties of future conditions and as such, the modeling results are typically expressed in probabilistic terms.

The hydrologic modeling also provides the basis for the analysis of the potential effects of each alternative on other environmental resources such as recreation, biology, and electrical power. The potential effects to specific resources are identified and analyzed for each action alternative and are compared to the potential effects to that resource under the No Action Alternative. These comparisons are typically expressed in terms of the relative differences in probabilities between the No Action Alternative and the action alternatives.

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ES.2.3 Water Deliveries

All of the action alternatives generally improve water supply conditions during the interim period relative to the No Action Alternative, improve the probability that normal deliveries will

643132.05

- 2 -

S-4

be met, and reduce the probability that Shortage condition deliveries will occur. The differences between the action alternatives and the No Action Alternative, in terms of the probability of occurrence for Normal conditions water supply deliveries, diminish after 2027 and converge by about 2038.

The Water Supply Alternative provides the same probability of Surplus condition deliveries as the No Action Alternative (between about 30 to 40 percent) between 2008 and 2016 and this alternative consistently provides the highest probability of Surplus condition deliveries during the interim period. The Reservoir Storage Alternative provides the lowest probabilities (between about 10 to 20 percent) during the interim period. The surplus provisions under the Basin States and Conservation Before Shortage alternatives are similar and the probability of Surplus conditions between 2010 through 2016 is slightly less than under the No Action Alternative. After 2026 the probability for all alternatives converges and ranges between 10 and 20 percent.

During most of the interim period, the probability of involuntary and voluntary shortage is less under all of the action alternatives compared to the No Action Alternative. The probability of occurrence of shortages under the Water Supply Alternative is generally less than under the No Action Alternative and other action alternatives during the interim period. However, after 2026, the Water Supply Alternative has the highest probability of occurrence. Average shortages that occur under the Water Supply Alternative are significantly less than those observed under the No Action Alternative during the interim period.

The probability of occurrence of shortages under the Reservoir Storage Alternative is slightly higher than under the No Action Alternative between 2008 and 2013. However, after 2013 and through about 2037, shortages under the Reservoir Storage Alternative occur less frequently as compared to the No Action Alternative. In terms of magnitude, the average shortage volumes that are observed during the interim period are highest under the Reservoir Storage Alternative.

Shortages also occur less frequently under the Basin States and Conservation Before Shortage alternatives during the interim period as compared to the No Action Alternative and are similar after 2026. The probability values of the Basin States Alternative and Conservation Before Shortage Alternative differ by a maximum of about five percent with those of the Conservation Before Shortage Alternative being generally slightly lower than those under the Basin States Alternative. The probability of an involuntary and voluntary shortage under the No Action Alternative in 2026 is 47 percent. In contrast, in 2026, the probability of an involuntary and voluntary shortage under the Basin States, Conservation Before Shortage, Water Supply, and Reservoir Storage alternatives is 35 percent, 33 percent, nine percent, and 37 percent, respectively. In terms of magnitude, the average involuntary and voluntary shortages that are observed under the Basin States and Conservation Before Shortage alternatives are similar to each other and both are less than those observed under the No Action Alternative during the interim period. After 2026, the average shortage volumes are similar.

The ICS Program assumed as part of the Basin States, Conservation Before Shortage and Reservoir Storage alternatives has the effect of decreasing the occurrence of shortages. The greatest reduction during the interim period occurs under the Reservoir Storage Alternative.

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- 3 -

S-4

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Chapter 1.

1.1 Introduction (Text unchanged and intentionally omitted)

1.2 Proposed Federal Action

The proposed federal action includes the adoption of specific interim guidelines for Lower Basin shortages and coordinated operations of Lake Powell and Lake Mead. These interim guidelines would remain in effect for determinations to be made through 2025 regarding water supply and reservoir operating decisions through 2026 and would provide guidance each year in development of the AOP. This proposed federal action considers four operational elements that collectively are designed to address the purpose and need for the proposed federal action; these elements are addressed in each of the alternatives described in Chapter 2.

The interim guidelines would be used by the Secretary to:

1. Determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) (Section 1.7) below 7.5 million acre-feet (maf) (a "Shortage") pursuant to Article II(B)(3) of the Consolidated Decree;
2. Define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;
3. Allow for the intentional creation of surplus pursuant to applicable federal law, so that conserved Colorado River system and non-system water in Lake Mead can be made available by forbearance in order to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions; and
4. Determine those conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing Interim Surplus Guidelines (ISG), published in the Federal Register on January 25, 2001 (66 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026.

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1.3 Purpose of and Need for Action

The purpose of the proposed federal action is to: 1) improve Reclamation's management of the Colorado River by considering the tradeoffs between the frequency and magnitude of reductions of water deliveries, and considering the effects on water storage in Lake Powell and Lake Mead, water supply, power production, recreation, and other environmental resources; 2) provide mainstream United States users of Colorado River water, particularly those in the Lower Division states, a greater degree of predictability with respect to the amount of annual water deliveries in future years, particularly under drought and low reservoir conditions; and, 3)

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provide for intentionally created surplus so that conserved Colorado River system and non-system water in Lake Mead can be made available by forbearance.

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The proposed federal action is needed for the following reasons:

- The Colorado River is of unique and strategic importance in the southwestern United States for water supply, hydropower production, flood control, recreation, fish and wildlife habitat, and other benefits. In addition, the United States has a delivery obligation to the United Mexican States (Mexico) for certain waters of the Colorado River pursuant to the 1944 Treaty between the United States and Mexico Relating to the Utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande (1944 Treaty);
- The seven-year period from 2000 through 2006 was the driest seven-year period in the 100-year historical record; this drought in the Colorado River Basin has reduced Colorado River system storage, while demands for Colorado River water supplies have continued to increase. From October 1, 1999 through September 30, 2006, storage in Colorado River reservoirs fell from 55.7 maf (approximately 97 percent of capacity) to 33.4 maf (approximately 56.4 percent of capacity), and was as low as 29.7 maf (approximately 52 percent of capacity) in 2004. This drought was the first sustained drought experienced in the Colorado River Basin at a time when all major storage facilities were in place, and when use by the Lower Division states met or exceeded the annual "normal" apportionment of 7.5 maf pursuant to Article II(B)(1) of the Consolidated Decree (Section 1.7). These conditions, among other factors, led the Department to conclude that additional management guidelines are necessary and desirable for the efficient management of the major mainstream Colorado River reservoirs;
- In the future, low reservoir conditions may not be limited to drought periods because of anticipated future demands on Colorado River water supplies. Future Colorado River water demands are projected to increase the frequency and magnitude of drought and low reservoir conditions on the Colorado River;
- As a result of actual operating experience and through reviews of the LROC and preparation of AOPs, particularly during recent drought years, the Secretary has determined a need for more specific guidelines, consistent with the Consolidated Decree and other applicable provisions of federal law to assist in the Secretary's determination of annual water supply conditions in the Lower Basin under low reservoir conditions. The increased level of predictability is needed by water managers and the entities that receive Colorado River water to better plan for and manage available water supplies, and to better integrate the use of Colorado River water with other water supplies that they rely on;
- To date, storage of water and flows in the Colorado River has been sufficient so that it has not been necessary to reduce Lake Mead annual releases below 7.5 maf; that is, the Secretary has never reduced deliveries by declaring a "shortage" on the lower Colorado River. Without operational guidelines in place, water users who rely on the Colorado River in the Lower Division states are not currently able to identify particular reservoir conditions under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Lower Division states below 7.5 maf. Nor

643132.05

- 5 -

S-4

are these water users able to identify the frequency or magnitude of any potential future annual reductions in their water deliveries;

- After public consultation meetings held in the summer of 2005, the Secretary has also determined the desirability of developing additional operational guidelines that will provide for releases greater than or less than 8.23 maf from Lake Powell; and
- To further enhance this coordinated reservoir approach, the Secretary has also determined a need for intentionally created surplus guidelines that provide water users in the Lower Division states the opportunity to conserve, and take delivery of water in and from Lake Mead for the purposes of enhancing existing water supplies, particularly under low reservoir conditions. The Secretary has determined the need to modify and extend the ISG to coincide with the duration of the proposed new guidelines. This will provide an integrated approach for reservoir management and more predictability for future Lower Division water supplies.

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1.4 Lead and Cooperating Agencies (Text unchanged and intentionally omitted)

1.5 Scope of the EIS (Text unchanged and intentionally omitted)

1.6 Summary of Contents of this Draft EIS (Text unchanged and intentionally omitted)

1.7 Water Supply Management and Allocation (Text unchanged and intentionally omitted)

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1.7.1.1 Apportionment Provisions

The initial apportionment of water from the Colorado River was determined as part of the Compact, which divided the Colorado River system into two sub-basins, the Upper Basin and the Lower Basin (Figure 1.7-1). The Upper Basin includes those parts of the states of Colorado, Utah, Wyoming, Arizona and New Mexico within and from which waters drain naturally into the Colorado River above Lee Ferry, Arizona. The Lower Basin includes those parts of the states of Arizona, California, Nevada, New Mexico and Utah within and from which waters naturally drain into the Colorado River system below Lee Ferry Compact Point. The Compact also divided the seven Basin States into the Upper Division and the Lower Division states (Figure 1.7-3). The Upper Division states are Wyoming, Utah, Colorado and New Mexico. The Lower Division states are Arizona, California, and Nevada.

The Compact apportioned to the Lower Basin states and the Upper Basin states, in perpetuity, the exclusive beneficial consumptive use of 7.5 maf of water per year (mafy). In addition to this apportionment, Article III(b) of the Compact gives the Lower Basin states the right to increase their beneficial consumptive use by 1.0 mafy. The Compact also stipulates in Article III(d) that the Upper Division states will not cause the flow of the river at Lee Ferry Compact Point to be depleted below an aggregate of 75 maf for any period of 10 consecutive years.

643132.05

S-4

The Compact, in Article VII, states that nothing in the Compact shall be construed as affecting the obligations of the United States to Indian tribes. While the rights of most Indian tribes to Colorado River water were subsequently adjudicated, some Tribal rights remain unadjudicated. To the extent that Indian tribes consumptively use water from the Colorado River, such uses are charged against the apportionment of the relevant Colorado River Basin state.

Upper Division State Apportionments. Upper Division state apportionments were established by the Upper Colorado River Basin Compact of 1948. These apportionments allocate the Upper Basin states consumptive use after deduction of up to 50,000 acre-feet per year (afy) for Arizona as follows: Wyoming, 14.00 percent; Utah, 23.00 percent; Colorado, 51.75 percent; and New Mexico, 11.25 percent. The Upper Basin state apportionments have not yet been fully developed.

Lower Division State Apportionments. Lower Division state apportionments were established by Congress in the BCPA. These apportionments are: California, 4.4 maf; Arizona, 2.8 maf; and Nevada, 0.3 maf, totaling 7.5 maf, subject to annual increases or reductions pursuant to Secretarial determinations of Shortage or Surplus conditions.

Under Article II(B)(2) of the Decree in *Arizona v. California,* when the Secretary determines there is a Surplus, California is entitled to 50% of the Surplus, Arizona is entitled to 46% and Nevada is entitled to 4%.

Figure 1.7-4 presents a schematic of the operation of the Colorado River, primarily in the Lower Basin. The Consolidated Decree confirms the apportionments to the Lower Division states established by the BCPA and guides the Secretary's operation of facilities, including Hoover Dam, on the lower Colorado River. If water apportioned for use in a Lower Division state is not consumed by that state in any year, the Secretary may release the unused water for use in another Lower Division state. Consumptive use by a Lower Division state includes delivered water that is stored off-stream for future use by that state or another state.

All mainstream Colorado River waters apportioned to the Lower Basin, except for a few thousand acre-feet (af) apportioned for use in Arizona, have been fully allocated to specific entities and, except for certain federal establishments, placed under permanent water delivery contracts with the Secretary for irrigation or domestic use. These entities include irrigation districts, water districts, municipalities, Indian tribes, public institutions, private water companies, and individuals. Federal establishments with federal reserved rights established pursuant to Article II(D) of the Consolidated Decree are not required to have a contract with the Secretary, but the water allocated to a federal establishment is included within the apportionment of the Lower Division state in which the federal establishment is located; e.g., Fort Mojave Indian Reservation in California and the Havasu National Wildlife Refuge in Arizona.

The highest priority lower Colorado River water rights are present perfected rights (PPRs), which the Consolidated Decree defines as those perfected rights existing on June 25, 1929, the effective date of the BCPA. The Consolidated Decree also recognizes federal Indian reserved rights for the quantity of water necessary to irrigate all the practicably irrigable acreage (lands considered suitable for irrigation) on five Indian reservations along the lower Colorado River. The Consolidated Decree defines the rights of Indian and other federal reservations to be federal

643132.05

- 7 -

S-4

establishment PPRs. PPRs are important because in any year in which less than 7.5 maf of Colorado River water is available for consumptive use in the Lower Division states, PPRs will be satisfied first, in the order of their priority without regard to state lines.

Waters available to a Lower Division state within its apportionment, but having a priority date later than June 25, 1929, have been allocated by the Secretary through execution of water delivery contracts to water users within that state as required by Section 5 of the BCPA.

Allocation of Colorado River water to Mexico is governed by the 1944 Treaty. Article 10(a) of the 1944 Treaty states:

> "(a) A guaranteed annual quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) to be delivered in accordance with the provisions of Article 15 of this Treaty"

Further, Article 10(b) of the 1944 Treaty provides:

> "(b) Any other quantities arriving at the Mexican points of diversion, with the understanding that in any year in which, as determined by the United States Section, there exists a surplus of waters of the Colorado River in excess of the amount necessary to supply uses in the United States and the guaranteed quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) annually to Mexico, the United States undertakes to deliver to Mexico, in the manner set out in Article 15 of this Treaty, additional waters of the Colorado River system to provide a total quantity not to exceed 1,700,000 acre-feet (2,096,931,000 cubic meters) a year. Mexico shall acquire no right beyond that provided by this subparagraph by the use of the waters of the Colorado River system, for any purpose whatsoever, in excess of 1,500,000 acre-feet (1,850,234,000 cubic meters) annually."

Additionally, Article 10 of the 1944 Treaty provides:

> "In the event of extraordinary drought or serious accident to the irrigation system in the United States, thereby making it difficult for the United States to deliver the guaranteed quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) a year, the water allotted to Mexico under subparagraph (a) of this Article will be reduced in the same proportion as consumptive uses in the United States are reduced."

The proposed federal action is for the purpose of adopting additional operational guidelines to improve the Department's annual management and operation of key Colorado River reservoirs for an interim period through 2026. However, in order to assess the potential effects of the proposed federal action in this Draft EIS, certain modeling assumptions (discussed in Chapter 2) are used that display projected water deliveries to Mexico. Reclamation's modeling assumptions

643132.05

S-4

are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current or future United States policy regarding deliveries to Mexico.

The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

* * * * *

1.7.1.2 Surplus Water Supply Condition Determinations

Surplus conditions exist when the Secretary determines that sufficient mainstream water is available for release to satisfy consumptive use in the Lower Division states in excess of 7.5 maf annually. This excess consumptive use is surplus and is distributed for use in Arizona, California, and Nevada pursuant to the terms and conditions provided in the ISG, adopted in 2001, as agreed by the Lower Basin States. The current provisions of the ISG are scheduled to terminate in 2016.

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In general terms, the ISG link the availability of surplus water to the elevation of Lake Mead. When Lake Mead is full and Reclamation is making flood control releases, surplus supplies are unlimited. As Lake Mead's elevation drops, surplus water amounts are reduced, and ultimately eliminated. Surplus availability is also linked to continued progress by California to take actions to reduce its historic reliance on water in excess of its 4.4 mafy apportionment.

If a state does not use all of its apportioned water for the year, the Secretary may allow other states of the Lower Division to use the unused apportionment, provided that the use is authorized by a water delivery contract with the Secretary.

* * * * *

2.1 Development of Alternatives

Based on the information and comments received during the scoping process, the proposed federal action has been designed to reflect, among others, three important considerations:

1. Encouraging Conservation of Water: Many comments submitted to Reclamation focused on the importance of encouraging and utilizing water conservation as an important tool to better manage limited water supplies and therefore minimize the likelihood and severity of potential future shortages. Water conservation could occur through a number of approaches such as fallowing of land, canal lining, financial incentives to maximize conservation, dry-year options, and associated storage and recovery methodologies and procedures to address conservation actions by particular parties.
2. Consideration of Reservoir Operations at all Operational Levels: Many comments submitted to Reclamation urged Reclamation to consider and analyze management and operational guidelines for the full range of operational levels at Lake Powell and Lake Mead. It was suggested that this approach is integral to the prudent development of new

643132.05

- 9 -

S-4

low-reservoir operational guidelines, as the approach and management of these reservoirs at higher elevations has a direct impact on available storage, thereby affecting the likelihood and severity of potential future shortages.

3. Term of Operational Guidelines: Many comments urged Reclamation to consider interim, rather than permanent, additional operational guidelines. In this manner, Reclamation would have the ability to use actual operating experience for a period of years, thereby facilitating a better understanding of the operational effects of the new guidelines. Modifications could then be made, if necessary, based on this operating experience.

As a result of the analyses of the comments and input received by Reclamation, the following four operational elements of the proposed federal action were developed;

1. **Shortage Guidelines**: Adoption of guidelines that would identify those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Lower Division states below 7.5 maf, pursuant to the Consolidated Decree.

The primary purpose of this element is the orderly rationing of water supplies during drought and low-reservoir conditions. While Lake Powell and Lake Mead have large storage capacities, water supply demands are increasing and careful management of existing water supplies will help ensure sufficient supplies are available to meet these demands. The proposed shortage guidelines in the alternatives range from aggressive shortages to no reduction of water supplies until the reservoirs are empty. Most of the alternatives have discrete stepped levels of shortage associated with specific Lake Mead reservoir elevations.

2. **Coordinated Reservoir Operations**: Adoption of guidelines for the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low-reservoir conditions.

Lake Powell and Lake Mead operations are currently coordinated only under high reservoir elevations through storage equalization. The action alternatives consider various options designed to better utilize existing reservoir storage throughout the full range of reservoir operations to enhance both water supply and other benefits of the reservoir system for both basins.

3. **Intentionally Created Surplus Guidelines.**: Adoption of guidelines for the intentional creation of surplus water and Secretarial declaration of surplus in order to make conserved Colorado River system and non-system water available in the Lower Colorado River to those who create such surplus water, pursuant to applicable federal law, to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low-reservoir conditions.

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One way to increase water deliveries during drought is the augmentation of existing water supplies through extraordinary conservation, system efficiency projects, tributary conservation and water importation . The alternatives consider options for the intentional creation of surplus water ("ICS") in Lake Mead whereby system and non-system water may be conserved in Lake

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- 10 -

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Mead, with various limits on the maximum amount and delivery of the ICS. The alternatives range from an operational scenario that considers no new mechanism (status quo) to a maximum Lake Mead ICS volume of 4.2 maf.

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Reclamation will establish guidelines for administration of ICS as part of this public NEPA process. The guidelines will set forth Reclamation requirements for verification of the creation of ICS and water accounting procedures. Although the guidelines for this element are interim and will expire in 2026, some of the conservation projects established under the guidelines could be permanent in duration.

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4. **Interim Surplus Guidelines (ISG)**: Adoption of guidelines that would identify the conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing ISG and extend the term of the ISG from 2016 to 2026.

The ISG are due to expire in 2016. The alternatives range from termination of the permissive provisions of the existing ISG in 2007 to extension of the current provisions of the ISG through 2026. This element of the proposed federal action helps establish an operational strategy for the full range of reservoir operations through 2026.

The alternatives considered and analyzed in this Draft EIS include some formulation of each of these four operational elements.

Reclamation has developed four action alternatives for analysis in this EIS. These alternatives reflect input from Reclamation staff, the cooperating agencies, stakeholders, and other interested parties. Reclamation received two written proposals for alternatives that met the purpose and need of the proposed federal action, one from the Basin States and another from a consortium of environmental organizations. These proposals were used by Reclamation to formulate two of the alternatives considered and analyzed in this Draft EIS. A third alternative (Water Supply Alternative) was developed by Reclamation and a fourth alternative (Reservoir Storage Alternative) was developed in coordination with the NPS and Western. The alternatives were posted on Reclamation's website (http://www.usbr.gov/lc/region/programs/strategies.html) on June 30, 2006.

Reclamation has not identified a preferred alternative in this Draft EIS. The preferred alternative will be identified following public comments on the Draft EIS and will be expressed in the Final EIS. The preferred alternative may be one of the specific alternatives described below or it may incorporate elements or variations of these alternatives.

2.2 No Action Alternative

The No Action Alternative provides a baseline against which action alternatives can be compared. The No Action Alternative represents a projection of current conditions to the most reasonable future responses or conditions that could occur during the life of the proposed federal action without any action alternative being implemented.

643132.05

S-4

Pursuant to the LROC, the Secretary makes a number of determinations at the beginning of each operating year through the development and execution of the AOP, including the water supply available to users in the Lower Basin and the annual release from Lake Powell. The LROC do not include specific guidelines for such determinations. Furthermore, there is no actual operating experience under very low reservoir conditions, e.g., there has never been a shortage determination in the Lower Basin. Therefore, in the absence of specific guidelines, the outcome of the annual determination in any particular year in the future cannot be precisely known. However, a reasonable representation of future conditions under the No Action Alternative is needed for comparison to each action alternative. The modeling assumptions used for this representation are consistent with assumptions used in previous environmental compliance documents for the ISG, the Colorado River Water Delivery Agreement, and the LCR MSCP (Section 1.8). However, the assumptions used in the No Action Alternative are not intended to limit or predetermine the action decision in any future AOP determination.

The formulation of the four elements for the No Action Alternative follows.

2.2.1 Shortage Guidelines

Each year, the Secretary makes a determination as to whether the consumptive use requirements of mainstream users in the Lower Division states will be met under a Normal, Surplus, or Shortage condition, in accordance with the Consolidated Decree and the LROC. The LROC specify that the Secretary will consider all relevant factors in making a shortage determination and list some of the factors to be considered. However, there is no specific guidance as to exactly when, how, or to whom reductions in deliveries would be made. Therefore, it is impossible to know exactly how the Secretary might make a shortage determination in the future. Furthermore, conditions in the Colorado River Basin have been such that there has not been a need to declare a Shortage condition and there is no actual operating experience with regard to shortage determinations.

To obtain a reasonable representation of future conditions under no action (while not representing official policy of the Department with regard to future determinations), the following assumptions were made;

- As used in modeling assumptions for previous environmental compliance documents, shortage trigger elevations (Figure 2.2-1) were used to prevent Lake Mead's water level from declining below elevation 1,050 feet msl with approximately an 80 percent probability (known as a "Level 1 Shortage", Appendix A). In a given year, a shortage (or reduction in deliveries) that ranges from approximately 350 to 500 kaf would be imposed when the projected January 1 Lake Mead elevation is below the trigger elevation for that year; and
- If Lake Mead's elevation were to continue to decline, additional reductions would be imposed to keep Lake Mead above 1,000 feet msl. This approach essentially provides absolute protection of SNWA's lower intake (elevation 1,000 feet msl) at Lake Mead and would reduce deliveries to water users (including SNWA) by amounts required to maintain the Lake Mead water level at or above 1,000 feet msl.

643132.05

- 12 -

S-4

In accordance with the Consolidated Decree, the CRBPA, and other key provisions of the Law of the River, the Secretary has the authority to declare and allocate shortages to the Lower Division states. Although some guidance exists with regard to how shortages would be allocated (e.g., PPR deliveries must be met without regard to state lines, California does not incur shortages until Arizona post-1968 contracts are reduced completely), there are no specific guidelines in place to further inform the Secretary's decision with respect to how shortages might be shared by the water users in Arizona, California and Nevada. In addition, the determination of deliveries to Mexico is not a part of the proposed federal action. Any such determination would be made in accordance with the 1944 Treaty (Section 1.7).

Nevertheless, modeling assumptions with respect to the distribution of shortages for the Lower Division states and Mexico are necessary in order to analyze potential impacts to hydrologic and other environmental resources. These modeling assumptions were applied to the No Action Alternative as well as the action alternatives, i.e., the modeling assumptions with regard to the distribution of shortages are identical in all alternatives.

It was assumed that shortages would be allocated to each Lower Division state and Mexico based on percentages of the total shortage being applied. The modeling assumptions for distribution of shortages used in this Draft EIS are presented in Table 2.2-1. More detailed descriptions of these modeling assumptions are provided in Appendix A under Stage 1.

Shortages are first imposed under Stage 1 and would be applied to the most junior users within Arizona (those with post-1968 water rights, i.e., 4t and 5th priority rights within Arizona) and Nevada (primarily the SNWA). Stage 1 shortages continue until the deliveries to the post-1968 water rights holders in Arizona (including the CAP) are reduced to zero. The maximum amount of Stage 1 shortages during the period of analysis is dependent on the scheduled depletions for the post-1968 water rights holders and decreases over time from approximately 1.8 maf in 2008 to 1.7 maf in 2060.

After deliveries to the 4th and 5th priority rights within Arizona are reduced to zero, additional reductions are applied to Arizona, California, and Nevada. These shortages, referred to as Stage 2 shortages, continue to the maximum necessary to keep Lake Mead elevation above 1,000 feet nisi.

2.2.2 Coordinated Reservoir Operations

The No Action Alternative assumes Lake Powell's operation would follow the current operating criteria as specified by the LROC and as implemented through the AOP process. The three possible factors affecting the annual releases from Lake Powell are: 1) minimum objective release; 2) storage equalization; and 3) spill avoidance.

Pursuant to the LROC, the objective under current operational conditions is to maintain a minimum release of water from Lake Powell of 8.23 maf for the water year. Under the No Action Alternative, a minimum release of 8.23 maf is assumed to be made each water year unless storage equalization or spill avoidance determinations are in effect.

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Annual releases from Lake Powell greater than the minimum objective release occur when Upper Basin storage is greater than the storage required by 602(a) storage, and the storage in Lake Powell is forecast to be greater than the storage in Lake Mead by the end of that water year. Under these conditions, additional releases are made from Lake Powell to equalize the storage in Lake Mead with the storage in Lake Powell by the end of the water year.

The 602(a) storage requirement specifies the amount of storage in Upper Basin reservoirs necessary to assure deliveries to the Lower Basin in compliance with the Compact without impairment to the annual consumptive use in the Upper Basin. If the 602(a) storage requirement is not met, equalization does not occur. The LROC specifies that all relevant factors including historic stream flows, the most critical period of record, the probabilities of water supply, and estimated future depletions be considered when determining the 602(a) storage amount.

In 2004, an Interim 602(a) Storage Guideline was adopted that specifies that through 2016, the 602(a) storage requirement shall utilize a storage amount of not less than 14.85 maf which corresponds to 3,630 feet msl for Lake Powell. Under the No Action Alternative, the determination of 602(a) storage is consistent with the storage criterion and the provisions of the Interim 602(a) Storage Guideline. The algorithm used to calculate the 602(a) storage requirement is presented in Appendix A.

Annual release volumes from Lake Powell greater than the minimum objective of 8.23 maf may also be made to avoid anticipated spills. An objective in the operation of Glen Canyon Dam is to attempt to safely fill Lake Powell each summer. When carryover storage from the previous year in combination with forecasted inflow is projected to exceed Lake Powell's storage capacity, Reclamation schedules the release of the volumes of water needed to avoid spills. Subject to actual inflows, Lake Powell is operated to reach storage of about 23.8 maf in July (0.5 maf from full pool). In years when Lake Powell fills or nearly fills during the summer, additional releases in the late summer and early winter are made to draw the reservoir level down, so that there is at least 2.4 maf of vacant space in Lake Powell on September 30 for flood protection. Under the No Action Alternative, it is assumed that spill avoidance releases are made when necessary.

2.2.3 Intentionally Created Surplus Guidelines

There are currently no guidelines in place for the creation and delivery of intentionally created surplus water ("ICS") in Lake Mead; therefore, the No Action Alternative assumes that none will exist during the interim period.

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2.2.4 Interim Surplus Guidelines

The ISG specify ranges of Lake Mead elevations and operational conditions that are used to determine the availability of surplus water for each year during their effective term. The elevation ranges are coupled with specific uses of surplus water so that if Lake Mead's elevation declines, the amount of surplus water is reduced. The different surplus conditions are described below:

2.2.4.1 Flood Control Surplus

643132.05

- 14 -

S-4

If flood control releases are anticipated to be required given the current inflow forecast, the Secretary declares Flood Control Surplus conditions for that year. The estimated annual amount of surplus water available for pumping and release from Lake Mead (in addition to the 7.5 maf normal apportionment) varies over time (2002 to 2016) and ranges between 1.20 to 1.58 mafy. Under current practice, Mexico is allowed to schedule up to an additional 200 thousand acre-feet (kaf) pursuant to the 1944 Treaty during flood control years when water supplies exceed those required for use in the United States.

2.2.4.2 Quantified Surplus (70R Strategy)

If flood control releases are anticipated to be required assuming the 70`h percentile inflow (the inflow value from the historical record that has not been exceeded more than 30 percent of the time), the Secretary declares Quantified Surplus conditions for that year. The estimated annual amount of surplus water available for pumping and release from Lake Mead (in addition to the 7.5 maf normal apportionment) varies over time (2002 to 2016) and ranges between 1.02 to 1.45 mafy.

2.2.4.3 Full Domestic Surplus (Lake Mead at or above Elevation 1,145 feet msl)

If the projected January 1 Lake Mead elevation is at or above 1,145 feet msl but below the elevation calculated by the 70R Strategy, the Secretary declares a Full Domestic Surplus condition for that year. The projected annual amounts of surplus water available for pumping and release from Lake Mead (in addition to the 7.5 maf normal apportionment) vary over time (2002 to 2016) and range between 340 to 535 thousand acre-feet per year (kafy).

2.2.4.4 Partial Domestic Surplus (Lake Mead at or above Elevation 1,125 feet msl)

If the projected January 1 Lake Mead elevation is at or above 1,125 feet msl and below 1,145 feet msl, the Secretary declares Partial Domestic Surplus conditions for that year. The estimated annual amounts of surplus water available for pumping and release from Lake Mead (in addition to the 7.5 maf normal apportionment) vary over time (2002 to 2016) and range between 90 to 375 kafy.

2.2.4.5 Normal and Shortage Conditions (Lake Mead below Elevation 1,125 feet msl)

If the projected January 1 Lake Mead elevation is at or below 1,125 feet msl, the Secretary declares Normal conditions or Shortage conditions for that year.

Under the No Action Alternative, surplus determinations through 2016 would be as described above. After 2016, it is assumed that surplus determinations would only be based on the more conservative Quantified Surplus (70R Strategy) and Flood Control Surplus conditions. Further details of these modeling assumptions to represent the ISG are presented in Appendix A.

643132.05

- 15 -

S-4

2.3 Basin States Alternative

The Basin States Alternative proposes a coordinated operation of Lake Powell and Lake Mead that would minimize shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin. This alternative also provides for ICS guidelines in order to promote, extraordinary conservation, system efficiency, tributary conservation and importation of non-system water in the Lower Basin. The formulation of the four elements for the Basin States Alternative follows.

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2.3.1 Shortage Guidelines

The Basin States Alternative provides discrete stepped levels of shortage associated with specific Lake Mead elevations as presented below. This alternative provides criteria for shortages of up to a maximum of 600 kaf at Lake Mead elevation of 1,025 feet msl and suggests that consultations between the Basin States and Reclamation would be undertaken to define additional shortages below that elevation. The possible outcomes of such a consultation process are unknown; therefore, for modeling purposes it was assumed that shortages of 600 kaf would continue to be applied at Lake Mead elevations below 1,025 feet msl. The stepped shortages modeled under the Basin States Alternative are as follows:

- When Lake Mead is projected to be below elevation 1,075 feet msl and at or above 1,050 feet msl on January 1, a shortage of 400 kaf shall be declared for that year;
- When Lake Mead is projected to be below elevation 1,050 feet msl and at or above 1,025 feet msl on January 1, a shortage of 500 kaf shall be declared for that year;
- When Lake Mead is projected to be below elevation 1,025 feet msl on January 1, a shortage of 600 kaf shall be declared for that year; and
- When Lake Mead elevation approaches the top of the dead pool (895 feet msl), the deliveries from Lake Mead are reduced to the amount of water available.

2.3.2 Coordinated Reservoir Operations

Under the Basin States Alternative, the annual Lake Powell release is based on a volume of water in storage or corresponding elevation in Lake Powell and Lake Mead as described below.

2.3.2.1 Equalization

The Basin States Alternative provides an elevation schedule (Table 2.3-1) that would be used in determining when equalization releases would be made.

When Lake Powell is at or above these specified elevations and when the volume of Lake Powell is projected to be greater than the volume of Lake Mead at the end of the water year, Lake Powell would release greater than 8.23 mafy to equalize its volume with Lake Mead. Otherwise, 8.23 maf is released from Lake Powell.

2.3.2.2 Upper Elevation Balancing

643132.05

- 16 -

S-4

When Lake Powell is below the elevations stated in Table 2.3-1 and is projected to be at or above 3,575 feet msl at the end of the water year, a release in the amount of 8.23 maf from Lake Powell would be made if the projected elevation of Lake Mead is at or above 1,075 feet msl at the end of the water year. If the projected end of water year elevation of Lake Mead is below 1,075 feet msl, the volumes of Lake Mead and Lake Powell would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.0 maf and no less than 7.0 maf.

2.3.2.3 Mid-Elevation Releases

When Lake Powell elevation is projected to be below 3,575 feet msl and at or above 3,525 feet msl at the end of the water year, a release in the amount of 7.48 maf would be made if the projected end of water year elevation of Lake Mead is at or above 1,025 feet msl. If the projected end of water year elevation of Lake Mead is below 1,025 feet msl, a release of 8.23 maf from Lake Powell would be made.

2.3.2.4 Lower Elevation Balancing

When the projected end of water year elevation of Lake Powell is below 3,525 feet msl, Lake Mead and Lake Powell would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.5 maf and no less than 7.0 maf.

2.3.3 Intentionally Created Surplus Guidelines

The Basin States Alternative includes the adoption of guidelines for the creation and delivery of ICS to encourage and account for augmentation and conservation of water supplies, e.g., fallowing of land, canal lining, system efficiency improvements, tributary conservation and introduction of non-system water in the Lower Basin.

In addition to increasing the flexibility of meeting water use needs from Lake Mead, the ICS would benefit the system by providing more water in Lake Mead. At the time ICS is created, five percent of the ICS would be dedicated to the system on a one-time basis. Additionally, ICS in Lake Mead longer than one year would be subject to annual evaporation losses of three percent per year. If flood control releases occur, ICS would be reduced on a pro-rata basis among all holders of ICS until no ICS remains, i.e., ICS would be released first. No ICS would be available for delivery in shortage years. However, Developed Water (water produced by tributary conservation and imported non-system water) would be available for delivery during a declared shortage, with certain limitations.

The maximum amount of ICS that can be created during any year, the maximum cumulative amount of ICS that can be available at any one time, and the maximum amount of ICS that may be recovered for use in each Basin State in any one year under this alternative are presented in Table 2.3-2.

Table 2.3-2

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- 17 -

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Basin States Alternative			
Volume Limitations of ICS			
Entity	*Maximum Annual Creation of ICS (kaf)*	*Maximum Cumulative Total ICS (kaf)*	*Maximum Annual Deliveries of ICS (kaf)*
Arizona	*100*	*300*	*300*
California	*400*	*1,500*	*400*
Nevada	*125*	*300*	*300*
Total	*625*	*2,100*	*1,000*

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2.3.4 Interim Surplus Guidelines

The Basin States Alternative includes both a modification and an extension of the ISG. The ISG would be extended through 2026 and be modified by eliminating the Partial Domestic Surplus condition, beginning in 2008, and limiting the amount of water available under the Full Domestic Surplus condition during the period 2017 through 2026.1 The elimination of the Partial Domestic Surplus condition reduces the amount of surplus water that could be made available and leaves more water in storage to reduce the severity of future shortages.

2.4 Conservation Before Shortage Alternative

The Conservation Before Shortage Alternative was developed by a coalition of NGOs, including Defenders of Wildlife, Environmental Defense, National Wildlife Federation, Pacific Institute, Sierra Club, Sonoran Institute, The Nature Conservancy, and the Rivers Foundation of the Americas. The Conservation Before Shortage Alternative includes voluntary, compensated reductions in water use to minimize involuntary shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin. This alternative also provides a mechanism for promoting water conservation in the Lower Basin by expanding the ICS mechanism. The formulation of the four elements for the Conservation Before Shortage Alternative follows.

2.4.1 Shortage Guidelines

Although the Conservation Before Shortage Alternative does not include stepped, involuntary shortages, it does include voluntary conservation levels similar to the Basin States Alternative shortage levels described in Section 2.3. These voluntary conservation levels are described below.

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During 2017 through 2026, the distribution of Domestic Surplus water would be limited as follows: 1) for use by MWD, 250 kafy in addition to the amount of California's basic apportionment available to MWD; 2) for use by SNWA, 100 kafy in addition to the amount of Nevada's basic apportionment available to SNWA; and 3) for use in Arizona, 100 kafy in addition to the amount of Arizona's basic apportionment available to Arizona contractors.

This alternative provides a shortage strategy that would absolutely protect Lake Mead elevation of 1,000 feet msl whereby water deliveries would be reduced by the amount required to maintain Lake Mead elevations at or above 1,000 feet msl.

2.4.2 Coordinated Reservoir Operations

The Conservation Before Shortage Alternative assumes the same coordinated reservoir operations as the Basin States Alternative described in Section 2.3.

Intentionally Created Surplus Guidelines. The ICS triggers proposed under this alternative are as follows:

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- When Lake Mead is projected to be below elevation 1,075 feet msl and at or above 1,050 feet msl on January 1, the Secretary will seek the conservation of 400 kaf of water which would become ICS;
- When Lake Mead is projected to be below elevation 1,050 feet msl and at or above 1,025 feet msl on January 1, the Secretary will seek the conservation of 500 kaf of water which would become ICS; and
- When Lake Mead is projected to be below 1,025 feet msl on January 1, the Secretary will seek the conservation of 600 kaf of water become ICS.

The ICS would be generated by activities similar to those described in the Basin States Alternative (Section 2.3). In addition, participation in the ICS program would be expanded to include other entities as shown in Table 2.4-1.

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The maximum amount of ICS that can be created during any year, the maximum cumulative amount of ICS that can be available at any one time, and the maximum amount of ICS that may be recovered by each entity in any one year under this alternative are presented in Table 2.4-1.

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Table 2.4-1

Conservation Before Shortage Alternative

Volume Limitations of ICS

Entity	*Maximum Annual Creation of ICS (kaf)*	*Maximum Cumulative Total ICS (kaf)*	*Maximum Annual Deliveries of ICS (kaf)*
Arizona	*100*	*300*	*300*
California	*400*	*1,500*	*400*
Nevada	*125*	*300*	*300*

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- 19 -

S-4

Unassigned	*825*	*2,100*	*600*
Total	*1,450*	*4,200*	*1,600*

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2.5 Water Supply Alternative

The Water Supply Alternative is intended to maximize water deliveries at the expense of retaining water in storage in the reservoirs for future use. This alternative would implement shortages only when insufficient water to meet entitlements is available in Lake Mead. The formulation of the four elements for the Water Supply Alternative follows.

2.5.1 Shortage Guidelines

Under the Water Supply Alternative, shortages would not be imposed until Lake Mead nears elevation 895 feet msl (top of the dead pool). Near that elevation, releases would be limited to the amount of water available. However, when Lake Mead elevation drops below 1,000 feet msl SNWA would be unable to take water through its lower intake.

2.5.2 Coordinated Reservoir Operations

When Lake Powell elevation is projected to be above 3,575 feet msl at the end of the water year, the operation of Lake Powell is the same as the No Action Alternative unless Lake Mead elevation is below 1075 feet msl. When Lake Powell elevation is projected to be below 3,575 feet msl at the end of the water year or Lake Mead elevation is projected to be below 1,075 feet msl at the end of the water year, the volumes of Lake Powell and Lake Mead would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.5 maf and no less than 7.0 maf.

2.5.3 Intentionally Created Surplus Guidelines

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The Water Supply Alternative does not include a guidelines for the creation and delivery of ICS.

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2.5.4 Interim Surplus Guidelines

Under this alternative, the existing ISG would be extended through 2026.

2.6 Reservoir Storage Alternative

The Reservoir Storage Alternative was developed in coordination with the cooperating agencies and other stakeholders, primarily Western and the NPS. This alternative would keep more water in storage in Lake Powell and Lake Mead by reducing water deliveries and increasing shortages to benefit power and recreational interests. This alternative also provides a mechanism for promoting water conservation in the Lower Basin. The formulation of the four elements for the Reservoir Storage Alternative follows.

2.6.1 Shortage Guidelines

The Reservoir Storage Alternative is similar to the Basin States Alternative in that it provides

643132.05

- 20 -

S-4

discrete stepped levels of shortage associated with specific Lake Mead reservoir elevations (Section 2.3). However, shortages in this alternative begin at a higher Lake Mead elevation and the stepped shortages are larger so that more water would be retained in storage and higher Lake Powell and Lake Mead elevations would be maintained. The Reservoir Storage Alternative does not contain provisions that would protect the Lake Mead elevation of 1,000 feet msl.

The stepped shortages under this alternative are as follows:

- When Lake Mead is projected to be below elevation 1,100 feet msl and at or above 1,075 feet msl on January 1, a shortage of 600 kaf would be imposed for that year;
- When Lake Mead is projected to be below elevation 1,075 feet msl and at or above 1,050 feet msl on January 1, a shortage of 800 kaf would be imposed for that year;
- When Lake Mead is projected to be below elevation 1,050 feet msl and at or above 1,025 feet msl on January 1, a shortage of 1,000 kaf would be imposed for that year; and
- When Lake Mead is projected to be below 1,025 feet msl on January 1, a shortage of 1,200 kaf would be imposed for that year.

2.6.2 Coordinated Reservoir Operations

When Lake Powell elevation is projected to be above 3,595 feet msl at the end of the water year, the operation of Lake Powell would be the same as under the No Action Alternative. Elevations at Lake Powell that trigger releases that are less than the minimum objective release of 8.23 maf are tied to critical recreation elevations at Lake Powell as follows:

- When Lake Powell elevation is projected to be below 3,595 feet msl and above 3,560 feet msl at the end of the water year, a release in the amount of 7.80 maf from Lake Powell would be made; and
- When Lake Powell elevation is projected to be below 3,560 feet msl at the end of the water year, the volumes of Lake Powell and Lake Mead would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.5 maf and no less than 7.8 maf.

2.6.3 Intentionally Created Surplus Guidelines

Under the Reservoir Storage Alternative, ICS would be created by activities similar to those described under the Basin States Alternative (Section 2.3). Participation in ICS program would include the entities as shown in Table 2.6-1.

The maximum amount of ICS that can be created during any year, the maximum cumulative amount of ICS that can be available at any one time, and the maximum amount of ICS that may be recovered by each entity in any one year under this alternative are presented in Table 2.6-1.

Table 2.6-1
Reservoir Storage Alternative
Volume Limitations of ICS

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- 21 -

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Entity	Maximum Annual ICS (kaf)	Maximum Cumulative Total ICS (kaf)	Maximum Annual Delivery of ICS (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Unassigned	475	950	950
Total	1,100	**3,050**	**1,950**

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2.6.4 Interim Surplus Guidelines

Under the Reservoir Storage Alternative, the permissive provisions of the existing ISG are terminated in 2007 and surplus determinations revert to the Quantified Surplus and Flood Control Surplus conditions during the period beginning in 2008 and ending in 2026.

2.7 Summary Comparison of Alternatives

A summary comparison of the alternatives identified and analyzed is provided in Table 2.7-1 through Table 2.7-3 for Lake Powell and Lake Mead.

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- 22 -

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TABLE 2.7-1

Matrix of Alternatives

Alternatives	Shortage Guidelines to reduce deliveries from Lake Mead (elevations in feet msl)	Coordinated Reservoir Operations (Lake Mead & Lake Powell) (elevations in feet msl)	Intentionally Created Surplus	Interim Surplus Guidelines for deliveries/releases from Lake Mead
No Action	• Determination made through the AOP process, absent shortage guidelines • Reasonably represented by a two-level shortage strategy – probabilistic protection of Lake Mead elevation 1,050 and absolute protection of Lake Mead elevation 1,000	• Minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required • Operation at low reservoir levels reasonably represented by a 8.23 maf release from Lake Powell down to Lake Powell dead pool	• No guidelines for creation and delivery of ICS. r	• No modification or extension of the ISG which end in 2016 • After 2016, determination made through the AOP process, absent surplus guidelines; reasonably represented by the spill avoidance (referred to as the 70R Strategy)
Basis States	• Shortages (i.e., reduced deliveries) of 400,500 and 600 kaf from Lake Mead at elevations 1,075, 1,050, and 1,025 respectively • Initiate efforts to develop additional guidelines for shortages if Lake Mead falls below elevation 1,025 (Note: includes reconsultation with Basin States	• Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization release are required • Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevation at Lake Powell and Lake Mead	• Guidelines for the creation and delivery of ICS for augmentation by extraordinary conservation , system efficiency, tributary conservation and importation of non system water • Maximum total ICS in Lake Mead of 2.1 maf • System assessment of 5 percent of ICS.	• Modification of ISG to eliminate Partial Domestic Surplus condition • Extension of the modified guidelines through 2026
Conservation Before Shortage	• Shortages are implemented in any given year when necessary to keep Lake Mead above SNWA's lower intake at elevation 1,000 (absolute protection of elevation 1,000)	• Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required • Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon	• Guidelines for the creation and delivery of different volumes of ICS tied to Lake Mead elevation • Guidelines for the creation Storage and delivery of ICS for augmentation by extraordinary conservation ed, system	• Modification of ISG to eliminate Partial Domestic Surplus condition • Extension of the modified guidelines through 2026

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Alternatives	Shortage Guidelines to reduce deliveries from Lake Mead (elevations in feet msl)	Coordinated Reservoir Operations (Lake Mead & Lake Powell) (elevations in feet msl)	Intentionally Created Surplus	Interim Surplus Guidelines for deliveries/releases from Lake Mead
		elevation at Lake Powell and Lake Mead	efficiency, tributary conservation and importation of system and/or non system water • • Water for environmental uses • Maximum total ICS greater than 4.2 maf • System assessment of 5 percent of ICS	
Water Supply	• Release full annual entitlement amounts until Lake Mead is drawn down to dead pool (elevation 895)	• Minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required • Balancing if Lake Powell is below elevation 3,575 or Lake Mead is below elevation 1,075	• No guidelines for creation and delivery of ICS.	• Extension of the existing ISG through 2026
Reservoir Storage	• Shortages (i.e. reduced deliveries) of 600, 800, 1,000 and 1,200 kaf from Lake Mead at elevations 1,100, 1,075, 1,050, and 1,025 respectively	• Minimum objective release of 8.23 maf from Lake Powell if Lake Powell is above elevation 3,595 unless storage equalization releases are required • 7.8 maf release from Lake Powell between Lake Powell elevations of 3,560 and 3,595 • Balancing below Lake Powell elevation of 3,560	• Guidelines for the creation Storage and delivery of ICS for augmentation by extraordinary conservation ed, system efficiency, tributary conservation and importation of system and/or non system water • r • Maximum total ICS of 3.05 maf • System assessment of 10 percent of ICS.	• Permissive provisions of existing ISG terminate in 2007, and during period from 2008 to 2026, surplus determinations are limited to Quantified and Flood Control Conditions.

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- 24 -

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SECTIONS 3.1 THROUGH 4.2.7 ARE UNCHANGED AND INTENTIONALLY OMITTED.

4.2.8 Modeling Assumptions Specific to Alternatives

Each alternative includes specific assumptions with regard to the four operational elements of the proposed federal action. Assumptions with regard to Shortage Guidelines, Coordinated Reservoir Operations, and the ISG were presented in Chapter 2 and are detailed in Appendix A. In this section, the assumptions with regard to the Creation and Delivery of ICS element are summarized. Details of these assumptions are presented in Appendix M.

Modeling Assumptions Regarding Creation and Delivery of ICS. The general concept of creation and delivery of ICS is that water users could conserve system water or non-system water and order equivalent quantities of water in Lake Mead to be delivered in non-shortage years, subject to specified losses and other conditions. .

Three alternatives assume ICS guidelines (Basin States Alternative, Conservation Before Shortage Alternative, and Reservoir Storage Alternative). Each alternative specifies the maximum amount of ICS that can be created during any year, the maximum amount of ICS that may be recovered during any year, and the maximum cumulative amount of ICS that can be available at any one time (Tables 2.3-2, 2.4 1, and 2.6-1). These volume limitations are recognized in the model as are other rules that specify under which water supply conditions ICS may be delivered.

Under all three alternatives, it is assumed that specific losses would be applied to the ICS in Lake Mead, including a one-time system assessment, and yearly evaporation losses. At the time the ICS is created, the entity that generates the ICS is required to dedicate a percent of the ICS to the system, defined as a system assessment, on a one-time basis to provide a water supply benefit to the system. For the Basin States Alternative and the Conservation Before Shortage Alternative, the system assessment is assumed to be five percent. For the Reservoir Storage Alternative, the system assessment is assumed-to be ten percent. Additionally, ICS in Lake Mead is subject

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to annual evaporation losses which are assumed to be three percent per year. The exception to this is during Shortage conditions, when no evaporation loss is applied.

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At this time, it is unknown which entities might participate in an ICS program. Furthermore, the timing and magnitude of the creation and delivery of ICS is unknown. However, modeling assumptions with respect to the entities that might participate and their respective level of participation were needed to enable the evaluation of the ICS program and its potential effects on environmental resources, particularly to reservoir storage and river flows below Lake Mead.

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Table 4.2-3 summarizes the modeling assumptions with regard to the entities that were assumed to participate under each alternative, the activities undertaken to create ICS, and the water supply conditions under which ICS could occur. Appendix M further describes these and other key modeling assumptions. The proposed federal action is for the purpose of adopting additional operational strategies to improve the Department's annual management and operation of key Colorado River reservoirs. However, in order to assess the potential effects of the proposed federal action in this Draft EIS, certain modeling assumptions are used that display projected water deliveries to Mexico. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current or future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State 1.

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Under the Conservation Before Shortage Alternative, extraordinary conservation is assumed to occur during voluntary shortage conditions but not during involuntary shortage conditions.

Notwithstanding the lack of an existing mechanism to implement such modeling assumptions, Reclamation utilized these assumptions for a number of reasons, including the following: (1) a larger volume of potential storage in Lake Mead is identified and the associated impacts are thereby analyzed; (2) the maximum potential changes to river flows below Hoover Dam are identified and the associated

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impacts analyzed; (3) the assignment of water conservation amounts to entities in the Lower Basin states in excess of amounts currently requested by each state is avoided; and (4) a program of potential future cooperation between the United States and Mexico is identified.

mechanism in place. For each alternative, the inclusion of the mechanism has the effect of decreasing the probability of shortages. Under the Basin States and Conservation Before Shortage alternatives the probability of shortage is reduced an average of about five percent from 2010 through 2026. Under the Reservoir Storage Alternative the reduction is greater, an average of 12 percent from 2010 through 2026, due to the greater amount of storage credits that are assumed to be generated under this alternative.

Table 4.2-3
Modeling Assumptions Creation and Delivery of ICS

		BS, CBS &RS[1]						CBS & RS	CBS	RS
		California	Arizona	Nevada				Mexico	Federal	Federal
Water Supply Condition		Extraordin Conservati	Extraordin Conservati	Tributary Conservati	Groundwat	Desalinizati	Drop 2 Reservoir	Extraordina Conservati	Extraordin Conservat	Extraord Conserva
Flood Control Surplus	Store	No	No	No	No	No	No	No	No	No
	Deliver	No	No	No	No	No	No	No	No	No
Quantified (70R) Surplus	Store	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes
	Deliver	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Full Domestic Surplus	Store	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes
	Deliver	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Normal	Store	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Deliver	Yes	yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shortage (involuntary voluntary)	Store	No	No	Yes	Yes	Yes	No	No	No[3]	Yes
	Deliver	No	No	Yes	Yes	Yes	No	No	No	Yes
System Assessment		Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Period of Activity		2006-2026	2017-2026	2009-2060	2009-2060	2020-2060	Temporary	2008-2026	2008-	2008-

Notes:

1. *BS = Basin States Alternative, CBS = Conservation Before Shortage Alternative,* RS = Reservoir *Storage Alternative*
2. *yes = activity assumed to occur*
3. *no = activity assumed to not occur*
4. *Beginning in 2012, Nevada is assumed* to *receive 40 kafy of the water conserved by the Drop* 2 *Reservoir during*

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Normal and Surplus years until a total of 300 kaf has been credited to Nevada. Thereafter, water conserved by the Drop 2 Reservoir is assumed to be system water.
5. *Under the Conservation Before Shortage Alternative, extraordinary conservation is assumed to be undertaken by the federal government during voluntary shortage conditions but not during involuntary shortage conditions*
6 *These modeling assumptions do not reflect policy decisions and are not intended to constitute an interpretation or application of the 1944 Treaty. They have been developed for comparison of the alternatives.*

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4.4.4.1 Shortage Conditions

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Sensitivity of Shortage Conditions to the Creation and Delivery of ICS. The ICS program assumed as part of the Basin States, Conservation Before Shortage and Reservoir Storage Alternatives impacts the probability of shortage occurrences. Because a potential effect of the ICS program is an increase in the amount of water in Lake Mead, a Shortage condition is likely to occur less often with the ICS guidelines in place. Figure 4.4-7 presents the sensitivity of the occurrence of a Shortage condition to the creation and delivery of ICS by comparing these three alternatives with and without the ICS guidelines in place. For each alternative, the inclusion of ICS has the effect of decreasing the probability of Shortages. Under the Basin States and Conservation Before Shortage alternatives, the probability of Shortage is reduced an average of about five percent from 2010 through 2026. Under the Reservoir Storage alternative the reduction is greater, an average of 12 percent from 2010 through 2026, due to the greater amount of ICS that is assumed to be generated under this alternative.

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Figure 4.4-7
Involuntary and Voluntary Lower Basin Shortages
Comparison of Action Alternatives With and Without ICS
Probability of Occurrence of any Amount
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4.4.4.2 Surplus Conditions

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A Surplus condition exists in a particular year when the Secretary determines that there is sufficient mainstream water available to satisfy in excess of 7.5 maf of consumptive use in the Lower Division states. The elements of the proposed federal action include a modification and/or extension of the ISG and each alternative expresses a particular assumption for determining Surplus conditions (Chapter 2).

Probability of Surplus of Any Amount. Figure 4.4-8 compares the probabilities of Surplus conditions between the alternatives. For the No Action Alternative, the probability of surplus drops from about 40 percent to 20 percent in 2017 due to the expiration of the ISG. For the Basin States, Conservation Before Shortage and Water Supply alternatives, the probabilities of surplus are between 30 percent and 40 percent through 2026 since they assume an extension of some provisions of the ISG. Probabilities for the Basin States and Conservation Before Shortage alternatives are lower compared to the Water Supply Alternative, however, since both assume that the ISG would be modified and the more permissive provisions (e.g., Partial Domestic Surplus) would be eliminated. For the Reservoir Storage Alternative, surplus determinations are limited to Quantified Surplus (70R Strategy).and Flood Control Surplus conditions, beginning in 2008, and that assumption is reflected in the lower probabilities compared to the other action alternatives throughout the interim period. The probabilities for all alternatives converge to between 10 percent and 20 percent after the interim period since they all revert to the No Action Alternative assumptions after 2026.

Probability of Various Types of Surplus. Figure 4.4-9 presents a comparison of the probability of occurrence of the Partial Domestic Surplus condition for each alternative. The probability is zero for the Basin States, Conservation Before Shortage and Reservoir Storage alternatives since no provisions for Partial Domestic Surplus are contained in those alternatives. The probability of Partial Domestic Surplus for the No Action and the Water Supply alternatives are identical through 2016. After 2016, the probability of Partial Domestic Surplus under the No Action Alternative drops to zero since the ISG expire, while the Water Supply Alternative assumes an extension of the existing ISG through 2026.

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Figure 4.4-10 presents a comparison of the probability of occurrence of the Full Domestic Surplus condition for each alternative. The probability is zero for the Reservoir Storage Alternative since it does not include a provision for this condition. The probability of Full Domestic Surplus for the No Action and Water Supply alternatives are nearly identical through 2016 since they have the same assumptions during that period, with the Water Supply Alternative continuing the Full Domestic Surplus provision through 2026. The Basin States and Conservation Before Shortage alternatives also have nearly identical probabilities through 2026 since they have the same assumptions during that period. The probabilities for the Basin States and Conservation Before Shortage alternatives are slightly higher than the No Action and Water Supply alternatives since they do not have a provision for Partial Domestic Surplus. This keeps the reservoir slightly higher increasing the chance of a Full Domestic Surplus determination.

Figure 4.4-11 presents a comparison of the probability of the Quantified (70R) Surplus condition for each alternative. The probabilities for the No Action, Basin States, Conservation Before Shortage, and Water Supply alternatives are nearly identical, with the Reservoir Storage Alternative being slightly higher since it tends to keep the reservoir at higher elevations.

Figure 4.4-12 presents a comparison of the probability of the Flood Control Surplus condition for each alternative. The probabilities for the No Action, Basin States, Conservation Before Shortage, and Water Supply alternatives are nearly identical, with the Reservoir Storage Alternative being slightly higher since it tends to keep the reservoir at higher elevations.

Sensitivity of Surplus Conditions to Creation and Delivery of ICS. The ICS program assumed as part of the Basin States, Conservation Before Shortage and Reservoir Storage alternatives impacts the probability of Surplus occurrences. Because a potential effect of the ICS guidelines is an increase in the amount of water in Lake Mead, a Surplus condition is likely to occur more often with the ICS guidelines in place.

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Figure 4.4-13 presents the sensitivity of the occurrence of a Surplus condition to the creation and delivery of ICS by comparing these three alternatives with and without the ICS program in place. For each alternative, the inclusion of the ICS program has the effect of slightly increasing the probability of a surplus. The maximum increase is about five percent under the Basin States and Conservation Before Shortage alternatives and occurs in 2011. The maximum increase is about four percent under the Reservoir Storage Alternative, occurring in 2014 and 2015.

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Figure 4.4-7
Surplus Deliveries to Lower Basin States
Comparison of Action Alternatives With and Without ICS
Probability of Occurrence

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4.4.5 Total Water Deliveries to the Lower Division States

This section presents the simulated water deliveries to the three Lower Division states. Deliveries to each state may deviate from a state's apportionment due to Surplus or Shortage conditions as well as the creation and delivery of ICS to and from Lake Mead. For the alternatives that do not include some form of ICS (the No Action Alternative and the Water Supply Alternative), water deliveries above or below a state's apportionment occur only during Surplus conditions or Shortage conditions respectively. Water deliveries under the Basin States, Conservation Before Shortage and Reservoir Storage alternatives in excess of a state's apportionment can occur due to a Surplus conditions as well as when ICS is delivered. Also under these alternatives, water deliveries less than a state's apportionment can occur due to a Shortage condition as well as when water is being created within that state under the ICS guidelines. In the following sections, the modeled water deliveries are presented with and without the ICS program to facilitate understanding of the differences.

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4.4.5.1 Total Water Deliveries to Arizona

This section presents the simulated water deliveries to Arizona under the No Action Alternative and the action alternatives.

No Action Alternative. Water deliveries to Arizona are projected to fluctuate throughout the 53-year period of analysis reflecting variations in hydrologic conditions. The 90th, 50th' and 10th percentile ranking of modeled water deliveries to Arizona under the No Action Alternative are presented in Figure 4.4-16. Since the No Action Alternative does not include an ICS program, deviations from annual deliveries of 2.8 mafy are due to Shortage and Surplus conditions.

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The 90th percentile line generally coincides with Arizona's depletion schedule during full surplus water supply conditions. The exceptions to this are the periods from 2008 through 2014 and 2055 through 2060. As indicated by this 90th percentile line, the probability that the No Action Alternative would provide Arizona's full surplus depletion schedule is at least 10 percent for the period 2015 through 2055.

The 50th percentile line represents the median annual depletion values. This 50th percentile line generally coincides with Arizona's projected depletion schedule under Normal conditions through year 2028. After 2028, the median annual Arizona modeled depletion values fluctuate between 2.41 maf and 2.80 maf.

The 10th percentile line represents the depletion values above which 90 percent of the annual depletion values were observed. The 10th percentile annual depletion values were 2.80 maf from 2008 through 2010, approximately 2.4 maf from 2011 through 2037. After 2037, the 10th percentile annual depletion values fluctuated between 2.17 maf and 2.33 maf.

Comparison of Action Alternatives Without ICS Guidelines to No Action Alternative. Figure 4.4-17 provides a comparison of the cumulative distribution of Arizona's depletions under the action alternatives without the ICS Guidelines to those of the No Action Alternative during the interim period (years 2008 through 2026). The results presented in Figure 4.4-17 can be used to compare how often Arizona

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might expect deliveries above and below its 2.8 mafy apportionment due to Surplus and Shortage conditions under the different alternatives.

Figure 4.4-17
Arizona Modeled Annual Depletions
Comparison of Action Alternatives (Without ICS Guidelines) to No Action Alternative
Years 2008 through 2026
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Figure 4.4-18 provides a similar comparison of the cumulative distribution of water deliveries to Arizona under the action alternatives without the ICS Guidelines to those of the No Action Alternative for the 34-year period (years 2027 through 2060) that would follow the interim period.

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Sensitivity of Total Water Deliveries to Arizona to Creation and Delivery of ICS Arizona water deliveries under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives are impacted by the modeling assumptions made to postulate potential future participation in an ICS program (Appendix M). This section isolates the impacts of those assumptions on Arizona's modeled depletions.

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Figure 4.4-18
Arizona Modeled Annual Depletions
Comparison of Action Alternatives (Without ICS Guidelines) to No Action Alternative
Years 2027 through 2060
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Figure 4-4.19 provides a comparison of the cumulative distribution of Arizona's depletions under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, with and without the ICS program in place during the interim period. With the ICS program in place, deliveries of approximately 2.7 mafy are due

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to the storage of conserved water. With the ICS program, removed, occurrences of deliveries less than 2.8 mafy or greater than 2.8 mafy reflect only Shortage or Surplus conditions respectively. These observations mirror the effects of the ICS program on the probability of voluntary and involuntary total Lower Basin Shortage and Surplus Conditions presented in the previous subsection.

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Figure 4-4.20 provides a comparison of the cumulative distribution of Arizona's depletions under the action alternatives that include the creation and delivery of ICS with and without the ICS program in place for the 34-year period that would follow the interim period. There is almost no effect of the ICS program during these years as it is assumed only ICS previously created may be delivered during this period.

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4.4.5.2 Total Water Deliveries to California

4.4.5.3 Total Water Deliveries to Nevada

4.4.6 Water Deliveries to Mexico

4.4.8 Summary

The following conclusions were drawn from the analyses of water deliveries.

4.4.8.1 Normal Conditions

All of the action alternatives improve water supply conditions during the interim period relative to the No Action Alternative, improve the probability that normal deliveries will be met, and reduce the probability that Shortage condition deliveries will occur. The differences between the action alternatives and the No Action

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Alternative, in terms of the probability of occurrence for Normal conditions water supply deliveries, diminish after 2027 and converge by about 2038.

4.4.8.2 Surplus Conditions

The Water Supply Alternative exhibits the same probability of Surplus condition deliveries as the No Action Alternative (between about 30 to 40 percent) between 2008 and 2016 due to the provisions for the Partial Domestic Surplus as provided in the ISG. The ISG provisions terminate under the No Action Alternative in 2016. These conditions are retained in the Water Supply Alternative through 2026 and therefore this alternative consistently provides the highest probability of Surplus condition deliveries during the interim period. The Reservoir Storage Alternative exhibits the lowest probabilities (between about 10 to 20 percent) during the interim period because surplus determinations are limited to Quantified and Flood Control Surplus conditions beginning in 2008. The surplus provisions under the Basin States and Conservation Before Shortage alternatives are similar and the probability of Surplus conditions between 2010 and the probability of occurrence through 2016 is slightly less than under the No Action • Alternative due to the absence of the Partial Domestic Surplus provision in these two alternative. After the end of the interim period in 2026 the probability for all alternatives converges to between 10 and 20 percent.

The ICS program assumed as part of the Basin States, Conservation Before Shortage and Reservoir Storage alternatives has the effect of increasing the occurrence of a Surplus Condition. The maximum increase observed is about four to five percent occurring in one to two years.

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4.4.8.3 Shortage Conditions

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The ICS program assumed as part of the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives has the effect of decreasing the occurrence of

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S-4

shortages. The greatest reduction during the interim period occurs in the Reservoir Storage Alternative (about 12 percent) as it is assumed that a larger amount of ICS is created under this alternative. The Conservation Before Shortage Alternative is assumed to create a larger amount of ICS than the Basin States Alternative, resulting in a shortage probability of about two to three percent less during the interim period.

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5.1.29 Cumulative Impacts by Resource

5.1.29.1 Hydrologic Resources and Water Delivery

SNWA's development of pre-BCPA water rights on the Virgin River and Muddy River, and the development of Coyote Spring Valley groundwater could potentially result in increased flows into Lake Mead, and increased deliveries from Lake Mead, under the ICS Guidelines element of the proposed federal action. These hydrologic effects were included in the modeling conducted for this EIS, and these impacts are already included in the analysis in Sections 4.3 and 4.4. Similarly, the increase in return flows to Lake Mead for the northern Nevada groundwater projects were also included in the hydrologic analysis.

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The LCR MSCP would not result in any cumulative effects because it would not alter water system operations.

The Drop 2 Reservoir Project would result in a reduction in over-deliveries to Mexico. These hydrologic effects were included in the hydrologic modeling for Lake Mead conducted for this EIS, and any resulting impacts are already included in the analysis in Sections 4.3 and 4.4.

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Appendix M

Modeling Assumptions:
Creation and Delivery of Intentionally Created Surplus

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Three of the action alternatives assume the creation and delivery of intentionally created surplus ("ICS") derived from extraordinary conservation system efficiency projects, tributary conservation and importation of non-system water (the Basin States, Conservation Before Shortage and Reservoir Storage alternatives). This appendix describes the modeling assumptions used in the CRSS regarding the activities assumed to generate ICS and the conditions under which the ICS is assumed to be created and delivered.

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M.1 Introduction

At this time, it is unknown which entities might participate in the Intentionally Created Surplus ("ICS") program that allows the creation and delivery of ICS derived from extraordinary conservation, system efficiency projects, tributary conservation or importation of non-system water. Furthermore, the timing and magnitude of the creation and delivery of ICS is unknown. However, modeling assumptions with respect to the entities that might participate and their respective level of participation were needed to enable the evaluation of the ICS program and its potential effects on environmental resources, particularly to reservoir storage and river flows below Lake Mead.

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The proposed federal action is for the purpose of adopting additional operational strategies to improve the Department's annual management and operation of key Colorado River reservoirs. However, in order to assess the potential effects of the proposed federal action in this Draft EIS, certain modeling assumptions are used that display projected water deliveries to Mexico. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current or future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State. [1]

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For two of the action alternatives (the Conservation Before Shortage Alternative and the Reservoir Storage Alternative), it was assumed that ICS would be created and used for environmental purposes. These modeling assumptions were utilized in this Draft EIS in order to analyze the potential impacts to environmental resources of the ICS program, particularly with regard to reservoir elevations and river flow impacts. The use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, these releases could be made under current administration of the river.

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M.2 General Modeling Assumptions

Three alternatives assume the creation and delivery of ICS (the Basin States, Conservation Before Shortage and Reservoir Storage alternatives). This section explains the general modeling assumptions

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regarding how ICS is created and delivered within the CRSS model. Examples of the accounting for ICS within the model are also presented below.

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[1] Notwithstanding the lack of an existing mechanism to implement such modeling assumptions, Reclamation utilized these assumptions for a number of reasons, including the following: (1) a larger volume of potential storage in Lake Mead is identified, (2) the maximum potential impacts on river flows below Hoover Dam are identified, (3) the alternative proponent's recommendations as to participating entities and levels of participation are modeled, (4) the arbitrary assignment of water conservation amounts to entities in the Lower Basin states is avoided, and (5) a program of potential future cooperation between the United States and Mexico is identified.

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M.2.1 Creation of ICS

When ICS is created, the model assumes either a delivery from Lake Mead is decreased or a new gain to the system is introduced, resulting in an increase to Lake Mead storage. If the reduced delivery is located downstream of Lake Mead, creation of the ICS results in a reduction in the release from Lake Mead and river flow downstream.

At the beginning of each year, the model assumes that ICS will be generated based on annual schedules and that the scheduled amount does not change throughout the year. The ability to create ICS in Lake Mead is assumed to be in effect from 2008 through 2026 (i.e., ICS is assumed to not be created in Lake Mead after 2026).

The activity resulting in the creation of ICS is assumed to originate from a point on the river located furthest downstream in order to evaluate the maximum effects of the creation and delivery of ICS on river flows. In general, ICS created for use by a particular state is assumed to be created by an entity within that state that had an annual depletion schedule sufficiently large enough to accommodate the reductions. In the case of the Conservation Before Shortage and Reservoir Storage alternatives, which assume creation and delivery of ICS for Mexico and the federal government, these activities were assumed to occur within Mexico because this is the last major user in the lower part of the river and again, this permitted evaluation of the potential effects on river flow reductions.

A one-time system assessment is assumed to be dedicated to the system upon the creation of ICS. The system assessment is assumed to be five percent of the volume of ICS created for the Basin States and Conservation Before Shortage alternatives. For the Reservoir Storage Alternative, the system assessment is assumed to be ten percent of the volume of ICS created. For example, if an entity wishes to create 100 kaf of ICS, then the ICS that must be created becomes: 100 kaf / (1 system assessment).

The model assumes that the accounting of ICS occurs annually, at the end of the year. ICS in Lake Mead is assumed to be subject to the following rules:

- An annual 3 percent deduction for evaporation. The deduction occurs at the end of the year and is based on the available ICS at the beginning of the year.
- No evaporation deductions occur during Shortage conditions.
- In the event of a flood control release, ICS is eliminated and stored water reverts to the system.
- The total volume of ICS in Lake Mead at any given time is not included in the determination of a Quantified Surplus using the 70R Strategy.
- The amount of ICS that may be generated in a single year is constrained by assumed maximum annual and maximum total limits. These assumed limits vary by alternative and are presented in Section M.3.

M.2.2 Delivery of ICS

When ICS is delivered from Lake Mead, the model assumed that a delivery from Lake Mead was increased for that year, resulting in a decrease in Lake Mead storage. If the increased delivery is located downstream of Lake Mead, delivery of

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the ICS results in an increase in the release from Lake Mead and river flow downstream.

At the beginning of each year, the model assumes that ICS will be delivered based on annual schedules and that the scheduled delivery amount does not change throughout the year. Although the ability to create ICS in Lake Mead is assumed to be in effect from 2008 through 2026 (i.e., ICS may not be created in Lake Mead after 2026), a IO-year period (from 2027 through 2036) was assumed for entities to take any ICS remaining after the end of the interim period.

After 2026, some conservation activities assumed to be undertaken by Nevada are assumed to continue through 2060 (tributary conservation, groundwater return flows, and desalinization described further in Section M.3.1). The model assumes delivery of that water to Nevada in the year that the conservation occurs.

M.2.3 Examples of ICS Accounting

Table M-I provides an example of ICS accounting in CRSS. A "put" refers to the creation of ICS. A "take" is the delivery of ICS. Although most calculations in CRSS occur on a monthly basis, the model calculates available ICS annually, at the end of the year. At the end of year n, the balance of ICS is determined as,

$$Balance_n = Balance_{n-1} + Put(1- Assessment\%) - Take - Evap\%(Balance_{n-1})$$

Table M-1
Example of ICS Accounting (af)

Year	Put	Assessment[1]	Put Adjusted for Assessment	Requested Take	Actual Take	Evaporation	Balance
1	0	0	0	0	a	a	0
2	200,000	10,000	190,000	0	0	0	190,000
3	100,000	5,000	95,000	50,000	50,000	5,700	229,300
4	0	0	a	200, 000	200,000	6,879	22,421
5	0	0	0	50.000	21,748	673	0

1 Assuming a system assessment of five percent

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Year 1: The ICS balance is zero and there is no activity for this year.

Year 2: A put of 200 kaf is scheduled for this year. There is a 200 kaf reduction in delivery for this year. Assuming a system assessment of 5 percent, 190 kaf of ICS is generated for this year and 10 kaf (five percent of 200 kaf) is credited to the system. There are no takes scheduled. Evaporation is counted as 3 percent of the previous year's balance. Because the balance in Year 1 is 0, there is no evaporation loss deducted in Year 2.

Year 3: Applying the scheduled put and take values to the equation above a balance of 229,300 is created.

$$229{,}300 = 190{,}000 + 100{,}000(1-0.05) - 50{,}000 - 0.03(190{,}000)$$

Year 4: Applying the scheduled put and take values to the equation above a balance of 22,421 is created.

$$22{,}421 = 229{,}300 + 0(1-0.05) - 200{,}000 - 0.03(229{,}300)$$

Year 5: The requested take is higher than the available ICS. Therefore the actual take is constrained by the available credits to be 21,748 af.

M.3 Modeling Assumptions Specific to Alternatives

Modeling assumptions with respect to the entities that might participate and their respective level of participation were needed to enable the evaluation of the potential effects of the ICS program for each alternative. These assumptions include the maximum amount of ICS that may be created during any year, the maximum amount of ICS that may be delivered during any year, and the maximum total amount of ICS that may be available at anyone time. In addition, assumptions with regard to the timing and magnitude of the creation and delivery of ICS are needed. The assumptions made for each alternative are detailed in the following sections.

M.3.1 Basin States Alternative

As discussed in Section 2.3, the Basin States Alternative assumes the levels of participation as shown in Table M-2.

Table M-2
Basin States Alternative Volume limitations on Creation and Delivery of ICS

Entity	Maximum Annual Creation of ICS (kaf)	Maximum Cumulative Total ICS (kaf)	Maximum Annual Delivery of ICS (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Total	625	2,100	1,000

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These volume limitations are recognized in CRSS as are other rules that specify under which water supply conditions ICS may be created or delivered, as summarized in Section M.3.4. The schedules for Arizona, California and Nevada were provided by the Arizona Department of Water Resources (ADWR), the Metropolitan Water District of Southern California (MWD) and the Southern Nevada Water Authority (SNWA), respectively, and are detailed below.

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M.3.1.1 ***Arizona***

In order to analyze the maximum effects on river flows, the model assumes that Arizona ICS is generated through extraordinary conservation by the Yuma County Water Users Association and are delivered to CAP. According to the creation and delivery schedules provided by ADWR, the creation of ICS begins in 2017, as shown in Table M-3. It was assumed that ICS is created and delivered only during otherwise Normal conditions.

M.3.1.2 ***California***

In order to analyze the maximum effects on river flows, the model assumes that California ICS is created through extraordinary conservation by the Imperial Irrigation District and is delivered to MWD. Schedules for the creation and delivery of ICS were provided by MWD. Ninety-nine (99) schedules were provided, corresponding to the 99 hydrologic traces used in the ISM simulations (Section 4.2). As an example, one of these schedules is presented in Table M-3. In 2008 California is assumed to begin with an ICS balance of 100 kaf due to pilot programs in place in 2006 and 2007. It was assumed that ICS is created and delivered only during otherwise Normal conditions.

M.3.1.3 ***Nevada***

As provided by SNWA, four different conservation activities are assumed to be undertaken by Nevada to generate ICS. Each activity is subject to different assumptions as to when ICS may be created, and used as described below. The schedules provided by SNWA are shown in Table M-3.

Tributary Conservation. It was assumed that water from extraordinary conservation on the Muddy and Virgin Rivers would generate ICS. This activity is assumed to be in place during the period from 2009 through 2060. In the CRSS model, a gain to Lake Mead was introduced as the source of these ICS and it is assumed that delivery is taken by SNWA from Lake Mead. In general, it was assumed that ICS may be created during all water supply conditions (except the Flood Control Surplus condition) and may be delivered during Normal and Shortage conditions. However, it was also assumed that SNWA would take ICS during a Full Domestic Surplus condition if needed to avoid exceeding the maximum cumulative total amount of ICS. After 2026, it is assumed that the tributary conservation ICS would continue to be created each year and would be delivered in the same year. The system assessment is assumed to be in effect through 2060.

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Groundwater. SNWA return flows originating from Nevada groundwater development projects are assumed to be available during the period from 2009 through 2060. In the CRSS model, a gain to Lake Mead was introduced as the source of groundwater and it is assumed that delivery is taken by SNWA from Lake Mead. It was assumed that groundwater return flows are stored and delivered only during Normal and Shortage conditions. After 2026, it is assumed that the groundwater return flows would continue to be created each year and would be used in the same year. The system assessment for groundwater is assumed to be in effect through 2060.

Desalinization. SNWA is assumed to receive water generated from desalinization beginning in 2012 through 2060. To account for water created through desalinization, a gain was introduced to the system below Imperial Dam. Desalinization water is assumed to be generated and taken during all water supply conditions except during Flood Control Surplus conditions. After 2026, it is assumed that the desalinization water would continue to be created each year and would be delivered in the same year. The system assessment for desalinization is assumed to be in effect through 2060.

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Drop 2 Reservoir. As discussed in Section 4.2.7, the proposed Drop 2 Reservoir is assumed to be in operation beginning in 2010 and to conserve an average of 69 kafy, reducing the average over-delivery to Mexico from 77 kafy to 8 kafy under all alternatives. Under the three action alternatives that assume the creation and delivery of ICS, SNWA is assumed to create and receive delivery of ICS conserved by the Drop 2 Reservoir beginning in 2013 during Surplus (excluding the Flood Control Surplus condition) and Normal conditions. A system assessment is not applied to Drop 2 Reservoir ICS. Nevada takes delivery of Drop 2 Reservoir ICS at a maximum rate of 40 kaf each year until a total of 300 kaf has been taken. Thereafter, water conserved by the Drop 2 Reservoir is assumed to be system water.

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Table M-3
Assumed ICS Creation and Delivery Schedules for Conservation Activities Under the Basin States Alternative¹

YEAR	Arizona Extraordinary Conservation (af)		California[2] Extraordinary Conservation (af)		Tributary Conservation (af)		Nevada Groundwater (af)		De
	CREATE	DELIVER	CREATE	DELIVER	CREATE	DELIVER	CREATE	DELIVER	CRE
2008	0	0	400,000	0	0	0	0	0	
2009	0	0	400, 000	0	30 ,000	5,000	13,000	13,000	
2010	0	0	400,000	0	30,000	5,000	13,000	13,000	
2011	0	0	400,000	0	30,000	5,000	13,000	13,000	
2012	0	0	400,000	0	30,000	5,000	13,000	13,000	
2013	0	0	400,000	0	30,000	5,000	13,000	13,000	
2014	0	0	100,000	0	30,000	5,000	13,000	13,000	
2015	0	0	0	0	30,000	5,000	13,000	13,000	
2016	0	0	300,000	0	30,000	5,000	13,000	13,000	
2017	100,000	0	400,000	0	30,000	5,000	13,000	13,000	
2018	100,000	0	300,000	0	30,000	5,000	13,000	13,000	
2019	100,000	0	200,000	0	30,000	5,000	13,000	13,000	
2020	0	300,000	0	100,000	30,000	5,000	80,000	80,000	75,
2021	100,000	50,000	0	100,000	30,000	5,000	80,000	80,000	75,
2022	100,000	0	0	200,000	30,000	5,00il	80,000	80,000	75,
2023	100,000	0	0	0	30,000	5,000	80,000	80, 000	75,
2024	50,000	0	100,000	0	30,000	5,000	80, 000	80,000	75,

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Table M-3
Assumed ICS Creation, and Delivery Schedules for Conservation Activities Under the Basin States Alternative[1]

	Arizona		California'		Nevada					
	Extraordinary)' Conservation (all		Extraordinary' Conservation (af)		Tributary Conservation (af)		Groundwater (af)		Desaliniz	
YEAR	CREATE	DELIVER	CREATE	DELIVER	CREATE	DELIVER	CREATE	DELIVER	CREATE	
2025	0	50,000	0	100,000	30,000	30,000	80,000	80,000	75,000	[illegible]
2026	0	50,000	0	400,000	30,000	30,000	80,000	80,000	75,000	[illegible]
2027	0	50,000	0	300,000	30,000	30,000	80,000	80,000	75,000	[illegible]
2028	0	50,000	0	200,000	30,000	30,000	80,000	80,000	75,000	[illegible]
2029	0	50,000	0	0	30,000	30,000	80,000	80,000	75,000	[illegible]
2030	0	50,000	0	0	30,000	30,000	80,000	80,000	75,000	[illegible]
2031	0	50,000	0	400,000	30,000	30,000	80,000	80,000	75,000	[illegible]
2032	0	50,000	0	400,000	30,000	30,000	80,000	80,000	75,000	[illegible]
2033	0	50,000	0	400,000	30,000	30,000	80,000	80,000	75,000	[illegible]
2034	0	50,000	0	400,000	30,000	30,000	80,000	80,000	75,000	[illegible]
2035	0	50,000	0	400,000	30,000	30,000	80,000	80,000	75,000	[illegible]
2036	0	50,000	0	400,000	30,000	30,000	80,000	80,000	75,000	[illegible]
2037	0	0	0	0	30,000	30,000	80,000	80,000	75,000	[illegible]
2038	0	0	0	0	30,000	30,000	80,000	80,000	75,000	[illegible]
2039	0	0	0	0	30,000	30,000	80,000	80,000	75,000	[illegible]
2040	0	0	0	0	30,000	30,000	80,000	80,000	75,000	[illegible]
2041	0	0	0	0	30,000	30,000	80,000	80,000	75,000	[illegible]
2042	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2043	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2044	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2045	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2046	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2047	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2048	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2049	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2050	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2051	0	0	0	0	30,000	30,000	80,000	80,000	75,000	[illegible]
2052	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2053	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2054	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2055	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2056	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2057	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2058	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000
2059	0	0	0	0	30,000	30,000	80,000	80,000	75,000	75,000

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2060	0	0	0	0	30,000	30,000	80,000-	80,000	75,000	75,000

[1] *Actual modeled delivery amounts may be less depending on availability, system assessment and evaporation losses.*

[2] *Reclamation was provided 99 distinct creation and delivery schedules by MWD to be used with the Index Sequential Method The schedule in this table is an example of one schedule corresponding to one hydrologic sequence.*

M.3.2 Conservation Before Shortage

As discussed in Section 2.4, the Conservation Before Shortage Alternative assumes the levels of participation as shown in Table M-4.

Table M-4
Conservation Before Shortage Alternative Volume limitations of ICS Creation and Delivery

Entity	Maximum Annual Creation Storage of ICS (kaf)	Maximum Cumulative Total ICS (kaf)	Maximum Annual Delivery of ICS or (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Unassigned	825	2100	600
Total	1,450	4,200	1,600

These volume limitations are recognized in CRSS as are other rules that specify under which water supply conditions ICS may be created or delivered as summarized in Section M.3.4. The schedules for the Conservation Before Shortage Alternative for the participation of the Lower Division states were assumed to be identical to those used in the Basin States Alternative (Table M-3). The schedules for the expanded participation by other entities (Unassigned in Table M-4) were provided by the NGOs and are detailed below.

The Conservation Before Shortage proposal includes voluntary, compensated reductions in water use prior to the imposition of involuntary shortages (Section 2.4). To model this proposal, it was assumed that ICS of 400, 500 and 600 kafy would be created when Lake Mead was at specific elevations within the range of 1,075 feet msl and 1 ,025 feet msl, as described in Section 2.4.3. For modeling purposes and to maximize river flow effects, this ICS were assumed to be created via extraordinary conservation within Mexico. The system assessment is applied when this ICS is created and it was assumed that this ICS would remain in Lake Mead and would be counted toward the replacement of the bypass flows to the Cienega de Santa Clara in Mexico.

The model maintains an accounting for the bypass flow replacement. In each year, the model releases 109 kaf (Section 4.2.6) for the bypass flows and deducts that amount from the bypass flow replacement account. Any deficit that accumulates in the account is tracked and offset at a later time when Lake Mead is below elevation 1,075 feet msl and ICS is created. The maximum positive volume for the account is assumed to be 1.5 maf and any additional ICS that is

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created above that amount is assumed to convert to system water. Evaporation losses are applied to any positive balance in the account at the end of each year.

The NGOs also postulated that ICS would be created by Mexico and be used for the purpose of environmental flows in Mexico. This ICS would be subject to the system assessment and evaporation losses and would be created and delivered during Surplus or otherwise Normal conditions, but not during Flood Control Surplus or Shortage conditions. Two sets of environmental flows are assumed to occur. The first are pulse flows to the Colorado River Delta flowing into the Gulf of California, assumed to occur every five years after the last flood control release, with the first flow scheduled for 2012 (referred to as "Delta Pulse Flows" in Table *M-5)*. Each year, ICS of 50 kaf is assumed to be created. Delta pulse flows are of magnitude 250 kaf; however, in the fifth year ICS of 50 kaf is assumed to be created and delivered in the same year and a system assessment is not applied. The model assumes that Delta pulse flows would flow past the NIB and are counted as part of Mexico's delivery. The second set of environmental flows (termed "Other Environmental Flows Below NIB" in Table *M-5)* is assumed also to occur every five years, with the first scheduled for 2010 at a volume of 80 kaf. Each year 40 kaf of ICS is scheduled to be created for these flows. After 2010, these flows increase to a volume of 200 kaf and similar to the Delta pulse flows, in the fifth year ICS of 40 kaf is assumed to be created and delivered in the same year. The model also assumes that this water would flow past the NIB and is counted as part of Mexico's delivery.

The NGOs postulated an additional activity to create 100 kafy of ICS to be delivered for environmental uses within the United States (termed "Additional Environmental Uses" in Table M-S). It was assumed that this ICS would be created and delivered during otherwise Normal and Surplus conditions and would be subject to the system assessment and evaporation losses. For modeling purposes and to maximize river flow effects, this ICS was also assumed to be generated via extraordinary conservation within Mexico.

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The assumed schedules for these activities are presented in Table *M-5*.

Table M-5
Assumed ICS Creation and Delivery Schedules for
Other Conservation Activities Under the Conservation Before Shortage Alternative[1]

Year	Delta Pulse Flows		Other Environmental Flows Below NIB		Additional Environmental Uses	
	CREATE	DELIVER	CREATE	DELIVER	CREATE	DELIVER
2008	52,632	0	42.105	0	105,263	100,000
2009	52,632	0	42.105	0	105,263	100,000
2010	52,632	0	0	80,000	105,263	100,000
2011	52,632	0	42,105	0	105,263	100,000
2012	50,000	250,000	42,105	0	105,263	100,000
2013	52,632	0	42,105	0	105,263	100,000
2014	52,632	0	42,105	0	105,263	100,000
2015	52,632	0	40,000	200,000	105,263	100,000
2016	52,632	0	42,105	0	105,263	100,000
2017	50,000	250,000	42,105	0	105,263	100,000
2018	52,632	0	42,105	0	105,263	100,000
2019	52,632	0	42,105	0	105,263	100,000
2020	52,632	0	40,000	200,000	105,263	100,000
2021	52,632	0	42,105	0	105,263	100,000
2022	50,000	250,000	42,105	0	105.263	100,000
2023	52,632	0	42,105	0	105,263	100,000
2024	52,632	0	42,105	0	105.263	100,000
2025	52,632	0	40,000	200,000	105,263	100,000
2026	52,632	0	42,105	0	105.263	100,000
2027	50,000	250,000	0	0	0	100,000
2028	0	0	0	0	0	100.000
2029	0	0	0	0	0	100,000

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Table M-5
Assumed ICS Creation and Delivery Schedules for
Other Conservation Activities Under the Conservation Before Shortage Alternative[1]

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Year	Delta Pulse Flows		Other Environmental Flows Below NIB		Additional Environmental Uses	
	CREATE	DELIVER	CREATE	DELIVER	CREATE	DELIVER
2030	0	0	0	200,000	0	100,000
2031	0	0	0	0	0	100,000
2032	0	250,000	0	0	0	100,000
2033	0	0	0	0	0	100,000
2034	0	0	0	0	0	100,000
2035	0	0	0	200,000	0	100,000
2036	0	0	0	0	0	100,000
2037	0	0	0	0	0	0
2038	0	0	0	0	0	0
2039	0	0	0	0	0	0
2040	0	0	0	0	0	0
2041	0	0	0	0	0	0
2042	0	0	0	0	0	0
2043	0	0	0	0	0	0
2044	0	0	0	0	0	0
2045	0	0	0	0	0	0
2046	0	0	0	0	0	0
2047	0	0	0	0	0	0
2048	0	0	0	0	0	0
2049	0	0	0	0	0	0
2050	0	0	0	0	0	0
2051	0	0	0	0	0	0
2052	0	0	0	0	0	0
2053	0	0	0	0	0	0
2054	0	0	0	0	0	0
2055	0	0	0	0	0	0
2056	0	0	0	0	0	0
2057	0	0	0	0	0	0
2058	0	0	0	0	0	0
2059	0	0	0	0	0	0
2060	0	0	0	0	0	0

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Creation e amounts are adjusted for system assessment. Actual modeled delivery amounts may be less depending on availability and evaporation losses.

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M.3.3 Reservoir Storage Alternative

As discussed in Section 2.6, the Reservoir Storage Alternative assumes the levels of participation as shown **in** Table M-6.

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Table M-6
Reservoir Storage Alternative Volume Limitations of ICS Creation and Delivery

Entity	Maximum Annual Creation of ICS (kaf)	Maximum Cumulative Total Storage of ICS (kaf)	Maximum Annual Delivery of ICS (kaf)
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Unassigned	475	950	950
Total	1,100	3,050	1,950

These volume limitations are recognized in CRSS as are other rules that specify under which water supply conditions ICS may be created or delivered as summarized in Section M.3.4. The schedules for the Reservoir Storage Alternative for the participation of the Lower Division states were assumed to be identical to those used in the Basin States Alternative (Table M-3). The schedules for the expanded participation by other entities (Unassigned in Table M-6) are detailed below.

Some of the activities assumed in the Conservation Before Shortage Alternative were also assumed for the Reservoir Storage Alternative. In particular, the schedules for the "Delta Pulse Flows" and "Other Environmental Flows Below NIB" (Table M-5) were assumed to be identical. Other additional activities were assumed for the Reservoir Storage Alternative in order to assess the potential effects of the creation and delivery of ICS with limits different from either the Basin States or the Conservation Before Shortage alternatives.

During all water supply conditions except the Flood Control Surplus condition, ICS is assumed to be created to replace bypass flows to the Cienega de Santa Clara in Mexico. As noted in Section 4.2.6, the model assumes that 109 kafy is released from Lake Mead for the bypass flows. Because the system assessment for the Reservoir Storage Alternative is assumed to be 10 percent, ICS of 121 kafy is assumed to be created each year to replace the bypass flows (termed "Bypass Flow Replacement" in Table M-7). For modeling purposes and to maximize river flow effects this ICS was assumed to be created via extraordinary conservation within Mexico.

It was also assumed that ICS of 55 kafy would be created for environmental consumptive uses (in the amount of 50 kafy after the system assessment) in the United States (termed "Environmental Uses" in Table M-7). This ICS is assumed to be created and delivered during all conditions (except the Flood Control Surplus condition). For modeling purposes and to maximize river now effects this water was assumed to be created via extraordinary conservation within Mexico.
During otherwise Normal and Surplus conditions only, an additional 150 kafy of ICS is assumed to be created each year with a delivery of 100 kafy (termed "Additional Conservation Activities" in Table M-7). For modeling purposes and to maximize river flow effects, this ICS was assumed to be created via extraordinary conservation within Mexico and delivered to SNWA at Lake Mead.

The assumed schedules for these activities are shown in Table M-7.

M.3.4 Summary of Assumed ICS Creation and Delivery Activities
A summary of the activities assumed to occur under the various water supply conditions (Surplus, otherwise Normal, and Shortage conditions) for each alternative is presented in Table M-8.

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Table M-7
Assumed ICS Creation and Delivery Schedules for Other Conservation Activities Under the Reservoir Storage Alternative

	Environmental Uses		Bypass Flow Replacement		Additional Conservation Activities	
YEAR	CREATE	DELIVER	CREATE	DELIVER	CREATE	DELIVER
2008	55,555	50,000	121,111	109,000	150,000	100,000
2009	55,555	50,000	121,111	109,000	150,000	100,000
2010	55,555	50,000	121,111	109,000	150,000	100,000
2011	55,555	50,000	121,111	109,000	150,000	100,000
2012	55,555	50,000	121,111	109,000	150,000	100,000
2013	55,555	50,000	121,111	109,000	150,000	100,000
2014	55,555	50,000	121,111	109,000	150,000	100,000
2015	55,555	50,000	121,111	109,000	150,000	100,000
2016	55,555	50, 000	121,111	109,000	150,000	100,000
2017	55,555	50, 000	121,111	109,000	150,000	100,000
2018	55,555	50, 000	121,111	109,000	150,000	100,000
2019	55,555	50,000	121,111	109,000	150,000	100,000
2020	55,555	50,000	121,111	109,000	150,000	100,000
2021	55,555	50, 000	121,111	109,000	150,000	100,000
2022	55,555	50,000	121,111	109,000	150,000	100,000
2023	55,555	50,000	121,111	109,000	150,000	100,000
2024	55,555	50,000	121,111	109,000	150,000	100,000
2025	55,555	50,000	121,111	109,000	150,000	100,000
2026	55,555	50,000	121,111	109,000	150,000	100,000
2027	0	50, 000	0	109,000	0	100,000
2028	0	50,000	0	109,000	0	100,000
2029	0	50,000	0	109,000	0	100,000
2030	0	50, 000	0	109,000	0	100,000
2031	0	50,000	0	109,000	0	100,000
2032	0	50, 000	0	109,000	0	100,000
2033	0	50, 000	0	109,000	0	100,000
2034	0	50,000	0	109,000	0	100,000
2035	0	50,000	0	109,000	0	100,000
2036	0	50,000	0	109,000	0	100,000
2037	0	0	0	0	0	0
2038	0	0	0	0	0	0
2039	0	0	0	0	0	0
2040	0	0	0	0	0	0
2041	0	0	0	0	0	0
2042	0	0	0	0	0	0
2043	0	0	0	0	0	0

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Table M-7
Assumed ICS Creation and Delivery Schedules for Other Conservation Activities Under the Reservoir Storage Alternative

YEAR	Environmental Uses		Bypass Flow Replacement		Additional Conservation Activities	
	CREATE	DELIVER	CREATE	DELIVER	CREATE	DELIVER
2044	0	0	0	0	0	0
2045	0	0	0	0	0	0
2046	0	0	0	0	0	0
2047	0	0	0	0	0	0
2048	0	0	0	0	0	0
2049	0	0	0	0	0	0
2050	0	0	0	0	0	0
2051	0	0	0	0	0	0
2052	0	0	0	0	0	0
2053	0	0	0	0	0	0
2054	0	0	0	0	0	0
2055	0	0	0	0	0	0
2056	0	0	0	0	0	0
2057	0	0	0	0	0	0
2058	0	0	0	0	0	0
2059	0	0	0	0	0	0
2060	0	0	0	0	0	0

Creation amounts are adjusted for system assessment. Actual modeled delivery amounts may be less depending on availability and evaporation losses.

Table M-8
Modeling Assumptions for Creation and Delivery of ICS

Water Supply Condition		BS, CBS & RS[1]						CBS & RS	CBS
		California	Arizona	Nevada				Mexico	Federal
		Extraordinary Conservation	Extraordinary Conservation	Tributary Conservation	Groundwater	Desalinization	Drop 2 Reservoir[4]	Extraordinary Conservation	Extraordinary Conservation
Flood Control	Create	no	no	no	no	no	no	no	no
Surplus	Deliver	no	no	no	no	no	no	no	no
Quantified (70R)	Create	no	no	yes	no	yes	yes	yes	yes
Surplus	Deliver	no	no	no	no	yes	yes	yes	yes
Full Domestic	Create	no	no	yes	no	yes	yes	yes	yes
Surplus	Deliver	no	no	yes	no	yes	yes	yes	yes
Normal	Create	yes	yes	yes	yes	yes	yes	yes	yes
	Deliver	yes	yes	yes	yes	yes	yes	yes	yes
Shortage (involuntary	Create	no	no	yes	yes	yes	no	no	no[5]
and voluntary)	Deliver	no	no	yes	yes	yes	no	no	no
System Assessment		yes	yes	yes	yes	yes	no	yes	yes
Period of Activity		2006-2026	2017-2026	2009-2060	2009-2060	2020-2060	Temporary	2008-2026	2008-2026

Notes:
1 *BS" Basin States, CBS" Conservation Before Shortage, RS" Reservoir Storage*
2 *yes" Activity assumed to occur*
3. *no " Activity assumed to not occur*
4 *Beginning in 2012, Nevada is assumed to receive 40 kafy of the water conserved by the Drop 2 Reservoir during Normal and Surplus years until a total of 300 kaf has been credited to Nevada. Thereafter, water conserved by the Drop 2 Reservoir is assumed to be system water.*
Under the Conservation Before Shortage Alternative, extraordinary conservation is assumed to be undertaken by the federal government during voluntary shortage conditions but not during involuntary shortage conditions.

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S-4

EXHIBIT 2

Letter from Herbert R. Guenther to Robert W. Johnson, November 28, 2005

S-4

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2. The Department requests that the alternative use actual Upper Basin depletions and projected new depletions that are verifiable to calculate the 602(a) storage requirement on an annual basis. The projected Upper Basin depletion schedules currently used in the algorithm are significantly overstated. This overstatement results in an increase in 602(a) storage of approximately 3.8 maf in 2006 and 2007, which increases the probability of shortages to Arizona. The Department recommends that Reclamation utilize the Upper Basin depletion projections contained in the Draft Interim Surplus Guidelines Environmental Impact Statement as they track far more closely with actual Upper Basin depletions than do the current Upper Basin depletion schedules used in the algorithm.

3. The Department requests that the alternative eliminate the 14.85 million acre-feet (maf) storage requirement set forth in the Interim 602(a) Storage Guideline for Management of Colorado River (Interim 602(a) Storage Guideline). The guideline artificially limits equalization releases and will have the same detrimental effect on the State of Arizona as the current algorithm. The amount of 14.85 maf is far in excess of the amount needed to fulfill the requirements of 602(a) of the Project Act.

The Department also notes that the Secretary does not appear to be considering the available storage in all of the reservoirs authorized by the Colorado River Storage Project Act, 43 U.S.C. § 620 *et seq.* in determining whether forecasted active storage in the Upper Basin is greater than the Section 602(a) storage requirement under subarticle II(3) of the Coordinated Long-Range Operation of Colorado River System Reservoirs. If this is the case, the Department requests that the Secretary adjust the Colorado River System Simulation Model to properly calculate active storage in the Upper Basin.

Finally, the Department requests that any alternative incorporate Arizona's recommendation for total Lower Basin shortages, which includes Mexico. Arizona's recommended shortages range in volume from 400,000 acre-feet (af)to 600,000 af and would be implemented as follows:

a. For Mead elevations between 1075 ft. and 1050 ft., the shortage reduction should be 400,000 af.
b. For Mead elevations between 1050 ft. and 1025 ft., the shortage reduction should be 500,000 af.
c. For Mead elevations beginning at elevation 1025 ft. and below, the shortage reduction should be 600,000 af.

Hydrologic conditions that could necessitate reductions in excess of 600,000 af must trigger a Secretarial consultation process to determine how to implement additional reductions in the least damaging and most equitable manner possible. Further, if hydrologic conditions indicate that Powell elevations are rising and may reach equalization elevations in the coming year, the Secretary may have the discretion, after consultation with Arizona, to forego a shortage declaration even if a Lake Mead trigger elevation has been reached.

S-4

Mr. Robert W. Johnson
November 28, 2005
Page 3 of 3

The Seven Colorado River Basin States continue to collaborate on the development of conjunctive operation of Lakes Powell and Mead to minimize shortages to the Lower Division States and avoid curtailment on the Upper Division States. Arizona is committed to finding a solution that benefits both basins. It is crucial, however, that the EIS be scoped broadly enough to include an alternative that incorporates the above adjustments to 602(a) storage and that all alternatives include Arizona's recommendation regarding shortages as outlined above. Please contact me if you have any questions.

Sincerely,

Herbert R. Guenther

HRG:ckl

S-4

EXHIBIT 3

Director's Shortage Sharing Workgroup Recommendation, October 24, 2006 (Revised) Final

S-4

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Director's Shortage Sharing Workgroup Recommendation

October 24, 2006
(Revised)
Final

In 2005, the Director established the Arizona Shortage Sharing Stakeholder Workgroup (Workgroup). The Workgroup had two specific goals:

1. Develop a recommendation to the Director regarding the appropriate volume and implementation strategy for implementing future Colorado River shortages in the lower basin.
2. Develop a recommendation to the Director for allocating shortages between the Central Arizona Project (CAP) and equivalent priority mainstream Colorado River water users.

The Workgroup effort supports a larger Bureau of Reclamation (Reclamation) Environmental Impact Analysis process to develop lower basin shortage criteria and conjunctive management strategies for the operation of Lakes Powell and Mead. Reclamation currently plans to issue a Record of Decision in December 2007.

Shortage Volume and Implementation Strategy

The Workgroup developed the following recommendation for implementing lower basin shortages:

1. At or below Lake Mead elevation 1075 feet, 400,000 acre-feet shortage
2. Below elevation 1050 feet, 500,000 acre-feet shortage
3. Below elevation 1025 to 1000 feet, 600,000 acre-feet shortage
4. Below elevation 1000 feet, reconsultation with Reclamation and the states

The recommendation assumes that the first step will be to reduce water deliveries to Mexico and the next step will be to calculate shortage sharing with Nevada. Hydrologic conditions that necessitate reductions in excess of 600,000 acre-feet will trigger a Secretarial consultation process to determine how to implement additional reductions in the least damaging and most equitable manner possible. That consultation process has not been defined, but should be developed with input from the basin states.

The Director forwarded this recommendation to the other Colorado River basin states, and it has been incorporated into the *Seven Basin States' Preliminary Proposal Regarding Colorado River Interim Operations, February 3, 2006,* with one modification, that reconsultation would be triggered at elevation 1025.

Shortage Allocation Between CAP and Fourth Priority Mainstream Entitlements

The Workgroup analyzed methods for allocating shortage reductions between CAP and fourth priority mainstream water users. The CAP has an established priority system for implementing shortage reductions. Excess water supplies are reduced first. If additional reductions are needed, non-Indian agricultural priority water supplies are reduced until gone, and finally municipal/industrial/Indian uses are reduced according to the formula in the Gila River Indian Community Water Rights Settlement

S-4

Director's Shortage Sharing Workgroup Recommendation
October 24, 2006
(Revised)
Final

Agreement. There is no equivalent shortage implementation system for fourth priority mainstream water users. Fourth priority mainstream uses (agricultural and municipal) will be reduced proportionately as soon as Arizona Colorado River shortage reductions are implemented. Future estimated shortage reductions to mainstream users including Lake Havasu and Bullhead City run as high as 30 percent. Under Reclamation's current interpretation for Article V accounting, there is no locally available, non-Colorado River water supply to offset these shortage reductions.

The Director requested that a small technical subgroup of Workgroup stakeholders begin working with the Department to develop a shortage allocation recommendation. The technical group established principals to guide a shortage allocation strategy:

1. Define a method for the Secretary to utilize when allocating shortages to Arizona users
2. Beneficiaries bear the costs of shortage protections
3. Shortages must be allocated in a reasonable manner based on existing contracts and agreements
4. To the extent possible, treat similar users groups equitably

The Mohave County Water Authority (MCWA) presented a recommendation for proportional shortage reductions to fourth priority mainstream water supplies based on entitlement. Shortage reductions to mainstream domestic water supplies could be mitigated by the Arizona Water Banking Authority. The Department completed additional technical analysis of the proposal, which was endorsed by the technical group. The technical group recommends that Arizona fourth priority shortages be allocated as follows:

1. Determine shortage amount and allocation to Mexico. Allocate the remaining shortage amount first to Nevada, and the remainder to Arizona. The enclosed spreadsheet first allocates 16.7% of the shortage to Mexico. The remaining shortage amount is then allocated 7.4% to Nevada and the remainder to Arizona.
2. Determine the estimated priority 1-3 consumptive use amount based on the last non-shortage year use. Determine the **Total Water Supply Available for Fourth Priority Diversion**. Subtract the priority 1-3 consumptive use amount from the Arizona Colorado River water allocation of 2,800,000 acre-feet.
3. Determine the **Fourth Priority Mainstream Shortage Percentage**. Divide the fourth priority mainstream diversion entitlement, 164,652 acre-feet, by the Total Water Supply Available for Fourth Priority Diversion (#2).
4. Determine the total water supply **Available for Fourth Priority Diversion after Shortage Reduction**. Subtract the Arizona portion of lower basin shortage from Total Water Supply Available for Fourth Priority Diversion amount (#2).
5. Determine the **Fourth Priority Mainstream Shortage Reduced Water Supply**. Multiply the Available for Fourth Priority Diversion after Shortage Reduction (#4) water supply by the Fourth Priority Mainstream Shortage Percentage (#3).
6. Determine the remaining, CAP water supply. The Total Water Supply Available for Fourth Priority Diversion amount is based on estimated priority 1-3 water use. Actual use may be higher than estimated, and could result in an inadvertent CAP overrun. The CAP has agreed to be responsible for payback, under the Inadvertent Overrun and Payback Policy, up to the amount of the water user's entitlement. Actual use may be lower than estimated, resulting in an increased water supply for CAP.

S-4

Director's Shortage Sharing Workgroup Recommendation
October 24, 2006
(Revised)
Final

Since there is a fixed maximum diversion entitlement for fourth priority mainstream water users, as noted in the *Contract Between the United States and the Central Arizona Water Conservation District for Delivery of Water and Repayment of Costs of the Central Arizona Project, December 1, 1988*, the mainstream fourth priority water supply has been calculated based on that entitlement. After determining the mainstream fourth priority water supply, the remaining water supply is available for diversion by the CAP, including any available return flow from mainstream water uses.

The shortage allocation recommendation includes the opportunity for mainstream municipal water users to firm 100 percent of their individual municipal/industrial entitlements. Based on updated population projections (2003) the AWBA would need between 450,000 and 525,000 acre-feet of credits for fourth priority mainstream municipal and industrial water users. As AWBA credits are used and replaced, the new credits will be earmarked in the name of the entity that replaced the credits, thereby creating a revolving fund. The AWBA has not foreclosed the opportunity for any fourth priority mainstream entitlement holder to contract with the AWBA for firming.

S-4

Shortage Sharing Scenarios - Pro Rata Reductions Based On Priority 4 Entitlements
(Values in Acre-feet)

Year	Priority 1-3 Mainstream Projected Consumptive Use[1]	Available for Priority 4 Diversions - Normal Supply[2]	Priority 4 Mainstream Total Entitlement	Priority 4 Mainstream Shortage Sharing Percentage	Arizona Portion of Lower Basin Shortage[3]	Available for Priority 4 Diversion - Reduced Supply	Priority 4 Mainstream Diversion - Reduced Supply	Projected Priority 4 Mainstream Diversion[1]	Priority 4 Mainstream Diversion - Net Reduction
400,000 Acre-Feet Shortage									
2010	1,171,867	1,556,133	164,652	10.58%	308,588	1,247,545	132,001	155,880	23,879
2016	1,177,135	1,550,865	164,652	10.62%	308,588	1,242,277	131,890	158,961	27,071
2025	1,185,597	1,542,403	164,652	10.68%	308,588	1,233,815	131,710	162,362	30,652
2031	1,191,580	1,536,420	164,652	10.72%	308,588	1,227,832	131,582	163,799	32,217
500,000 Acre-Feet Shortage									
2010	1,171,867	1,556,133	164,652	10.58%	385,735	1,170,398	123,838	155,880	32,042
2016	1,177,135	1,550,865	164,652	10.62%	385,735	1,165,130	123,699	158,961	35,261
2025	1,185,597	1,542,403	164,652	10.68%	385,735	1,156,668	123,475	162,362	38,887
2031	1,191,580	1,536,420	164,652	10.72%	385,735	1,150,685	123,314	163,799	40,485
600,000 Acre-Feet Shortage									
2010	1,171,867	1,556,133	164,652	10.58%	462,881	1,093,251	115,675	155,880	40,204
2016	1,177,135	1,550,865	164,652	10.62%	462,881	1,087,983	115,509	158,961	43,452
2025	1,185,597	1,542,403	164,652	10.68%	462,881	1,079,521	115,239	162,362	47,122
2031	1,191,580	1,536,420	164,652	10.72%	462,881	1,073,538	115,047	163,799	48,752

ENDNOTES

[1] Source: Arizona Department of Water Resources 2003 mainstem Colorado River water use projections.

[2] An amount of 72,000 acre-feet has also been deducted to account for higher priority Ak-Chin and Salt River Pima-Maricopa Indian settlement water.

[3] This amount is determined by first deducting Mexico's share (16.7%) of the total Lower Basin shortage. The remaining shortage volume is apportioned first to Nevada (7.42%) and the remainder to Arizona.

S-4

EXHIBIT 4

Arizona Multiple Consecutive Year Shortage Graphs

S-4

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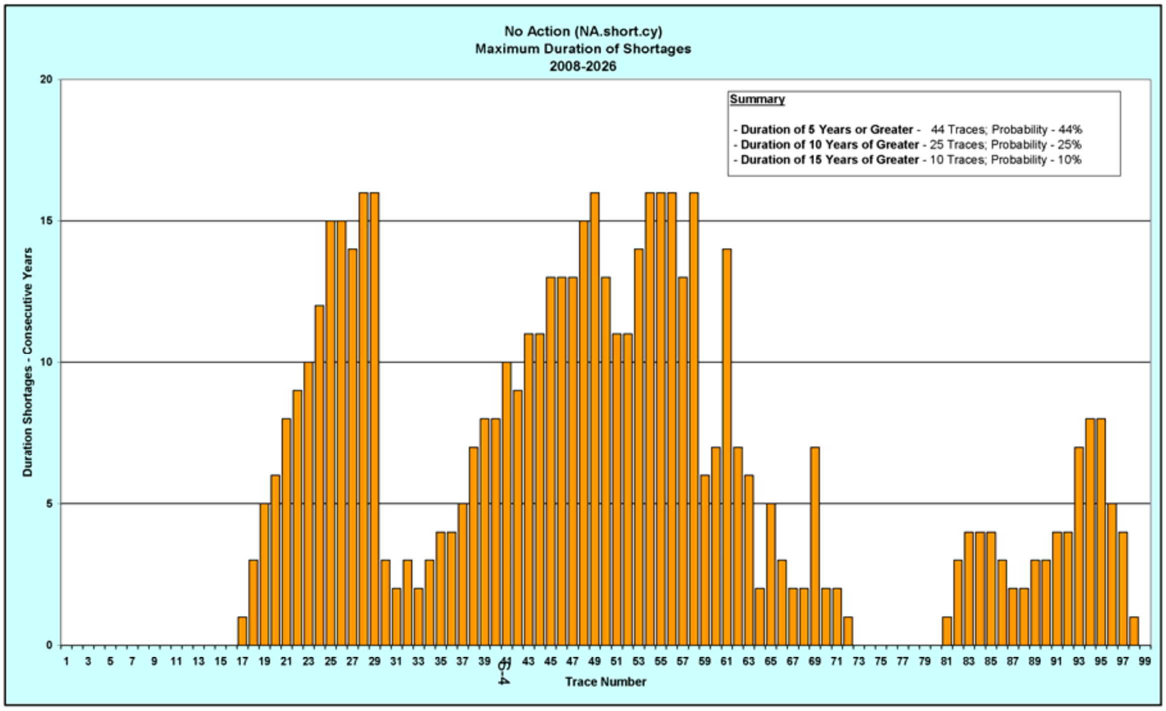
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Maximum Duration of Shortages
2008-2026
Summary
- Duration of 5 Years or Greater - 44 Traces; Probability - 44%
- Duration of 10 Years of Greater - 25 Traces; Probability - 25%
- Duration of 15 Years of Greater - 10 Traces; Probability - 10%
Duration Shortages - Consecutive Years
Trace Number

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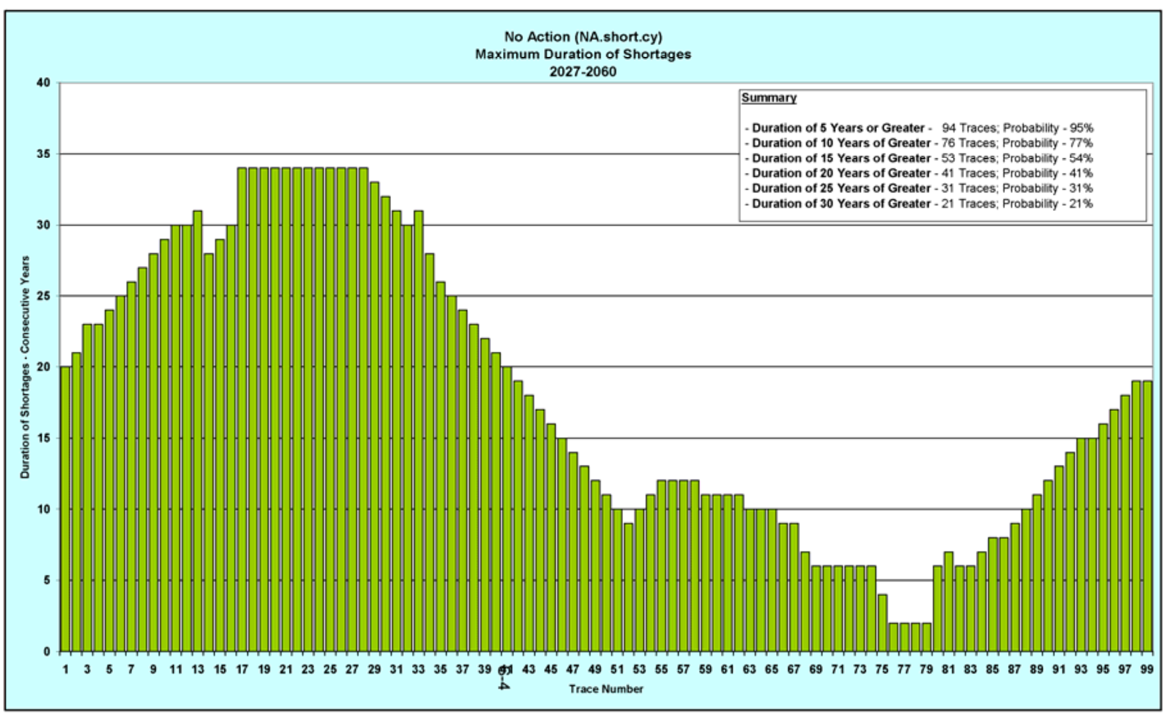
No Action (NA.short.cy)
Maximum Duration of Shortages
2027-2060
Summary
- Duration of 5 Years or Greater - 94 Traces; Probability - 95%
- Duration of 10 Years of Greater - 76 Traces; Probability - 77%
- Duration of 15 Years of Greater - 53 Traces; Probability - 54%
- Duration of 20 Years of Greater - 41 Traces; Probability - 41%
- Duration of 25 Years of Greater - 31 Traces; Probability - 31%
- Duration of 30 Years of Greater - 21 Traces; Probability - 21%
Duration of Shortages - Consecutive Years
Trace Number

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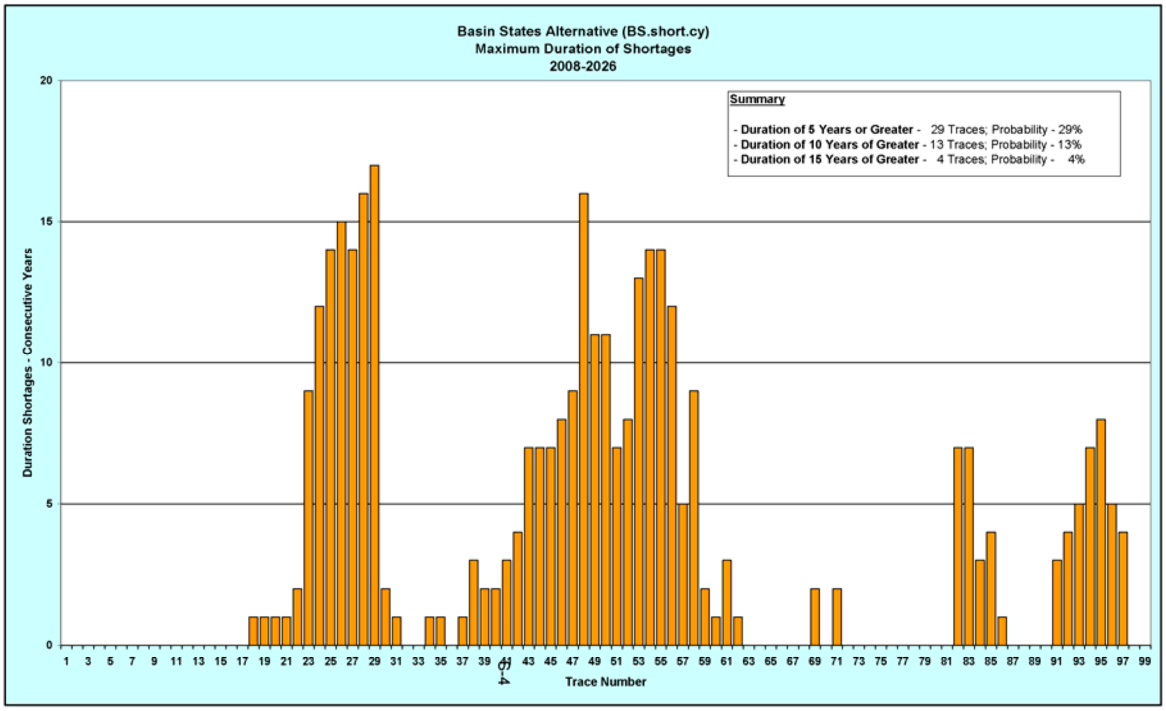
Basin States Alternative (BS.short.cy)
Maximum Duration of Shortages
2008-2026
Summary
- Duration of 5 Years or Greater - 29 Traces; Probability - 29%
- Duration of 10 Years of Greater - 13 Traces; Probability - 13%
- Duration of 15 Years of Greater - 4 Traces; Probability - 4%
Duration Shortages - Consecutive Years
Trace Number

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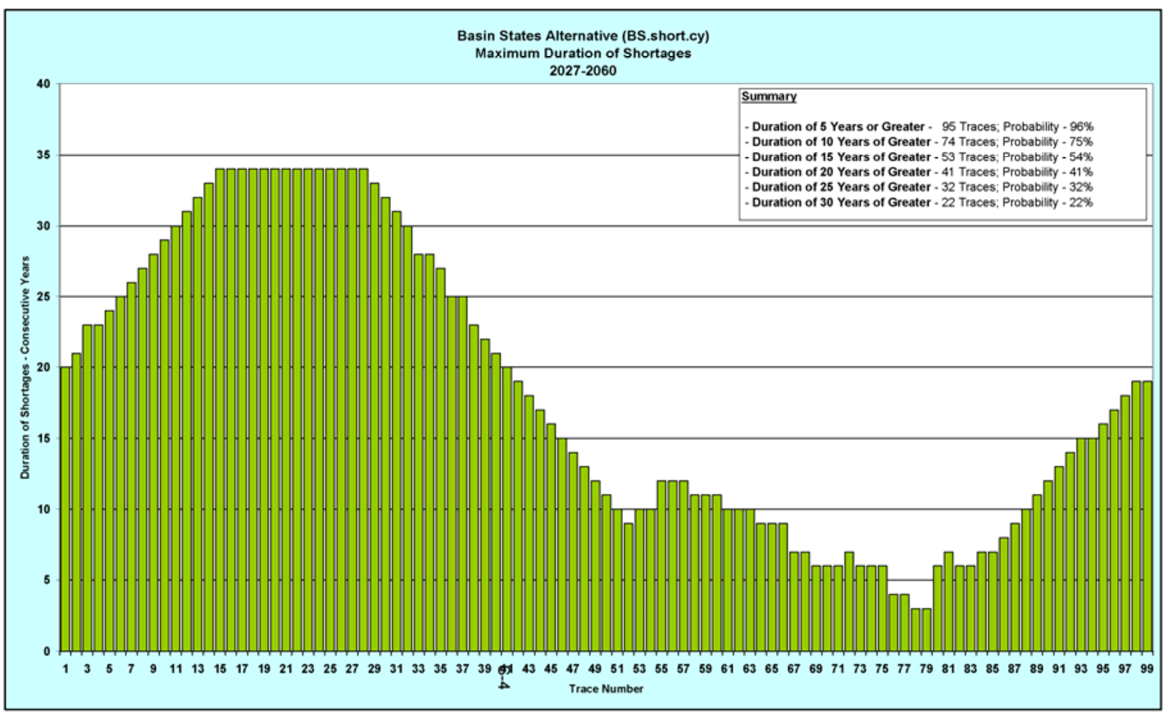
Basin States Alternative (BS.short.cy)
Maximum Duration of Shortages
2027-2060
Summary
- Duration of 5 Years or Greater - 95 Traces; Probability - 96%
- Duration of 10 Years of Greater - 74 Traces; Probability - 75%
- Duration of 15 Years of Greater - 53 Traces; Probability - 54%
- Duration of 20 Years of Greater - 41 Traces; Probability - 41%
- Duration of 25 Years of Greater - 32 Traces; Probability - 32%
- Duration of 30 Years of Greater - 22 Traces; Probability - 22%
Duration of Shortages - Consecutive Years
Trace Number

S-4

EXHIBIT 5

ADWR Technical Corrections to DEIS

S-4

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ARIZONA DEPARTMENT OF WATER RESOURCES

COMMENTS ON UNITED STATES BUREAU OF RECLAMATION'S
DRAFT ENVIRONMENTAL IMPACT STATEMENT
COLORADO RIVER INTERIM GUIDELINES FOR LOWER BASIN SHORTAGES AND COORDINATED OPERATIONS FOR LAKE MEAD AND LAKE POWELL

Page	Chapter/ Section	Line(s)	Comment Type	Comment
ES-3	ES.1.3	8	Text	Change bullet to read: Arizona water users, particularly lower priority users **along the main stem of the lower Colorado River** and located in the Central Arizona Project service area.
ES-17	ES.2.13		Analysis	ADWR believes that the duration of shortages has not been properly addressed through out the DEIS and thus the impacts of shortages to Arizona have been minimized in the DEIS.
ES-19	Table ES-2	4.8	Text	Biological Resources, a superscript 1 appears, indicating a footnote but there is no footnote.
ES-19	Table ES-2	4.10	Text	Indian Trust Assets, a superscript 2 appears but there is no footnote.
ES-21	Table ES-2	4.13	Text	Transportation, a superscript 1 appears but there is no footnote.
ES-22	Table ES-2	4.14	Analysis	Addition of a table comparing the relative performance of the action alternatives to the No Action alternative in achieving the purposes identified in the DEIS is suggested. The qualitative approach utilizing "+" and "-" symbols, e.g. +++ is better than ++, etc., is suggested.
ES-22	Table ES-2	4.14	Analysis	Socioeconomics and Land Use, a superscript 1 appears but there is no footnote. The information presented under 4.14 is not clear. What are the percentages of? Also, since the number for socioeconomic effect for the Conservation Before Shortage alternative is based on only counting effects once shortage is mandatory, as described in Chapter 2, a footnote should be added to clarify that the number shown is not directly comparable to the others in the same row.
ES-22	Table ES-2	4.14	Analysis	ADWR believes that there are significant impacts to municipal and industrial sectors caused by shortages, especially due to the duration of shortages.
1-14	1.7.2.2	Figure 1.7-3	Text	The portion of northeastern Arizona north of the dashed green basin dividing line should be crosshatched to indicate that it is Upper Division.
1-18	1.7.3	29-38	Text	There is no mention of municipal and industrial uses along the lower Colorado River that withdraw water from wells located within the floodplain of the Colorado River.
1-26	1.8.5	19	Analysis	The Conservation Plan was actually designed to mitigate adverse effects of covered activities under the Endangered Species Act. The LCR MSCP EIS does not address nor provide NEPA compliance for the covered activities. The finding that "…all species that use the habitats impacted by LCR MSCP-covered activities benefit from the conservation actions currently being carried out under the LCR MSCP, and are therefore fully mitigated for within the limits of the LCR MSCP analysis." needs clarification. Supporting quantification and documentation would be needed before concluding that all effects of covered activities, to all species, have been mitigated. As stated in the LCR MSCP EIS, p. 1-17, line 8 at 1.2.4 "This EIS/EIR evaluates only the impacts of implementing the Conservation Plan and issuance of a section 10(a)(1)(B) permit by the Service based on this plan because these are the two components of the proposed action."
2-13	2.4.5	18	Text	The Conservation Before Shortage alternative features the additional objective of making water available for environmental uses. This additional objective is beyond the stated purpose of the proposed federal action identified on p. 1-3, line 2 at 1.3.
2-14	2.6.1	25	Text	The Reservoir Storage alternative features the additional objective of maintaining Lakes Powell and Mead at higher elevations. This additional objective is beyond the stated purpose of the proposed federal action identified on p. 1-3, line 2 at 1.3.
2-19	2.7	Table 2.7-2	Text	A line needs to be added that separates the "Flood Control Surplus" from the "Quantified Surplus (70R) - which is not shown.
2-21	2.8	Table 2.8-1	Analysis	ADWR would like to see a line for Lake Mead December elevation, probability of elevations less than or equal to 1,000 feet msl for both 2026 and 2060.

S-4

Page	Chapter/ Section	Line(s)	Comment Type	Comment
2-25	Table 2.8-1	4.14	Analysis	Socioeconomics and Land Use, the information presented is not clear. What are the percentages of? Also, since the number for socioeconomic effect for the Conservation Before Shortage alternative is based on only counting effects once shortage is mandatory, as described in Chapter 2, a footnote should be added to clarify that the number shown is not directly comparable to the others in the same row.
2-25	Table 2.8-1	4.14	Analysis	ADWR believes that there are significant impacts to municipal and industrial sectors caused by shortages, especially due to the duration of shortages.
3-7	3.2.1.4	23	Text	Picacho State Recreation Area is managed by the State of California, not Arizona.
3-10	3.2.2	Figure 3.2-3	Text	The City of Nogales no longer has a CAP allocation and should not be shown in this figure. There are also several dots in shown Gila County, what are these ?
3-16	3.3.1	5-12	Text	This section is repetitive; it has already been described on page 3-15, lines 31-35 and page 3-16, lines 1-3.
3-24	3.3.6	14	Text	The numbers should be checked. It appears that a decimal point was used where a comma should have been placed.
3-33	3.4.2.1	Table 3.4-3	Text	The estimated diversion entitlement value for Arizona of 1,078,398 does match the value of 1,077,971 shown in Table G-80. ADWR believes that the latter value is correct.
3-39	3.4.6.1	Table 3.4-4	Text	A footnote should be added that states the Priorities 2 and 3 is co-equal.
3-41	3.4.3.6	Table 3.4-6	Text	The listing for Nevada Department of Wildlife should be checked.
3-50	3.5.6	15-17	Text	Lines 15-17 should follow the discussion of the McCulloch plant in line 10, and all that should follow the completed discussion of the PG&E plume as the latter is downstream from the former.
3-70	3.8.3	Table 3.8-7	Text	Under location "GCS" should be GCD for Glen Canyon Dam.
3-71	3.8.3	Table 3.8-7	Text	Under Yuma clapper rail the subspecies should yumanensis.
3-80	3.9.7.3	1	Text	The heading should be 3.9.8 as the section is not a subsection under Davis Dam to Parker Dam.
3-80	3.9.7.4	27	Text	The heading should be 3.9.9 as the section is not a subsection under Davis Dam to Parker Dam.
3-82	3.10.2.1	Table 3.10-1	Text	It would be helpful if a total for all of the Tribes is shown after the States totals.
3-86	3.10.2.2	Table 3.10-2	Text	The table has left out the allocations for the Tonto-Apache (128 acre-feet) and Pascua-Yaqui (500 acre-feet) Reservations, and Tohono O'Odham - Chuichu District (8,000 acre-feet).
				There are also 22,000 acre-feet for the Salt River-Pima Maricopa Community, which is delivered to various Phoenix area cities, and 500 acre-feet for the Yavapai-Prescott Tribe; which has been assigned to the City of Scottsdale. Both these allocations retain their CAP Indian Priority.
3-87	3.10.2.2	10-13	Text	Why is a CAP Indian allocation, which is not covered by water rights settlement, not considered an Indian Trust Asset?
3-121	3.12.4.6	34	Text	Delete "an area." Except for areas specifically closed the entire reach is open and accessible to fishing.
3-127	3.14	9	Analysis	The assumption "No long-term permanent changes in land uses are expected to be caused by the proposed federal action because only agricultural lands would be directly affected during a shortage and these lands would be fallowed and not permanently removed from production." may not be valid. Extended fallowing could result in a change in land use or economic failure of the agricultural operation.
3-127	3.14	9-16	Analysis	If an evaluation of the duration of shortages had been made, agricultural land may in fact be permanently removed.
3-127	3.14	17-24	Analysis	There is no mention of agricultural lands along the main stem of the lower Colorado River, such as the Mohave Valley Irrigation District or numerous smaller agricultural operations that will be impacted by shortages.
3-128	3.14.2	13	Text	As a county the correct spelling is Mohave. While water stored in Lake Pleasant does overlay lands within Yavapai County, CAP water does not serve Yavapai County.
3-128	3.14.2.1	Table 3.14-1	Text	Under the column "Total Land Acres", the acreage values for the CAP Counties and Western Arizona Counties are shown as the same - 14,928,438. This does not appear to be correct.

S-4

ADWRComments-Revised 042007.xls Page 2 of 7 As of 4/27/2007

Page	Chapter/ Section	Line(s)	Comment Type	Comment
3-129	3.14.2.1	8-13	Text	There is no mention of municipal entities located along the main stem of the lower Colorado River, such as Bullhead City, Lake Havasu City, Parker, and Ehrenberg. They will also be affected by shortages, probably more so than the Central Arizona cities.
3-129	3.14.2.1	21-29	Analysis	Why was 1994 chosen as the reference year ? Why wasn't data from the 2000 census utilized?
3-130	3.14.2.2	4-8	Text	There is only a small portion of the Fort Mojave Indian Reservation that is located in Clark County, Nevada, which appears to be less than 5,000 acres shown in Table 3.14-2. All of the agricultural lands in Clark County do not use Colorado River water.
3-131	3.14.2.3	9-14	Text	There are also significant agricultural lands found in these counties, especially located in the Palo Verde and Imperial Irrigation Districts, and the Coachella Valley Water District.
4-10	4.2.7.1	Table 4.2-1	Text	Under the "Calculation" column, the "-" in the formula for the calculation for Nevada's stage 1 shortage distribution should be an "=" sign.
4-37	4.3.2.2	13	Text	The value should be **82.3** maf rather than **8.23** maf.
4-61	4.3.6.2	8	Text	As described "A point immediately downstream of Havasu NWR…." would be in Lake Havasu north of Lake Havasu City. The description should be checked.
4-61	4.3.6.2	7-8	Text	Table 4.3-24 does show that the Basin States Alternative goes below Lake Mead elevation 1,000 feet msl, so the statement in these lines is not accurate.
4-64	4.3.6.3	9-13	Text	It would be useful if a table showing the analysis of stage versus flow be shown here, instead of simply referencing the LCR MSCP. This comment also applies to section 4.3.7.2
4-81	4.4.1.1		Analysis	There is no discussion or evaluation of the length or duration of shortages.
4-83	4.4.4.1		Text	The duration of shortages should also be displayed in this section.
4-86	4.4.4.1	7-13	Text	ADWR believes that the determination of the average shortage volume is incorrect. The probability of any shortage occurring in a given year throughout the 99 traces is 1/99. So the average shortage volume for the year would be divided by 99. The average shortage for a given year is then the sum of yearly average shortages that occur throughout the 99 traces.
4-93	4.4.4.1	Figure 4.4-6	Text	The maximum values of shortages shown in this figure do not appear to match the values shown in Table 4.4-10.
4-123	4.4.7.1	Table 4.4-15	Text	Why are CAP Indian and M&I users shorted in the year 2017 for a shortage of 400,000 acre-feet ? Based on Table G-55, there is enough Excess Water and CAP NIA Priority Water to cover the Arizona portion of the shortage.
4-124	4.4.7.1	Table 4.4.-15	Text	For the shortage year of 2040 and under the shortages of 1,800,000 and 2,500,000 acre-feet, the shortages to CAP Indian and M&I sectors should not exceed their CAP subcontract allocations.
4-128	4.4.8	2	Text	A section should be added comparing the timeline within the year for implementation of the approach of each alternative. Implementation issues should be identified. For example, under the Conservation Before Shortage alternative there should be a discussion of what happens if the Secretary is not able to achieve sufficient reductions in use through voluntary conservation and when in the year, or if, a decision to make a mandatory reduction to make up for the insufficiency of voluntary conservation would be made. A narrative discussion is suggested.
4-261	4.14.1.1	13	Text	Economic impacts to entities that benefit from CAP allocations through exchange should be addressed. The ability of such entities to find other water may be limited. The priority of such exchanged water should be addressed as well. Entities receiving CAP water through exchange include: Camp Verde Yavapai-Apache Nation, Tonto Apache Tribe, and San Carlos Apache Tribe.
4-261	4.14.1.1	14-21	Text / Analysis	There is no mention of agricultural lands along the main stem of the lower Colorado River. There is not any analysis of the effects caused by the length or duration of shortages.
4-263	4.14.1.1	22	Analysis	The assumption "While fallowing of lands may occur during shortages, there are other sources of water that may be used by farmers in order to offset shortages." is not valid for Mohave Valley agriculture or other lands along the Colorado River since groundwater has been found by Reclamation to be within the accounting surface of the Colorado River.
4-263	4.14.1.2	26-27	Text	In Arizona, there is not any groundwater banking that is available for use by the agricultural sector.
4-264	4.14.1.3	3-11	Text	There is no mention of agricultural uses along the main stem of the lower Colorado River that would be affected by shortages

S-4

ADWRComments-Revised 042007.xls Page 3 of 7 As of 4/27/2007

Page	Chapter/ Section	Line(s)	Comment Type	Comment
4-266	4.14.1.3	8-18	Analysis	There are direct and indirect costs associated with paying farmers to fallow lands in the Conservation Before Shortage alternative. Reclamation should contact the Imperial Irrigation District to get information about their fallowing programs (as part of Quantification Settlement Agreement and California Water Delivery Agreement).
4-267	4.14.1.3	13	Analysis	Analyses of the following is not clear: "The M&I shortages allocated to each state were compared to the drought plans or actions that state or local agencies could institute during a shortage." Cities along the Colorado River that utilize post 1968 contract water may not have alternative supplies available.
4-269	4.14.2	Table 4.14-1	Text	In the "Indian Agriculture" section of this table, why is there Indian agricultural lands shown for shortages of 400,000 and 500,000 acre-feet for the year 2017 ?
4-270	4.14.2	6	Analysis	The assumption "No permanent change in land uses would occur under any of the alternatives because shortages would be of a temporary nature and agricultural lands would likely not be permanently removed from production." may not be valid. Multi-year fallowing could result in alternate land use or collapse of the farming operation.
4-270	4.14.2	7	Analysis	ADWR believes that the impacts would not be "temporary" because of the length of shortages.
4-271	4.14.2.1	10	Text	Why are effects in Graham County evaluated?
4-272	4.14.2.1	Table 4.14.-2	Text	In the year "2025" section, why is the probability of shortage value of 16 for 400,000 acre-feet under the "BS" column less than probability of shortage value of 18 shown in the year "2017" section ?
4-274	4.14.2.1	29-32	Text	"Even if considered to be permanent, these potential changes in jobs and personal income area not considered substantial because the changes represent less than one percent of total employment and personal income within the seven-county study area in Arizona." The impact analysis should be reported on a county by county basis in order to avoid understating the impact due to the overwhelming influence of total employment and income in urban Maricopa County. Impacts in Maricopa County may not be comparable to those in Pinal County.
4-275	4.14.2.1	10	Text	Under the Conservation Before Shortage alternative there should be a discussion of what happens if the Secretary is not able to achieve sufficient reductions in use through voluntary conservation and when in the year, or if, a decision to make a mandatory reduction to make up for the insufficiency of voluntary conservation would be made. The timeline for the process under the Conservation Before Shortage should be considered and compared against the purpose statement identified in the DEIS, particularly the purpose of increasing predictability. Since Reclamation has attempted voluntary reductions to replace the bypass stream for the Yuma Desalting Plant, the relative success of that program might serve as a benchmark for the concept.
4-275	4.14.2.1	10	Analysis	Economic effects of the Conservation Before Shortage alternative are not directly comparable to the other alternatives. That alternative assumes federal subsidy of conservation actions up to 1.5 mafy then 50:50 cost share with non-fed users after that. The impact analysis only includes effects of involuntary shortages. Impact analysis does not include effects to users of a water use fee to cost share conservation measures.
4-275	4.14.2.1	10-18	Analysis	There should be an estimate of the cost to pay farmers to fallow land under this alternative.
4-275	4.14.2.1	39	Analysis	Economic effects and reduction in jobs are compared against all seven CAP service area counties. The large size of the Maricopa County economy may mask effects.
4-276	4.14.2.1	2	Text	The word "both" doesn't fit.
4-277	4.14.2.2	26-35	Analysis	What about losses in tax revenue from decreases in tourism or manufacturing. The impacts seem low considering that the impacts of the length or duration of shortages was not analyzed.
4-281	4-.14.2.4	36-40	Text	It appears that the only agricultural lands located in Clark County that use Colorado River water are the Fort Mojave Indian Reservation lands.
4-282	4.14.3.1	28	Text	Shortages greater than 800,000 acre-feet occur; they should also be evaluated.
4-282	4.14.3.1	37-8	Analysis	ADWR believes there are economic costs associated drought response programs that need to be addressed.
4-283	4.14.3.2	14-16	Text	The sentence that begins with "MWD has implemented…" seems redundant.
4-286	4.14.5.3	29-32	Analysis	The statements may be true for shortages of 1 or 2 years in length, but would not be true for shortages of long duration.

S-4

ADWRComments-Revised 042007.xls Page 4 of 7 As of 4/27/2007

Page	Chapter/ Section	Line(s)	Comment Type	Comment
5-6	5.1.20	36	Text	It appears that section 5.1 "Federal Statutes and Policies" runs into a listing of cumulative projects on page 5-8. Separation of the sections by adding 5.2 Cumulative Projects between lines 35 and 36 on p. 5-6, and renumbering thereafter, would address the issue.
5-10	5.1.26	20	Analysis	Again, as stated in the LCR MSCP EIS, p. 1-17, line 8 at 1.2.4 "This EIS/EIR evaluates only the impacts of implementing the Conservation Plan and issuance of a section 10(a)(1)(B) permit by the Service based on this plan because these are the two components of the proposed action." It is important that the scope not be misconstrued. The LCR MSCP EIS did not make findings on the effects of the covered activities from a NEPA perspective.
A-21	A.6.3	32-33	Text	References Table A-22 in Section A-10. A-10 does not include any tables.
A-23	A.6.3.1	1-10	Text	ADWR believes that the shortage distribution between CAP and Priority 4 main stem users should follow the ADWR shortage recommendations
A-24	A.6.3.1	1-2	Text	This line is redundant.
A-24	A.6.3.1	7	Text	It seems that the CRSS model should determine how much shortage is needed to protect the 80P1050 level and absolute protection of elevation 1,000 feet at Lake Mead. The amount of shortage is distributed among the lower Basin users. From the discussion, it appears that the total shortage is not determined by the model, per se.
D-4	Appendix C	Table D-1d	Text	The schedules shown for the Hopi Tribe and Mohave County Water Authority (entitlement portion transferred from the Cibola Valley Irrigation District) do not match the schedules provide by ADWR.
D-7	Appendix C	Table D-1g	Text	Should these schedules be included as part of the CAP contractors' schedules ?
D-9	Appendix C	Table D-1i	Text	The schedule shown for Desert Lawn Memorial Park does not match the schedule provided by ADWR.
E-1 to E-4	Appendix E	Table E-1	Text	The "Date" column within the Table needs to indicate what the date is associated with. The contract and priority dates associated with each entitlement are not always the same, particularly when an entitlement has been transferred. The Department believes that this column should indicate the priority date. The following priority dates that need to be revised are those associated with partial transfers of Cibola Valley Irrigation and Drainage District (CVIDD) entitlements. The dates associated with the Hopi Tribe (Contact No. 04-XX-30-W0432) and Mohave County Water Authority (MCWA) (Contract No. 04-XX-30-W0431) for their surplus, unused apportionment and the fourth priority entitlements need to be changed to CVIDD's 1983 priority date. The priority date for B&F Investment, LLCs entitlement (Contract No. 06-XX-30-W0453) also needs to be changed to 1983.
E-1 to E-4	Appendix E	Table E-1	Text	For 5th and 6th priority entitlements, list the type of water use in the "Use" column rather than listing the priority of the entitlement. Those entitlements that are 5th and/or 6th can be listed under the "5th priority" category.
E-1 to E-4	Appendix E	Table E-1	Text	For those 4th priority entitlement holders that can provide both agricultural and M&I water, present the associated volumes and types of use on separate lines.
E-1 to E-4	Appendix E	Table E-1	Text	For those entitlement holders that have an entitlement that specifies both a consumptive use and a diversion volume, only present the consumptive use volume, or if both values are displayed, only count the consumptive use volume. Counting both values results in an inflated entitlement. The affected entitlement holders include Cibola, Imperial and Havasu National Wildlife Refuges and the City of Parker.
E-1 to E-4	Appendix E	Table E-1	Text	The 5th and 6th priority entitlement associated with Arizona State Land Department Contract No. 4-07-30-W0317 is **9,067** acre-feet, not **9,067.2** acre-feet.
E-1 to E-4	Appendix E	Table E-1	Text	The "not specified ******" and "unquantified ******" footnoted items are not described in footnotes section. To increase legibility, numbers, rather than asterisks, should be used to identify footnoted items.
E-1 to E-4	Appendix E	Table E-1	Text	The Amendment No. 1 of MCWA's Contract No. 05-07-30-W0320, which includes the conversion of 3,500 acre-feet of 5th and 6th priority entitlement to 4th priority entitlement, has been finalized and is ready for signature. As a result, the 3,500 acre-feet of entitlement should be reflected as 4th priority M&I entitlement. The priority date for this entitlement is 1968. The 5th and 6th priority entitlement should continue to remain "upon request" with a priority date of 1995.

S-4

ADWRComments-Revised 042007.xls Page 5 of 7 As of 4/27/2007

Page	Chapter/ Section	Line(s)	Comment Type	Comment
E-1 to E-4	Appendix E	Table E 1	Text	The 5th and 6th priority entitlement that has been subcontracted under the above MCWA contract needs to be revised: Arizona-American Water Company has a subcontract for 950 acre feet; MVIDD has two subcontracts, one for 380 acre-feet and another for 600 acre-feet.
E-1 to E-4	Appendix E	Table E 1	Text	Revise the "Total" for this section (5th priority) according to recommended changes.
E-1 to E-4	Appendix E	Table E 1	Text	The Brooke Water Company's new M&I contract (Contract No. 4-07-30-W0444) has been finalized and is ready for signature. This contract will supersede and replace Brooke's existing contract (Contract No. 4-07-30-W0042). Under the new contract, Brooke will have 360 acre-feet of 1st priority entitlement with a priority date of 1910, 320 acre-feet of 4th priority with a priority date of 1983 and 120 acre-feet of 4th priority with a priority date of 2007.
E-1 to E-4	Appendix E	Table E 1	Text	For "ChaCha", give full entitlement holder name, which is CHACHA, LLC.
E-1 to E-4	Appendix E	Table E 1	Text	CVIDD's total 4th priority entitlement is **12,126** acre-feet, not **12,066** acre-feet. Also, the domestic water component of 300 acre-feet should be presented separately from the 11,826 acre feet that is available for irrigation purposes.
E-1 to E-4	Appendix E	Table E 1	Text	The contract (Contract No. 6-XX-30-W0450) for Fisher's Landing Water and Sewer Works, LLC for 53 acre-feet of 4th priority M&I entitlement has been executed.
E-1 to E-4	Appendix E	Table E 1	Text	Jessen Family Limited Partnership has an irrigation contract (Contract No. 00-XX-30-W0448) for 1,080 acre-feet.
E-1 to E-4	Appendix E	Table E 1	Text	MVIDD – 8,000 acre-feet would better represent the M&I component of the District's 4th priority entitlement. Present 8,000 acre-feet M&I component on separate line from 27,060 acre-feet for irrigation use.
E-1 to E-4	Appendix E	Table E 1	Text	North Baja – Display the 72 acre-feet M&I component on a separate line from North Baja's 408 acre-feet irrigation entitlement.
E-1 to E-4	Appendix E	Table E 1	Text	There is no amount displayed for the total unallocated 4th priority water. The amount is 11,487 acre-feet. As it will be used to cover existing and projected M&I uses, it should be characterized as M&I entitlement.
E-1 to E-4	Appendix E	Table E 1	Text	Revise the "Total" for this section (4th priority) according to recommended changes.
E-1 to E-4	Appendix E	Table E 1	Text	While the Harold Sturges and Erma Sturges Warren Act contracts may not have been terminated, the contract volumes were incorporated into the ASLD irrigation contract (Contract No. 4-07-30-W0317) for farm land that is located within the Gila Monster Ranch. If the contracts are not removed completely from the list, the entitlement amounts need to be removed
E-1 to E-4	Appendix E	Table E 1	Text	Revise the "Total" for this section (2nd/3rd priority) according to receommended changes.
E-1 to E-4	Appendix E	Table E 1	Text	Revise the "Total" for this section (1st priority) according to recommended changes.
G-1	Appendix G	33-35	Text	There is not any mention of the Priority 4 lower Colorado River main stem users and shortage sharing between them and the CAP.
G-3	Appendix G	Table G 2	Text	There is no explanation on how the value of 1,729,907 under the "Consumptive Use Entitlement" is derived for the "Stage 1 Shortage". This is a critical value in the computation of the distribution of the shortages..
G-3	Appendix G	Table G 2	Text	The value under the "Deliverable Consumptive Use" column for Arizona should be **1,063,925** not **2,063,925**.
G-10	Appendix G	Table G 3	Text	In the "CAP Priorities Before 2044 (after Losses)" and "CAP Priorities After 2044 (After Losses)" sections of the, in the CAP 2 row, some of the values shown for the Indian priority water are incorrect. The value **343,097** should be **343,079**. The total of the values shown above the 291,574 acre-feet of Indian priority water should be 51,505 acre-feet not 51,415 acre-feet. GRIC subcontract entitlement listed as 11.305, should be 11,305 - appears twice in table. (PB)
G-14	Appendix G	18	Text	Text references the next 18,735 of shortage (11,305+7,430); Table G-3 total is 18,645 (11,305+7,340)
G-18	Appendix G	2-3	Text	"The consumptive use entitlement column above shows the potential Stage I and II Shortages for each state and Mexico." Change to: The consumptive use reduction column above shows the potential Stage I and Stage II Shortages for each state and Mexico.

ADWRComments-Revised 042007.xls Page 6 of 7 S-4 As of 4/27/2007

Page	Chapter/ Section	Line(s)	Comment Type	Comment
G-20	Appendix G	Table G-9	Text	It would be easier to follow this table if the columns for "Adjusted Delivery" and "Shortage Allocation" were switched.
G-23	Appendix G	Table G-11	Text	The total allocations for CAP Indian priority water should total 343,079 acre-feet, not the 332,966 acre-feet shown in the "Entitlement" section.
G-25	Appendix G	Table G-12	Text	The Hopi Tribe irrigation entitlement that it acquired from CVIDD needs to be included in this Table.
G-25	Appendix G	Table G-12	Text	The Mohave County Water Authority entitlement is in the final stages of the process to convert it to an M&I use to meet the future increased water demands of Bullhead and Lake Havasu cities.
G-25	Appendix G	Table G-12	Text	Although priority 2 and 3 entitlements are considered coequal, the contractors listed under priority 2 should be correctly listed as priority 3.
G-26	Appendix G	Table G-12	Text	Harold and Irma Sturges contracts - Refer to the comment described above regarding the Harold and Irma Sturges contract inclusions in Appendix E, Table E-1.
G-26	Appendix G	Table G-12	Text	The "Arizona Total" values appear to be incorrect. This total and the "Total Ag by County" totals should be equal.
G-47	Appendix G	Table G-15	Text	The "Subtotal Values" in the "Arizona" section of this table do not appear equal the sum of the values for the various Arizona priority groups.
G-107	Appendix G	Table G-55	Text	How were CAP conveyance losses computed.
H-1	Appendix H	1-18	Text	The Salt-River Pima Maricopa Community, the Fort McDowell Indian Community, and the Chuichu District of the Tohono O"Odham Nation are not listed.
H-4	Appendix H, H.3.1.	Table H-2	Text	Several values in this appear to be a negative cost of water. What does this mean?
M-8	Appendix M	10-18	Text	Text indicates that CBS includes voluntary, compensated reductions in water use that also create storage credits in Lake Mead. CBS may create compensated water use reductions OR create water storage in Lake Mead, but may not do both using the same water at the same time. Please add text that describes the timing of conservation savings, when storage occurs, and for how long before application to shortage.

S-4

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Reponses to Comment Letter S-4

The comment letter from Arizona Department of Water Resources included five exhibits: 1) Changes to Volume 1 and Appendix M to conform to the Basin States' Proposal regarding Intentionally Created Surplus, 2) letter from Herb Guenther to Robert W. Johnson dated November 28, 2005, 3) the Director's Shortage Sharing Workgroup Recommendation dated October 24, 2006 (Revised) Final, 4) Arizona Multiple Consecutive Year Shortage Graphs, and 5) ADWR technical corrections to the Draft EIS. The substantive issues contained in these attachments have been addressed in the comment responses below, and Reclamation considered the edits and technical corrections in preparing the Final EIS. Individual comment responses were not developed for each of the editorial and technical corrections in Exhibits 1 and 5 due to their volume and nature.

As described in the Draft EIS, the proposed federal action is comprised of four key elements, one of which is a mechanism for "Lake Mead Storage and Delivery of Conserved System or Non-system Water" (Section 1.2 and Section 2.1). Three of the four action alternatives in the Draft EIS included some expression of a storage and delivery mechanism. Intentionally Created Surplus (ICS), as proposed by the Basin States, is one way to implement this element. Many of Arizona's comments suggested changes to all alternatives and discussion regarding this element. Reclamation believes that the more general statements were appropriate, while acknowledging that references to the Basin States expression of this element should refer to ICS. Consequently, Reclamation has made, as appropriate, the majority of the suggested editorial changes as related to the Basin States Alternative. It should be noted that Reclamation has adopted ICS as the storage and delivery mechanism in the Preferred Alternative and has utilized consistent language when describing that element.

S-4-1

Your comment is noted. No change to the Final EIS was necessary.

S-4-2

Your comment is noted. No change to the Final EIS was necessary.

S-4-3

Your comment is noted. No change to the Final EIS was necessary.

S-4-4

Your comment is noted. No change to the Final EIS was necessary.

S-4-5

Your comment is noted. No change to the Final EIS was necessary.

S-4-6

Reclamation conducted extensive public outreach, held public scoping meetings, and consulted with representatives from the cooperating agencies, Basin States, Indian tribes, non-governmental organizations (NGOs), and other interested parties to obtain input on the scope of the study. The purpose and need for the proposed federal action as well as the action alternatives that were evaluated in the EIS were formulated based on the input that was received throughout the process.

S-4-7 and S-4-8

The No Action Alternative represents a projection of current conditions to the most reasonable future responses that would occur during the life of the proposed federal action without any action alternative being implemented (Section 2.2 of the Draft EIS). Given that there currently are not shortage guidelines in place, specific modeling assumptions were made to obtain a reasonable representation of future conditions under no action (Section 2.2.1).

S-4-9

Your comment is noted. No change to the Final EIS was necessary.

S-4-10

Your comment is noted. No change to the Final EIS was necessary.

S-4-11

Your comment is noted. No change to the Final EIS was necessary.

S-4-12

Your comment is noted. No change to the Final EIS was necessary.

S-4-13

Your comment is noted. No change to the Final EIS was necessary.

S-4-14

Your comment is noted. No change to the Final EIS was necessary.

S-4-15

Your comment is noted. No change to the Final EIS was necessary.

S-4-16

Your comment is noted. No change to the Final EIS was necessary.

S-4-17

Your comment is noted. See also responses to Comment Nos. F-5-2 and F-5-5.

S-4-18

Your comment is noted. No change to the Final EIS was necessary.

S-4-19

Your comment is noted. No change to the Final EIS was necessary.

S-4-20

Your comment is noted. No change to the Final EIS was necessary.

S-4-21

Your comment is noted. No change to the Final EIS was necessary.

S-4-22

Your comment is noted. No change to the Final EIS was necessary.

S-4-23

Your comment is noted. No change to the Final EIS was necessary.

S-4-24

Your comment is noted. Where appropriate, changes have been made throughout the Final EIS to more clearly describe the ICS mechanism.

S-4-25 and S-4-26

Your comment is noted. No change to the Final EIS was necessary.

S-4-27 and S-4-28

Your comment is noted. Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that discuss the administration of ICS, including a description of the forbearance necessary for the creation and delivery of ICS.

S-4-29

Your comment is noted. No change to the Final EIS was necessary.

S-4-30

Your comment is noted. No change to the Final EIS was necessary.

S-4-31

Your comment is noted. No change to the Final EIS was necessary.

S-4-32

Your comment is noted. No change to the Final EIS was necessary.

S-4-33 and S-4-36

Your comment is noted. Appropriate modeling assumptions used in the Final EIS were modified to be consistent with the Director's Shortage Sharing Workgroup Recommendation (Section 3.4.6.1 and Appendix G). In addition, Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that reflect the Shortage-Sharing Agreement with Nevada.

S-4-37

Your comment is noted. A quantitative analysis of the probabilities of multi-year shortages has been added to Section 4.4.1 and to the subsequent resource analysis, where appropriate.

S-4-38

See response to Comment No. L-1-11.

S-4-39

The quantitative assessment of the socioeconomic effects of the loss of agricultural production did not assume that some agricultural producers would switch from surface water to groundwater. Farm production costs would increase if pumping groundwater is more expensive than purchasing surface water. However, keeping agricultural lands in production by switching to groundwater during a shortage would also reduce the losses in employment, income, and tax revenues reported in the EIS.

S-4-40

Your comment is noted. See response to S-4-37.

S-4-41

See response to Comment No. L-1-11.

S-4-42

The Draft EIS did address socioeconomic impacts to the agricultural sector at the County level, including impacts along the Colorado River mainstream (e.g. Mohave County). Reclamation concurs that fourth priority municipal contractors such as Lake Havasu City and Bullhead City will be affected by shortages, and additional information has been added to the Final EIS to acknowledge this. The specific reductions distributed to affected Arizona M&I users under specific shortage determinations is included in Appendix G. See also response to Comment No. G-1-25.

S-4-43

Your comment is noted. No change to the Final EIS was necessary.

S-4-44

See also response to Comment No. G-1-25.

S-4-45

Your comment is noted. Additional information regarding the Arizona Water Bank has been added to the Final EIS in Section 3.4 and 4.14.

S-4-46

Your comment is noted. No change to the Final EIS was necessary.

S-4-47

See response to Comment No. S-2-14.

S-4-48

Your comment is noted. No change to the Final EIS was necessary.

CHANGES TO DEIS VOLUME I AND APPENDIX M TO CONFORM TO BASIN STATES PROPOSAL RE INTENTIONALLY CREATED SURPLUS

ES.1 Background

The Secretary of the United States Department of the Interior (Secretary), acting through the Bureau of Reclamation (Reclamation), proposes to adopt specific interim guidelines for Colorado River Lower Basin (Lower Basin) shortages and coordinated operations for Lake Powell and Lake Mead, particularly under drought and low reservoir conditions.

Reclamation, as the agency that is designated to act on the Secretary's behalf with respect to operation of Olen Canyon Dam and Hoover Dam and managing the mainstream waters of the lower Colorado River pursuant to federal law, is the lead federal agency for the purposes of compliance pursuant to the National Environmental Policy Act of 1969 (NEPA) for the development and implementation of the proposed interim guidelines. Five federal agencies are cooperating for purposes of assisting with environmental analysis and preparation of the Draft EIS. The cooperating agencies are the Bureau of Indian Affairs (BIA), United States Fish and Wildlife Service (FWS), National Park Service (NPS), Western Area Power Administration (Western), and the United States Section of the International Boundary and Water Commission (USIBWC).

The Draft EIS includes six chapters as outlined below:

- Chapter 1: Purpose and Need;
- Chapter 2: Description of Alternatives;
- Chapter 3: Affected Environment;
- Chapter 4: Environmental Consequences;
- Chapter 5: Other Considerations and Cumulative Impacts; and
- Chapter 6: Consultation and Coordination.

ES.1.1 Purpose and Need for Action

During the period of 2000 through 2006, the Colorado River Basin experienced the worst drought conditions in approximately one hundred years of recorded history. During this period, storage in Colorado River reservoirs has dropped from nearly full to less than 60 percent of capacity at the end of 2006. Currently, the Department of the Interior (Department) does not have specific operational guidelines in place to define the circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead nor to address the coordinated operations of Lake Powell and Lake Mead during drought and low reservoir conditions.

643132.05

S-4

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Rebecca Palmer

From: Clearinghouse [clearinghouse@budget.state.nv.us]
Sent: Friday, March 02, 2007 10:46 AM
To: Rebecca Palmer
Subject: E2007-257 DEIS for Lower Basin Shortages and Operations for Lk Mead and Lk Powell - Lower Colorado Region

NEVADA STATE CLEARINGHOUSE
Department of Administration, Budget and Planning Division
209 East Musser Street, Room 200, Carson City, Nevada 89701-4298
(775) 684-0209 Fax (775) 684-0260
DATE: March 2, 2007

State Historic Preservation Office

Nevada SAI # E2007-257
Project: DEIS for Lower Basin Shortages and Operations for Lk Mead and Lk Powell

Follow the link below to download an Adobe PDF document concerning the above-mentioned project for your review and comment.

http://www.usbr.gov/lc/region/programs/strategies/draftEIS/index.html

Please evaluate it with respect to its effect on your plans and programs; the importance of its contribution to state and/or local areawide goals and objectives; and its accord with any applicable laws, orders or regulations with which you are familiar.

Please submit your comments no later than Tuesday, April 24, 2007.

Use the space below for short comments. If significant comments are provided, please use agency letterhead and include the Nevada SAI number and comment due date for our reference. Questions? Gosia Sylwestrzak, (775) 684-0209 or mailto:clearinghouse@budget.state.nv.us

____No comment on this project ____Proposal supported as written

AGENCY COMMENTS: The SHPO looks forward to consultations with the NPS and BREC on the effect to cultural resources from the undertaking. 1

Signature: Rebecca Palmer Date: 3/2/07

Distribution:
Gary McCuin, Department of Agriculture
Phillip Lehr, Colorado River Commission
Sandy Quilici, Department of Conservation & Natural Resources Stephanie Martensen, Division of Emergency Management Stan Marshall, State Health Division Skip Canfield, AICP, Division of State Lands Michael J. Stewart, Legislative Counsel Bureau Sandi Gotta, Division of Conservation Districts John Walker, Nevada Division of Environmental Protection Catherine Cuccaro, Department of Transportation Anthony Grossman, Department of Wildlife, Director's Office D. Bradford Hardenbrook, Department of Wildlife, Las Vegas Robert Martinez, Division of Water Resources James D. Morefield, Natural Heritage Program Steve Weaver, Division of State Parks Mark Harris, PE, Public Utilities Commission Pete Konesky, State Energy Office Rebecca Palmer, State Historic Preservation Office John Muntean, UNR Bureau of Mines Jon Price, UNR Bureau of Mines Cliff Lawson, Nevada Division of Environmental Protection Russ Land, Nevada Division of Environmental Protection Gosia Sylwestrzak, zzClearinghouse Reese Tietje, zzClearinghouse -Reese Maud Naroll, zzClearinghouse-Maud Gosia Sylwestrzak, zzClearinghouse -Gosia

S-5

1

JIM GIBBONS
Governor

STATE OF NEVADA

ANDREW K. CLINGER
Director

DEPARTMENT OF ADMINISTRATION
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Carson City, Nevada 89701-4298
(775) 684-0222
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http://www.budget.state.nv.us/

April 24, 2007

Terrance Fulp
US Department of the Interior
Bureau of Reclamation
Lower Colorado Region
PO Box 61470
Boulder City, NV 89006

Re: SAI NV # **E2007-257** Reference: **BCOO-1000 ENV-6.00**

Project: **DEIS for Lower Basin Shortages and Operations for Lk Mead and Lk Powell**

Dear Terrance Fulp:

Enclosed are comments from the agencies listed below regarding the above referenced document. Please address these comments or concerns in your final decision.

Division of State Lands

State Historic Preservation Office

The following agencies support the above referenced document as written:

Division of State Lands

This constitutes the State Clearinghouse review of this proposal as per Executive Order 12372. If you have questions, please contact me at (775) 684-0209.

Sincerely,

for

Gosia Sylwestrzak
Nevada State Clearinghouse

Enclosure

4/30/07

BCOO 1000
1003

S-5

The Nevada Division of State Lands supports this proposal. 2

Skip Canfield, AICP

-----Original Message-----
From: Clearinghouse [mailto:clearinghouse@budget.state.nv.us]
Sent: Friday, March 02, 2007 10:46 AM
To: Skip Canfield
Subject: E2007-257 DEIS for Lower Basin Shortages and Operations for Lk Mead and Lk Powell - Lower Colorado Region

NEVADA STATE CLEARINGHOUSE
Department of Administration, Budget and Planning Division
209 East Musser Street, Room 200, Carson City, Nevada 89701-4298
(775) 684-0209 Fax (775) 684-0260
DATE: March 2, 2007

Division of State Lands

Nevada SAI # E2007-257
Project: DEIS for Lower Basin Shortages and Operations for Lk Mead and Lk Powell

Follow the link below to download an Adobe PDF document concerning the above-mentioned project for your review and comment.

http://www.usbr.gov/lc/region/programs/strategies/draftEIS/index.html

Please evaluate it with respect to its effect on your plans and programs; the importance of its contribution to state and/or local areawide goals and objectives; and its accord with any applicable laws, orders or regulations with which you are familiar.

Please submit your comments no later than Tuesday, April 24, 2007.

Use the space below for short comments. If significant comments are provided, please use agency letterhead and include the Nevada SAI number and comment due date for our reference. Questions? Gosia Sylwestrzak, (775) 684-0209 or mailto:clearinghouse@budget.state.nv.us.

____No comment on this project ____Proposal supported as written

AGENCY COMMENTS:

Signature: Date:

Distribution:
Gary McCuin, Department of Agriculture
Phillip Lehr, Colorado River Commission
Sandy Quilici, Department of Conservation & Natural Resources
Stephanie Martensen, Division of Emergency Management

S-5

Stan Marshall, State Health Division
Skip Canfield, AICP, Division of State Lands
Michael J. Stewart, Legislative Counsel Bureau
Sandi Gotta, Division of Conservation Districts
John Walker, Nevada Division of Environmental Protection
Catherine Cuccaro, Department of Transportation
Anthony Grossman, Department of Wildlife, Director's Office
D. Bradford Hardenbrook, Department of Wildlife, Las Vegas
Robert Martinez, Division of Water Resources
James D. Morefield, Natural Heritage Program
Steve Weaver, Division of State Parks
Mark Harris, PE, Public Utilities Commission
Pete Konesky, State Energy Office
Rebecca Palmer, State Historic Preservation Office
John Muntean, UNR Bureau of Mines
Jon Price, UNR Bureau of Mines
Cliff Lawson, Nevada Division of Environmental Protection
Russ Land, Nevada Division of Environmental Protection
Gosia Sylwestrzak, zzClearinghouse
Reese Tietje, zzClearinghouse -Reese
Maud Naroll, zzClearinghouse-Maud
Gosia Sylwestrzak, zzClearinghouse -Gosia

S-5

Reponses to Comment Letter S-5

S-5-1

Reclamation is proceeding with the Section 106 (36 CFR 800) compliance process, including consultation with the Nevada SHPO and other interested parties.

S-5-2

Your comment is noted. No change to the Final EIS was necessary.

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04/30/2007 16:06 FAX 8015387279 Utah Div of Water Res 001

State of Utah

Department of Natural Resources

MICHAEL R. STYLER
Executive Director

Division of Water Resources

DENNIS J. STRONG
Division Director

JON M. HUNTSMAN, JR.
Governor

GARY R. HERBERT
Lieutenant Governor

FAX TRANSMITTAL COVER SHEET

Date April 30, 2007

Time 3:55 pm

TO:

Name Regional Director

Agency USBR

Telephone No. ____________ Fax No. 702-293-8156

FROM:

Name UTAH Division of Water Resources - Dennis Strong

Telephone No. 801-538-7250 Fax No. (801) 538-7279

TOTAL NUMBER OF PAGES (INCLUDING COVER SHEET) 4

COMMENTS:

UTAH's comments on DEIS

1594 West North Temple, Suite 310, PO Box 146201, Salt Lake City, UT 84114-6201
telephone (801) 538-7230 • facsimile (801) 538-7279 • www.water.utah.gov

S-6

State of Utah

Department of Natural Resources

MICHAEL R. STYLER
Executive Director

Division of Water Resources

DENNIS J. STRONG
Division Director

JON M. HUNTSMAN, JR.
Governor

GARY R. HERBERT
Lieutenant Governor

April 30, 2007

Honorable Dirk Kempthorne
Secretary of the United States Department of the Interior
1849 C. Street, NW
Washington, D.C. 20240

Utah Division of Water Resources comments on the *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

Mr. Secretary:

The Utah Division of Water Resources submits the following comments to the *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Draft Environmental Impact Statement* (February 2007). The Director of the Utah Division of Water Resources is the Governor of Utah's designated representative with the responsibility to consult, advise and confer with the Secretary of Interior on Colorado River operations.

Reclamation Should Adopt the Basin States' Alternative as the Preferred Alternative

Utah recommends the Secretary adopt the Basin States' Alternative as the preferred alternative as this is the result of extensive negotiations and compromise 1
among the seven Colorado River Basin States. The Basin States Alternative addresses the issues identified during the Environmental Impact Statement (EIS) scoping process, and it can be implemented immediately upon issuance of the 2
Record of Decision (ROD).

Five alternatives were analyzed in the Draft EIS to provide a wide range of operation evaluations. Only the Basins States' Alternative can be readily implemented and accomplish the purposes identified during scoping. 3
While the analysis of the No Action and Water Supply Alternatives provide a broad range of impacts, neither includes criteria for the coordinated operation of Lake Powell and Lake Mead, 4
or specific guidelines for the implementation of future water supply reductions in the Lower Colorado River Basin under defined shortage conditions. 5

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telephone (801) 538-7230 • facsimile (801) 538-7279 • www.water.utah.gov

S-6

04/30/2007 16:07 FAX 8015387279 Utah Div of Water Res 003

The Honorable Dirk Kempthorne
April 30, 2007
Page 2:

Implementation of the Conservation Before Shortage (CBS) or the Reservoir Storage
Alternative would require extensive changes to the Law of the River, which Utah disfavors. The CBS 6
Alternative includes the intentional creation of surplus and release of the surplus on the positive side
from Lake Mead contained in the Basin States' Alternative. But it depends on a funding mechanism
that does not currently exist. "Reclamation currently does not have the authority to implement all 7
facets of this proposal and additional legislation would be necessary to gain such authority."[1] The
CBS Alternative proposes allowing for the intentional creation of surplus by Mexico, and release of
Intentionally Created Surplus (ICS) to Mexico in excess of the maximum delivery volumes identified 8
in the 1944 Treaty. Therefore, a Treaty amendment would be required to accommodate the creation 9
by and delivery of ICS water to Mexico. Because discussion with Mexico of the specific criteria that
would govern the accounting and delivery of this water has just begun implementation of this 10
alternative would be slow and complex.

The Reservoir Storage Alternative, like the No Action and Water Supply Alternatives, serves a
valuable purpose by allowing analysis of a broad range of impacts in the EIS. Its provisions that
impound water for power generation and recreation benefit Utah to the detriment of downstream 11
agricultural and domestic uses while we would welcome such benefits they may be in violation of
Article IV (b) of the Colorado River Compact (Compact). And, the Reservoir Storage Alternative 12
does not address many of the other issues identified during the scoping phase and thus does not meet 13
all needs identified.

<u>Basin State Proposed Guidelines.</u>

Since the February 3, 2006 letter to the Secretary outlining the Basin States' Alternative, the
seven Colorado River Basin States have met extensively and developed Proposed Interim Guidelines
for Colorado River Operations to implement the Basin States' Alternative as well as the necessary
agreements among the states. These proposed guidelines are being transmitted jointly by the seven
Colorado River Basin States in a separate submission. Utah strongly endorses these proposed
guidelines as providing a framework to meet future demand on the Colorado River during the interim 14
period (present to 2026).

<u>Default Operating Criteria after Termination of Interim Guidelines</u>

For the most part, the Interim Guidelines that would be put in place upon adoption of a ROD in
concert with the Basin States Alternative will terminate in 2026, and could, under certain
circumstances, terminate prior to 2026. The DEIS does not clearly set forth the default operating
criteria for Lakes Powell and Mead that would apply upon termination of the Interim Guidelines. The 15
proposed guidelines by the Seven Basin States submitted as comments to the DEIS remedy this

---

[1] Page 2-13, Draft EIS, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.

S-6

The Honorable Dirk Kempthorne
April 30, 2007
Page 3:

deficiency. Upon termination of those guidelines, operations of the Colorado Rivers System will
revert to the baseline conditions of the Final Environmental Impact Statement for the Interim Surplus
Guidelines dated December 2000 (i.e. modeling assumptions are based upon a 70R strategy for the 16
period commencing January 1, 2026).

<u>2020 Review</u>

The Seven Basin States' Proposed Guidelines also include a review beginning no later than
December 31, 2020 to evaluate the effectiveness of operations under these guidelines. As part of this 17
review, the Secretary should also undertake the development process to account for the Mexican
Treaty obligations. In addition to the Compact delivery of 75 million acre-feet over 10 years, the
Upper Basin is only responsible for one-half of the deficiency in the Lower Basin towards meeting the 18
Mexican Treaty obligation. Such Mexican Treaty deficiency accounting has never been under taken
and Utah strongly objects to the release of any water by the Upper Basin to meet the Mexican Treaty
delivery requirement unless such an accounting process is in place and is used to determine the 19
required amount from the Upper Basin. Upon termination of these guidelines the Mexican Treaty
issue should be addressed and resolved so as to justify the release of any Upper Basin water to meet 20
Mexican Treaty obligations.

To summarize Utah's comments, Utah requests the Secretary designate the Basin States' Alternative as the preferred alternative and give strong preference to the Basin States' Proposed Guidelines on Colorado River Operations when formulating its Record of Decision.

Respectfully,

Dennis J. Strong, P.E.
Director
Governor's Representative

S-6

Reponses to Comment Letter S-6

S-6-1

Your comment is noted. No change to the Final EIS was necessary.

S-6-2

Your comment is noted. No change to the Final EIS was necessary.

S-6-3

Your comment is noted. No change to the Final EIS was necessary.

S-6-4

Your comment is noted. No change to the Final EIS was necessary.

S-6-5

Your comment is noted. No change to the Final EIS was necessary.

S-6-6

Your comment is noted. No change to the Final EIS was necessary.

S-6-7

Your comment is noted. No change to the Final EIS was necessary.

S-6-8 through S-6-10

Your comment is noted. No change to the Final EIS was necessary. See also responses to Comment Nos. F-5-2 and F-5-5.

S-6-11

Your comment is noted. No change to the Final EIS was necessary.

S-6-12

Your comment is noted. No change to the Final EIS was necessary.

S-6-13

See response to Comment No. IT-2-1.

S-6-14

Your comment is noted. No change to the Final EIS was necessary.

S-6-15 and S-6-16

See response to Comment S-2-11.

S-6-17

See response to Comment No. S-2-14.

S-6-18 through S-6-20

Your comment is noted. No change to the Final EIS was necessary.

STATE OF CALIFORNIA – THE RESOURCES AGENCY ARNOLD SCHWARZENEGGER, Governor

COLORADO RIVER BOARD OF CALIFORNIA
770 FAIRMONT AVENUE, SUITE 100
GLENDALE, CA 91203-1068
(818) 500-1625
(818) 543-4685 FAX

VIA: Electronic Mail
& U.S. Mail

April 30, 2007

The Honorable Dirk Kempthorne, Secretary
Department of the Interior
1849 C Street, NW
Washington, D.C. 20240

Re: Colorado River Board of California Comments on *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

Dear Secretary Kempthorne:

Thank you for the opportunity for California to provide comments on the *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* (72 *FR* 39, 9026-9028) (February 28, 2007) ("DEIS") released for review and comment by the U.S. Bureau of Reclamation (Reclamation). The purpose of this letter is to provide the Department of the Interior and Reclamation with several comments associated with the DEIS, as well as indicate California's overall support for the adoption of the Basin States Alternative as the preferred alternative in the Final Environmental Impact Statement 1
(FEIS) and subsequent Record of Decision (ROD).

As the Department of the Interior knows, the water and power resources of the Colorado River System are of utmost importance to the 36 million residents in the State of California, particularly the nearly 21 million residents in the metropolitan and agricultural regions of southern California. Water supplies diverted from the mainstream of the Colorado River, and utilized in southern California, support an overall service area economy in excess of $850 billion annually. Consequently, decisions made regarding the management, use, and accounting of Colorado River water are of significant interest and concern to the State of California, the Colorado River Board of California (Board), as well as specific agencies within California holding entitlements to Colorado River mainstream water.

With the adoption of the Interim Surplus Guidelines in January 2001 and California's implementation of the 2003 Colorado River Water Delivery Agreement and Quantification Settlement Agreement (QSA), the State's Colorado River water entitlement-holders have worked diligently to ensure that California continues to live within its basic mainstream apportionment of 4.4 million acre-feet, while encouraging and supporting the efficient management and administration of the Colorado River reservoir system. Ongoing programs and activities within California and the other Lower Division States contribute to more efficient management of the water supplies stored, diverted, and used by entitlement-holders in the Lower and Upper Basins (e.g., All-American Canal

S-7

The Honorable Dirk Kempthorne, Secretary
April 30, 2007
Page 2

Lining Project, Lower Colorado Water Supply Project, Off-stream storage programs, weather modification demonstration programs, etc.).

With the goal of establishing an interim period of more efficient reservoir system management and shortage guidelines during periods of drought within the Basin, California urges the Department of the Interior to adopt the Basin States' Alternative as articulated in the Basin States' Proposed Guidelines as the preferred alternative in the FEIS and subsequent ROD. Toward this end, California joins with the other six Colorado River Basin states in support of the following elements of the Basin States' package submitted to the Department of the Interior and Reclamation on April 30, 2007: (1) Basin States' Letter, dated April 30, 2007; (2) Proposed Interim Guidelines for Colorado River Operations; (3) Agreement Concerning Colorado River Management and Operations; (4) Lower Colorado River Basin Intentionally Created Surplus Forbearance Agreement; and (5) Shortage Sharing Agreement between Arizona and Nevada. An additional element of this package will need to be a water delivery agreement or agreements between the Secretary and the Parties to the Forbearance Agreement. 2

<u>California's Specific Comments on the DEIS</u>

In addition to California's endorsement and support of the Basin States' Alternative, the Board submits several specific comments regarding the information described within the DEIS. These comments address issues or concerns that for the most part are unique to California and are therefore submitted separately from the comments submitted on April 30, 2007, by the Colorado River Basin States Governors' Representatives on Colorado River Operations. These specific comments or concerns include the following:

Issues Related to Stage-Two Shortage-Sharing

In various places within the DEIS (e.g., section 2.2.1 on pages 2-5 and 2-6 and section 4.2.7.1 on pages 4-9 and 4-10), the document sets forth an assumption regarding Stage-Two shortages that result in California receiving 60 to 65 percent of such shortages. This is an incorrect assumption under the Law of the River and does not reflect the priority position of the California water delivery contractors relative to the positions of other Colorado River mainstream entitlement-holders. 3

If interim guidelines on Colorado River operations proposed for adoption by the Secretary cover possible shortage situations greater than the post-September 30, 1968, volume of contractual and other water rights (approximately 1.7 to 1.8 million acre-feet (maf) depending upon the year), then imposition of Stage-Two shortages would be based on the priority dates of the water entitlements in the June 25, 1929, to September 30, 1968, pool of contracts and other water rights without regard to state lines. Delivery of water would then be reduced to the holder of the second most recent priority if insufficient water were available for delivery. Reductions in deliveries would then continue in 4

S-7

The Honorable Dirk Kempthorne, Secretary
April 30, 2007
Page 3

reverse order of priority date. If the maximum shortage considered for purposes of this DEIS during the interim period is 2.5 maf, then the correct assumption is that California entitlement-holders would not experience a reduction in deliveries during a Stage-Two shortage. 4

Tables E-2 and G-18 and California Entitlement Holders

Table E-2 (State of California Colorado River Water Entitlement Holders and Priorities; Appendix E) contains a listing of California entitlement-holders and their diversion and consumptive use entitlements. Table G-18, (State of California; Appendix G) contains the listing of California entitlement-holders and their assumed adjusted deliveries during a 400,000 acre-foot shortage in 2017. These two tables contain several errors. For ease of reference, the Board has attached corrected versions of these tables and requests Reclamation to make these corrections in the FEIS. 5

Both Tables E-2 and G-18 imply that Water Certificates have been issued for use of water on the Yuma Island in California. The Board has found no evidence of the issuance of any Water Certificates for use of water on the Island. Thus, Reclamation should clarify this fact in the FEIS and revise the tables accordingly. 6

Furthermore, Reclamation should refer to the August 5 and 9, 2002, "Submittal of the Colorado River Board of California, Coachella Valley Water District, Imperial Irrigation District, Los Angeles Department of Water and Power, Metropolitan Water District of Southern California, Palo Verde Irrigation District, and San Diego County Water Authority regarding 'Review of Water Use On The Yuma Island," copies of which were provided to Reclamation's Lower Colorado Regional Director. It has been the long-standing position of the Board and the six agencies that water use on Yuma Island in California are illegal and should be eliminated, particularly when California is limited to use of 4.4 maf of water from the Colorado River. 7

Lake Mead Reservoir Elevations

Two of the alternatives analyzed in the DEIS include imposition of reduced deliveries to permit the elevation of Lake Mead to remain at or above elevation 1,000 feet, Southern Nevada Water Authority's lowest water intake. This condition, however, was not an element of the Basin States' Alternative. 8 California suggests that, in order to present information on the full range of potential impacts associated with possible droughts that is as complete and accurate as possible, the FEIS include 2005 natural flow data 9 and further sensitivity analysis of the possible influence of climate change and global warming on runoff during the 2008 to 2060 study period. 10 In this regard, California suggests that Reclamation review the latest data and information from reports such as the recent United Nations report on climate change and global warming and other proxy record data describing potential streamflow and precipitation conditions within the Colorado River Basin. 11

S-7

The Honorable Dirk Kempthorne, Secretary
April 30, 2007
Page 4

Voluntary/Involuntary Shortages & Economic Impacts Analysis

In numerous places in the DEIS the potential impacts of voluntary (i.e., contained within the 'Conservation Before Shortage' Alternative) and involuntary shortages are analyzed and discussed. As a general matter, California suggests that the potential socioeconomics and air quality impacts of such shortages need to be more fully addressed. 12 For example, under the 'Conservation Before Shortage' Alternative the maximum suggested water conservation amount is 600,000 acre-feet in one year. If that were to be carried out through land fallowing, about 100,000 acres of farmland would need to be fallowed. Although the exact location of the fallowed farmland cannot be forecast with precision at this stage, the general location of the larger irrigation districts in California and Arizona is well understood. 13 Accordingly, the FEIS should contain a more thorough explanation and analysis of the potential impact resulting from land fallowing as a means of voluntary conservation. 14

With respect to the 'Conservation Before Shortage' Alternative, page 4-275 of the DEIS states that the potential socioeconomic impacts resulting from voluntary shortages would be offset by payments made to farmers to forgo raising crops. Given the large volume of fallowing that might occur under this alternative, it is unclear whether this is a correct assumption supported by available data. For example, the FEIS should include reference to economic data related to ongoing voluntary fallowing programs to either support or refine this conclusion. 15

The air quality section of the DEIS at page 4-149 describes the potential effects on air quality at Lake Powell, Lake Mead, and the Glen Canyon-Lake Mead reach from particulate matter emissions. This section of the DEIS does not describe the potential effects on air quality resulting from the fallowing of as much as 100,000 acres of farmland as a voluntary conservation measure or how those potential effects may be minimized and mitigated. 16

Default Operating Criteria after Termination of the Interim Guidelines

Consistent with the 2001 Interim Surplus Guidelines , the Basin States' Proposed Interim Guidelines state: "At the conclusion of the effective period of these Guidelines, the operating criteria for Lake Powell and Lake Mead are assumed to revert to the operating criteria used to model baseline conditions in the Final Environmental Impact Statement for the Interim Surplus Guidelines dated December 2000 (i.e., modeling assumptions are based upon a 70R strategy for the period commencing January 1, 2026 (for preparation of the 2027 AOP))." 17

The Basin States' proposed guidelines regarding access to surplus supplies address a full range of expected operations for both Lake Powell and Lake Mead during the interim period of 2008 through 2025 (through preparation of the 2026 AOP). Since there is no reliable way to predict the elevation of the reservoirs on January 1, 2027, it is important to address the possibility that the Lower Basin would be in a Shortage Condition, rather than in a Surplus Condition.

S-7

The Honorable Dirk Kempthorne, Secretary
April 30, 2007
Page 5

The DEIS addressed this scenario. Presumably, the FEIS, new interim surplus guidelines, and ROD
also will address this possibility of shortage conditions. Therefore, to be consistent with the
assumptions in the DEIS, California suggests that Reclamation apply the modeling assumption of
"80P1050" (shortage trigger elevation to prevent Lake Mead's water level from declining below 18
1,050 feet with approximately an 80 percent probability, commencing January 1, 2026) for
preparation of the 2027 AOP. Reclamation would apply this default strategy if the Secretary and the
Basin States could not agree on an operating strategy that extends or modifies any new interim 19
guidelines for Colorado River operations.

Recent Mainstream Water Use by California

Several places in the DEIS suggest that California is in the process of *reducing* its water use from
the Colorado River (see, e.g., p. 1-22:4-6, p. 1-25 and 3-36). These sections of the DEIS reflect an 20
inaccurate perspective. As Reclamation has reported in its annual "Colorado River Accounting and
Water Use Report, Arizona, California, and Nevada," California's annual Colorado River water use
was less than 4.4 million acre-feet in 2004 and 2005. Accordingly, it is inaccurate to suggest that
California needs to implement programs to assist "in reducing its projected Colorado River depletion 21
to its normal apportionment of 4.4 maf" (page 3-36). Under the current version of California's
Colorado River Water Use Plan and other documents, such as the 2003 QSA and related agreements, 22
California is in the process of shifting some water use within its 4.4 maf per year normal
apportionment, from agricultural to municipal/industrial use for a period of years.

Description of Conservation Before Shortage Alternative

In various places in the DEIS, and specifically in Appendix M (modeling assumptions) the
'Conservation Before Shortage' Alternative is discussed and analyzed. However, Reclamation does
not carefully distinguish between two separate components advanced in the 'Conservation Before
Shortage' Alternative in Chapter 2 of the DEIS, Description of Alternatives, at page 2-12: 23

1) actions to avoid a shortage by paying users to fallow land; and

2) allowing "others" to participate in the Intentionally Created Surplus (ICS) program by creating ICS credits to meet certain proposed consumptive uses.

The main purpose of the 'Conservation Before Shortage' Alternative, is to create storage in Lake
Mead through compensated voluntary land fallowing, hopefully to counteract the impact of Lower 24
Basin shortages. Lake Mead would retain that water presumably to forestall a shortage threat,

S-7

The Honorable Dirk Kempthorne, Secretary
April 30, 2007
Page 6

instead of devoting that water to specific downstream uses.[1] In contrast, the development of ICS
credits by "others" is for the specific purpose of having water that can then be *used* for specific 25
environmental or other purposes either within the United States or in Mexico. Section 2.4 of the
FEIS should clearly explain these concepts so that the reader fully will understand these two distinct 26
operational approaches.

Mexican Treaty Issues

The "Congressional Budget Justification, Fiscal Year 2008, United States Department of State," states on page 838 (copy attached) that the United States Section of the International Boundary and Water Commission (USIBWC) plans to:

> *"Conclude discussions or consultations with Mexico related to development of shortage*
> *criteria for Colorado River deliveries carried out pursuant to the 1944 Water Treaty"* 27

in Fiscal Year 2007. California fully supports the conclusion of these discussions or consultations in Fiscal Year 2007 to permit USIBWC to inform Reclamation of the volume of deliveries to be made to Mexico, beginning in 2008, in years in which insufficient mainstream water is available for release to satisfy annual consumptive use of 7.5 maf in Arizona, California, and Nevada.

Conclusion of these discussions or consultations is important because of the interrelationship
between reductions in deliveries to Mexico during shortage conditions and the effectiveness of the
Basin States Proposal for stepped reductions in deliveries to minimize the frequency and magnitude 28
of shortages in the Colorado River System. The Basin States Proposal is premised on deliveries to
Mexico being reduced in proportion to the reduction in deliveries to the Lower Division States under
the Step One, Step Two and Step Three reductions, so that the aggregate annual reductions in 29
deliveries in both the Lower Division States and Mexico under those steps will total 400,000 acre-
feet, 500,000 acre-feet and 600,000 acre-feet, respectively. The DEIS has used this assumption in
modeling the impacts of the Basin States Alternative, and the Basin States Agreement, which was
included in the package submitted to the Department of the Interior on April 30, 2007, provides that 30
California users shall not bear any portion of those reductions. These aggregate reductions in
deliveries from Lake Mead are essential to maintain reservoir levels under the coordinated operating
criteria contained in the Basin States Proposal. These stepped reductions are not the exclusive
conditions under which deliveries to Mexico may be reduced, and other circumstances may require 31
reductions in deliveries to Mexico under the 1944 Water Treaty with Mexico.

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1 See page 2 of the 'Conservation Before Shortage' proposal in Appendix K – "Federal ICS credits created in excess of the federal cap [of 1.5 maf to be devoted to replacement of bypass flows] would become system water."

S-7

The Honorable Dirk Kempthorne, Secretary
April 30, 2007
Page 7

Elimination of Interim Surplus Guidelines benchmarks

Section 10 of the proposed Guidelines incorporates certain provisions from Section 5 of the Interim 32
Surplus Guidelines (ISG) approved in 2001. The purpose and function of Section 5 of the ISG, and
of the benchmarks in particular, was to provide assurances to the other Basin states as California
reduced its use of Colorado River water from about 5.2 maf to 4.4 maf over a period of years. In 33
fact, at the time of the development of the ISG this was referred to as a "soft landing" for California
so as to not unnecessarily impose an abrupt usage reduction from 5.2 maf to 4.4 maf if surplus water
was not available. However, in light of the drought situation that unfolded in 2002 and 2003,
California was compelled to reduce its use of Colorado River water to 4.4 maf at the beginning of 34
2003, and California's use of Colorado River water was below 4.4 maf in 2004 and 2005 and based
on preliminary records in 2006.

Furthermore, the terms of the 2003 Colorado River Water Delivery Agreement, the QSA, and related
agreements are binding on the California parties; and there is also an order of the California State
Water Resources Control Board relating to the transfer of conserved water from Imperial Irrigation 35
District. All of these factors indicate that circumstances have changed and the magnitude of
California's use of Colorado River water poses no meaningful risk to the other Basin states.
Moreover, any failure or modification of the QSA and related agreements presents risks solely for
parties within California who would then have to consider remedies that would be effectuated by the 36
California parties. Stated differently, there is currently no meaningful purpose or function behind
the California benchmark provisions in the proposed Guidelines (see sections 1.7.6.2, 1.8.3, and
1.8.4 of Volume 1 of the DEIS) as benchmarks for the State of California's agricultural use are the 37
subject of Section 8 of the October 10, 2003, Colorado River Water Delivery Agreement that
Secretary of the Interior Norton signed. Thus, the benchmarks and associated text need not be a part
of the final EIS and the ROD.

Conclusion

In summary, California wishes to reiterate its support for the Basin States' Alternative, as described
in the Basin States' "Proposed Interim Guidelines for Colorado River Operations." Further,
California urges the Department of the Interior and Reclamation to adopt this proposal as the
preferred alternative in the FEIS and to reflect this decision in the subsequent ROD. This proposal
represents many months of hard work among the Basin States representatives; and it reflects the 38
spirit of interstate comity and goodwill that has been developed during the course of this very
important process. Finally, California requests that the Department of the Interior forward
California's specific comments on the DEIS to Reclamation for its use in preparing the FEIS for
your review and concurrence.

S-7

The Honorable Dirk Kempthorne, Secretary
April 30, 2007
Page 8

The Colorado River Board of California thanks you for the opportunity to participate in this very important process, as well as providing you with specific comments on the DEIS. Please feel free to contact me at (818) 500-1625 if you have any questions, or require additional information.

Sincerely,

Dana B. Fisher, Jr.
Chairman

Attachments (3)

cc: Robert W. Johnson, Commissioner of Reclamation
Jayne Harkins, Acting Regional Director, Lower Colorado Region of Reclamation
Rick L. Gold, Regional Director, Upper Colorado Region of Reclamation
strategies@lc.usbr.gov
Colorado River Basin States Representatives

S-7

CONGRESSIONAL BUDGET JUSTIFICATION

FISCAL YEAR 2008

United States Department of State

S-7

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INTERNATIONAL BOUNDARY AND WATER COMMISSION - SALARIES AND EXPENSES

Administration

($ in thousands)

	Positions		Total Funds
	American	FSN	
FY 2008 Request	59	0	5,799

The FY 2008 budget request is $5,799,000 for IBWC Administration activities.

FY 2007 Administration Department plans consist of the following:

- Implementation of the provisions of existing treaties and binational agreements;
- Pursue compliance and implementation of applicable domestic laws, mandates, and regulations;
- Continue to exercise the agency's administrative functions and activities, including human resources management, budget, procurement, payroll, property, and finance and accounting with modern information management capabilities using established internal control procedures;
- Ensure full implementation of policies and procedures, which conform to federal statutes and regulations, by using the Commissioner's executive staff which include, two principle engineers, chief administrative officer, legal counsel, and foreign affairs advisors who possess the expertise in the complexities related to international negotiations and agreements and provide guidance on all matters related to the full scope and operations of the USIBWC;
- Publication of the proceedings of the Binational Rio Grande Summit. Based on the results of the Summit, submit recommendations to the two Governments for the sustainable management of the Rio Grande Basin;
- Conclude a minute related to implementation of the IBWC Minute 311/Public Law 106-457 sanitation project for San Diego-Tijuana;
- Conclude discussions or consultations with Mexico related to development of shortage criteria for Colorado River deliveries carried out pursuant to the 1944 Water Treaty;
- Engage in consultations with Mexico regarding Mexican water deliveries to the United States under the 1944 Water Treaty;
- Continue to aggressively pursue implementation of the President's Management Agenda Program Initiatives, and in accordance with the various laws, regulations, and OMB circulars and guidance;
- Continue to fully comply with the President's goal to eliminate improper payments, which the USIBWC has excelled in meeting in prior years. Independent financial audits for the last five years confirm that the USIBWC fully implements generally accepted accounting principles for federal financial reporting purposes;
- Develop an information resources management (IRM) plan, which describes information and technology management functions and activities, along with an information technology/information resources management (IT/IRM) plan. This plan supports the USIBWC Strategic Goals, ensuring that IT investments are provided and funded only where they have the greatest impact on mission results;
- Continue to utilize the Capital Planning & Investment Control (CPIC) process to assist in the review of new capital investments for construction projects;
- Initiated the development of all Federal Information Security Management Act (FISMA) requirements;
- Comply with new initiatives in accordance with OMB Circulars A-123;
- Full implementation of Executive Order 13031, Federal Alternative-Fueled Vehicle Leadership.

Appendix E

Colorado River Water Entitlement Priority Systems within Arizona, California, and Nevada

S-7

Table E-2
State of California Colorado River Water Entitlement Holders and Priorities as of 2007

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement: Diversion	Entitlement: CU
Surplus	Bureau of Land Management	8-07-30-W0374	1973	M&I	1,000	1,000
	City of Needles	5-07-30-W0091	1985	M&I	10,000	10,000
	Coachella Valley Water District	7-07-30-W0150	1987	M&I/Ag	100,000	100,000
	Department of the Navy	6-07-30-W0351	1999	M&I	253	23
	Metropolitan Water District of Southern California	7-07-30-W0171	1987	M&I	180,000	180,000
	TOTAL				**291,023**	**291,023**
7th	For agricultural use in the Colorado River Basin in California as said basin is designated on map no. 23000 of the Department of the Interior, Bureau of Reclamation					Unquantified
6th7th- Unused & Surplus	Palo Verde Irrigation District (6b) - Lower Palo Verde Mesa Lands	PVID20733C	1933	Ag	≤16,000 acres	
	Coachella Valley Water District (6a)	I1r-781	1934	Ag		119,000
	Imperial Irrigation District (6a)	I1r-747	1932	Ag		63,000
	Palo Verde Irrigation District (6b) - Mesa Lands Metropolitan Water District of Southern California	PVID20733C Colorado River Water Delivery Agreement	1933	Ag		38,000 300,000
	TOTAL					**300,000**
5th6th- Unused & Surplus	City of San Diego County Water Authority (5b) (transferred right to MetropolitanET)	I1r-1151	19334	M&I		
	Metropolitan Water District of Southern California[1] (5a) (Annexed 5b's Eentitlement)	I1r-645	1930, 1931	M&I		662,000
	TOTAL					**662,000**
4th5th	Metropolitan Water District of Southern California (4)	I1r-645	1930, 1931	M&I		550,000
	TOTAL				**0**	**550,000**
3rd4th	Palo Verde Irrigation District (3b) - Lower Palo Verde Mesa Lands	PVID20733C_P5	1933	Ag	≤<16,000 acres	Unquantified0
	Coachella Valley Water District (3a)	I1r-781	1934	Ag		347,000[CRB1]
	To permit the Secretary of the Interior to Satisfy Present Perfected Rights (PPR) Uses					3,000
	Metropolitan Water District of Southern California	Agreement Relating to Supplemental Water				[CRB2]
	San Diego County Water Authority	Colorado River Water Delivery Agreement				[CRB3]
	Imperial Irrigation Districts (3a)[2*]	I1r-747	1932	Ag		300,470561,159
	To permit the Secretary of the Interior to Satisfy PPR Uses	Colorado River Water Delivery Agreement				11,500
	Metropolitan Water District of Southern California	1988 Conservation. Agreement and Approval Agreement	1988	M&I		8590,000
	Coachella Valley Water District	Approval Agreement				20,000
	San Diego County Water Authority	SDCWA TransferColorado River Water Delivery Agreement		M&I		7530,000[3]
	Lower Colorado Water Supply Project	Lower Colorado Water Supply Project Exchange Contract				8,030[4]
	TOTAL					**830,000908,159**
2nd3rd	Yuma Project, Reservation Division (includes Bard, Indian, Island[5])	Water Certificates[5]	1905	Ind./Ag	≤<25,000 acres	Unquantified

Draft EIS – Lower Colorado River Basin Shortage Guidelines and Coordinated Operations for Lake Powell and Lake Mead

E-1

February 2007

S-7

Table E-2
State of California Colorado River Water Entitlement Holders and Priorities as of 2007

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement	
					Diversion	CU
	TOTAL				~~0~~	Unquantified~~0~~
1st2nd	Palo Verde Irrigation District (1) – Valley Lands	PVID20733C_P2	1933	Ag	≤104,500 acres ~~unlimited~~	Unquantified
	TOTAL				~~0~~	Unquantified~~0~~
~~1st (PPR's)~~6**	One Acre PPR's	PPR's 45-80	1895-1928	M&I	36	21.62
	Sonny Gowan (Grannis)	PPR 32 & 7-07-30-W0158	1928	Ag	180	
	Chagnon	PPR No. 41	1925	Ag	120	
	Stephenson	PPR No. 30	1923	Ag	240	
	Colorado River Sportsmen's League	PPR No. 36	1921	Ag	96	
	Andrade (AKA Andrade, Andrews, Bly, Brown, Carney, Daniel, Fairbanks, Glynn, Lindeman, Leon, Schroeder, Sherman, Perrett, Wetmore, Wetmore, Williams)	PPR No. 38	1921	M&I/Ag	66	
	Milpitas	PPR No. 34	1918	Ag	108	
	Lawrence	PPR No. 42	1915	Ag	120	
	Milpitas	PPR No. 37	1914	Ag	69	
	Morgan	PPR No. 33	1913	Ag	150	
	Chemehuevi Indian Reservation	PPR No. 22	2/2/1907	Ind.	(i) 11,340	or (ii) CU required for irrigation of 1,900 acres and for satisfaction of related uses, whichever of (i) or (ii) is less
	Cooper	PPR No. 40	1905	Ag	60	
	Yuma Project, Reservation Division (~~includes~~ non-Indian portion~~/Island~~)	PPR 28 & Water Cert.	7/8/1905	Ind./Ag	(i) 38,270	or (ii) CU required for irrigation of 6,294 acres and for satisfaction of related uses, whichever of (i) or (ii) is less
	Reynolds	PPR No. 39	1904	Ag	36	
~~1st (PPR's)~~6**	Imperial Irrigation District (~~includes lands in CVWD~~)	PPR No. 27	1901	Ag	(i) 2,600,000	or (ii) CU required for irrigation of 424,145 acres and for satisfaction of related uses, whichever of (i) or (ii) is less
	Atchison, Topeka, and Santa Fe Railway Co. (being assigned to Needles)	PPR No. 44	1896	M&I	1,260	273

Table E-2
State of California Colorado River Water Entitlement Holders and Priorities as of 2007

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement: Diversion	Entitlement: CU
	Picacho Development Corp and CA Department of Parks and Recreation	PPR 31 & 8-07-30-W0187	1893	Ag	120	
	Fort Mohave Indian Reservation	PPR No. 25	9/18/1890	Ind.	(i) 16,720	or (ii) CU required for irrigation of 2,587 acres and for satisfaction of related uses, whichever of (i) or (ii) is less
	Simons	PPR No. 35	1889	Ag	60	
	City of Needles	PPR No. 43/5-XX-30-W0445	1885	M&I	1,500	950
	Fort Yuma Indian Reservation	PPR No. 23	1/9/1884	Ind.	(i) 71,616	or (ii) CU required for irrigation of 10,742 acres and for satisfaction of related uses, whichever of (i) or (ii) is less
	Palo Verde Irrigation District	PPR No. 26	1877	Ag	(i) 219,780	or (ii) CU required for irrigation of 33,604 acres and for satisfaction of related uses, whichever of (i) or (ii) is less
	Colorado River Indian Reservation	PPR No. 24	5/15/1876	Ind.	(i) 5,860	or (ii) CU required for irrigation of 879 acres and for satisfaction of related uses, whichever of (i) or (ii) is less

S-7

Table E-2
State of California Colorado River Water Entitlement Holders and Priorities as of 2007

Priority	Entitlement Holder	Contract No.	Date	Use	Entitlement	
					Diversion	CU
	Colorado River Indian Reservation	PPR No. 24	11/16/1874	Ind.	(i) 40,241	or (ii) CU required for irrigation of 6,037 acres and for satisfaction of related uses, whichever of (i) or (ii) is less
	Colorado River Indian Reservation	PPR No. 24	10/22/1873	Ind.	(i) 10,745	or (ii) CU required for irrigation of 1,612 acres and for satisfaction of related uses, whichever of (i) or (ii) is less
	Yuma Associates LTD and Winterhaven Water District (262.8 M&I)	PPR 29 & 4-07-30-W0053	1856	M&I/Ag	780	
	TOTAL				**3,019,573**	~~**1,245**~~

Note: CU means Consumptive Use; all units are in AFY.
Forbearances and Transfers~~Leases~~ are displayed below the Priority Entitlement Holder and indented five spaces.

[1]Under contract I1r-645, the Metropolitan Water District of Southern California has the exclusive right to withdraw and divert into its aqueduct any water in Lake Mead accumulated to the individual credit of said District (not exceeding at any one time 5 million acre-feet in the aggregate) by reason of reduced diversions by said District; provided that accumulations shall be subject to such conditions as to accumulation, retention, release, and withdrawal as the Secretary of the Interior may from time to time prescribe in his discretion.
[2*]IID's PPR protects 2,600,000 acre-feet of it's Seven Party 3rd~~4th~~ Priority Entitlement. ~~Therefore the~~ Use of the 3rd~~4th~~ priority entitlement shown in this table is reduced by the ~~the~~ PPR right~~, and~~ forbearances and transfers ~~an 11,500af reduction~~ agreed to in the 2003 Colorado River Water Delivery Agreement, and the exchange for Lower Colorado Water Supply Project water~~QSA for the tribes~~. It is assumed that water forborne and transferred by IID ~~QSA agreements~~ retains a 3rd~~4th~~ priority right. Of the ~~561,159af~~ remaining 3rd~~4th~~ priority right, IID forbears use of 11,500 af to permit the Secretary of the Interior to satisfy PPR use not covered by the Seven Party Agreement, 85,000 af for MWD~~, receives 90,000af~~ and 20,000 af for CVWD, and IID transfers 50,000 af to San Diego County Water Authority~~receives 30,000 acre-feet~~ in 2007. IID forbears use of Colorado River water for Lower Colorado Water Supply Project water discharged into the All-American Canal.
[3]In 2007 with 25,000 acre-feet of this amount for Salton Sea mitigation purposes.
[4]In 2007.
[5]Incorporation of Yuma Island pumpers' use within this priority does not represent either a final approval of this use by Reclamation or a final determination of the appropriate Decree accounting for this use; and is not an admission by any Colorado River contractor as to the legality of this use or diversion of Colorado River water. No Water Certificates have been issued for use of water on the Yuma Island in California.
[6**]PPR's are reduced last in the region, in order of priority date, regardless of state lines.

These priorities are based on the California Seven Party Agreement, modified to include the PPR's identified by the Consolidated Decree and executed contracts and agreements.

S-7

Page: 1
[CRB1]Amount to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project with the amount equal to 327,000 minus the amount of water resulting from the Coachella Canal Lining Project made available to Metropolitan and San Diego County Water Authority.

Page: 1
[CRB2]Amount to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project.

Page: 1
[CRB3]Amount to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project.

S-7

Page: 1
[CRB1] Amount to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project with the amount equal to the quantity, 327,000 minus the amount of water resulting from the Coachella Canal Lining Project made available to Metropolitan and San Diego County Water Authority in 2007.

Page: 1
[CRB2] Amount to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project with the amount equal to the quantity, 327,000 minus the amount of water resulting from the Coachella Canal Lining Project made available to Metropolitan and San Diego County Water Authority in 2007, plus return flow credit.

Page: 1
[CRB3] Amount to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project with the amount equal to 327,000 minus the amount of water resulting from the Coachella Canal Lining Project made available to Metropolitan and San Diego County Water Authority in 2007.

Page: 1
[CRB4] Amount to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project with the amount equal to the quantity, 327,000 minus the amount of water resulting from the Coachella Canal Lining Project made available to Metropolitan and San Diego County Water Authority in 2007, plus return flow credit.

Page: 1
[CRB5] Amount to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project with the amount equal to 327,000 minus the amount of water resulting from the Coachella Canal Lining Project made available to Metropolitan and San Diego County Water Authority in 2007.

Page: 1
[CRB6] Amount to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project.

Page: 1
[CRB7] Amount in this column and the column to the left to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project.

Page: 1
[CRB8]Amount in this column and the column to the left to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project.

Page: 1
[CRB9] Amount in this column and the next two columns to the left to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project.

Page: 1
[CRB10] Amount in this column and the column to the left to be inserted by the Bureau of Reclamation once the Secretary of the Interior has issued the determination of the amount of water conserved by the Coachella Canal Lining Project.

Page: 2
[CRB11] Value to be inserted in this column and the next four columns to the right once the Bureau of Reclamation has inserted values above.

Page: 5
[CRB12] Value to be inserted in this column, the next column to the right, and the third to the next column to the right once the Bureau of Reclamation has inserted values above.

S-7

1

Table G-18
State of California

2017		400,000				ENTITLEMENT		FULL ENTITLEMENT USE[1*]		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	No.	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
		State Consumptive Use							4,400,000		4,400,000		0
4th 5th	15	Metropolitan Water District of Southern California[2] (4)	I1r-645	1930, 1931	M&I		550,000	464,935547,535	461,872486,872	464,935547,535	461,872486,872	0	0
		TOTAL				0	550,000	464,935547,535	461,872486,872	464,935547,535	461,872486,872	0	0
		PERCENT									100%		0%
3rd 4th	18	Palo Verde Irrigation District (3b) - Lower Palo Verde Mesa Lands	PVID20733C_P5	1933	Ag	≤<16,000 acres	Unquantified 0	26,9090	11,4600	26,9090	11,4600	0	0
	6	Coachella Valley Water District (3a)	I1r-781	1934	Ag		347,000 [CRB1]	336,973 [CRB2]	327,000 [CRB3]	336,973 [CRB4]	327,000 [CRB5]	0	0
		Metropolitan Water District of Southern California or San Luis Rey Indian Water Rights Settlement Parties (Exchange with Metropolitan)	Agreement Relating to Supplemental Water		M&I or TBD		[CRB6]		[CRB7]		[CRB8]		
		San Diego County Water Authority	Colorado River Water Delivery Agreement		M&I				[CRB9]		[CRB10]		
	13	Imperial Irrigation District[3]s (3a)	I1r-747	1932	Ag		93,459561,159	96,146577,292	93,459561,159	96,146577,292	93,459561,159	0	0
	15	Metropolitan Water District of Southern California	1988 Cons. Agreement and Approval Agreement	1988	M&I		8590,000	85,000	85,000	85,000	85,000		
		Coachella Valley Water District	Approval Agreement /Acquisition Agreement		Ag		65,000	66,982	65,000	66,982	65,000		

S-7

Table G-18
State of California

2017		400,000				ENTITLEMENT		FULL ENTITLEMENT USE[1*]		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	No.	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
	21	__San Diego County Water Authority****	Colorado River Water Delivery Agreement ~~SDCWA Transfer~~		M&I		156,200~~30,0 00~~	156,200	156,200	156,200	156,200		
		__San Diego County Water Authority (Salton Sea Mitigation)	Colorado River Water Delivery Agreement				150,000	154,312	150,000	154,312	150,000		
		__Metropolitan Water District of Southern California or San Luis Rey Indian Water Rights Settlement Parties (Exchange with Metropolitan)	Agreement Relating to Supplemental Water		M&I or TBD		11,500	11,500	11,500	11,500	11,500		
		__Lower Colorado Water Supply Project	2-07-30-W0280	1992	M&I		10,000	Dependent upon demand and Project capacity~~0~~	Dependent upon demand and Project capacity~~0~~	Dependent upon demand and Project capacity	Dependent upon demand and Project capacity		
		TOTAL					~~1,028,159~~ [CRB11]	~~914,264~~	~~888,159~~	~~914,264~~	~~888,159~~	**0**	**0**
	-	PERCENT									100%		0%
2nd 3rd	26	Yuma Project, Reservation Division (includes Bard[3], Indian[3], Island[4])	Water Certificates[4]	1905	Ind./Ag	≤<25,000 acres	Unquantified	13,644	7,545	13,644	7,545	0	0
		TOTAL	~~3,863,169~~			~~0~~	**0**	**13,644**	**7,545**	**13,644**	**7,545**	**0**	**0**
		PERCENT									100%		0%

S-7

Appendix G

Shortage Allocation
Model Documentation

Table G-18
State of California

2017		400,000				ENTITLEMENT		FULL ENTITLEMENT USE[1]		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	No.	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
1st 2nd	18	Palo Verde Irrigation District[3] - Valley Lands (1)	PVID20733C_P2	1933	Ag	≤104,500 acresunlimited	Unquantified	722,352690,559	307,639294,099	722,352690,559	307,639294,099	0	0

S-7

Draft EIS – Colorado River Interim Guidelines for
Lower Basin Shortages and Coordinated Operations
for Lake Powell and Lake Mead

G-3

February 2007

Table G-18
State of California

2017		400,000				ENTITLEMENT		FULL ENTITLEMENT USE[1]		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	No.	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
		Metropolitan Water District of Southern California	Fallowing and Forbearance Agreement		M&I		Dependent upon fallowing call	Dependent upon fallowing call	Dependent upon fallowing call	Dependent upon fallowing call	Dependent upon fallowing call		
		TOTAL				0	0	722,352690,559	307,639294,099	722,352690,559	307,639294,099	0	0
		PERCENT									100%		0%
1st (PPR's[5]) **	27	One Acre PPR's	PPR's 45-80	1895-1928	M&I	36	22	36	22	36	22	0	0
	23	Sonny Gowan (Grannis)	PPR 32 & 7-07-30-W0158	1928	Ag	180		180	108	180	108	0	0
	3	Chagnon	PPR No. 41	1925	Ag	120		120	72	120	72	0	0
	24	Stephenson	PPR No. 30	1923	Ag	240		240	144	240	144	0	0
	8	Colorado River Sportsmen's League	PPR No. 36	1921	Ag	96		96	58	96	58	0	0
	1	Andrade	PPR No. 38	1921	M&I /Ag	66		66	47	66	47	0	0
		(AKA Andrade, Andrews, Bly, Brown, Carney, Daniel, Fairbanks, Glynn,											
		Lindeman, Leon, Schroeder, Sherman, Perrett, Wetmore, Wetmore, Williams)											
	16	Milpitas	PPR No. 34	1918	Ag	108		108	65	108	65	0	0
	14	Lawrence	PPR No. 42	1915	Ag	120		120	72	120	72	0	0
	16	Milpitas	PPR No. 37	1914	Ag	69		69	41	69	41	0	0
	17	Morgan	PPR No. 33	1913	Ag	150		150	90	150	90	0	0
	4	Chemehuevi Indian Reservation	PPR No. 22	1907	Ind.	11,340		11,340	6,094	11,340	6,094	0	0
	9	Cooper	PPR No. 40	1905	Ag	60		60	36	60	36	0	0

S-7

Table G-18
State of California

2017		400,000				ENTITLEMENT		FULL ENTITLEMENT USE[1]		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	No.	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
	26	Yuma Project, Reservation Division (~~includes~~ non-Indian portion~~/Island~~)	PPR 28 & Water Cert.	1905	Ind./ Ag	38,270		38,270	17,918	38,270	17,918	0	0
	20	Reynolds	PPR No. 39	1904	Ag	36		36	22	36	22	0	0
	13	Imperial Irrigation District ~~(includes lands in CVWD)~~	PPR No. 27	1901	Ag	2,600,000		2,600,000	2,527,341	2,600,000	2,527,341	0	0
	5	Atchison, Topeka, and Santa Fe Railway Co. (being assigned to Needles)	PPR No. 44	1896	M&I	1,260	273	1,260	273	1,260	273	0	0
	19	Picacho Development Corp and CA Dept of Parks and Recreation	PPR 31 & 8-07-30-W0187	1893	Ag	120		120	66	120	66	0	0
	11	Fort Mohave Indian Reservation	PPR No. 25	1890	Ind.	16,720		16,720	8,994	16,720	8,994	0	0
	22	Simons	PPR No. 35	1889	Ag	60		60	36	60	36	0	0
	5	City of Needles	PPR No. 43/5-XX-30-W0445	1885	M&I	1,500	950	1,500	950	1,500	950	0	0
	12	Fort Yuma Indian Reservation	PPR No. 23	1/9/1884	Ind.	71,616		71,616	34,506	71,616	34,506	0	0
	18	Palo Verde Irrigation District	PPR No. 26	1877	Ag	219,780		219,780	93,601	219,780	93,601	0	0
	7	Colorado River Indian Reservation	PPR No. 24	1876	Ind.	5,860		5,860	3,324	5,860	3,324	0	0
	7	Colorado River Indian Reservation	PPR No. 24	1874	Ind.	40,241		40,241	22,823	40,241	22,823	0	0
	7	Colorado River Indian Reservation	PPR No. 24	1873	Ind.	10,745		10,745	6,094	10,745	6,094	0	0
	25	Yuma Associates LTD and Winterhaven Water District (262.8 M&I)	PPR 29 & 4-07-30-W0053	1856	M&I /Ag	780		780	528	780	528	0	0
		TOTAL				**3,019,573**	**1,245**	**3,019,573**	**2,723,325**	**3,019,573**	**2,723,325**	**0**	**0**
		PERCENT									100%		0%
S-7		**CALIFORNIA TOTALS**				~~3,310,596~~	~~2,541,403~~ [CRB12]	~~6,378,066~~	4,400,000~~5,646,423~~	~~5,185,576~~	4,400,000	0-~~1,192,49~~	0-~~1,2~~

Table G-18
State of California

2017		400,000				ENTITLEMENT		FULL ENTITLEMENT USE[1*]		ADJUSTED DELIVERY		SHORTAGE ALLOCATION	
Priority	No.	Entitlement Holder	Contract No.	Date	Use	Diversion	CU	Diversion	CU	Diversion	CU	Diversion	CU
												1	46,422
		CALIFORNIA PERCENT									10078%		0-22 %

Note: CU means Consumptive Use; TBD means To Be Determined; all units are in AFY.
Forbearances and TransfersExchange Agreements are displayed below the Priority Entitlement Holder and indented five spaces and include the amount of water to be conserved by the All-American Lining Project.

[1]*2004 Decree Accounting values and Diversion/CU conversion ratios were used to estimate not specified and unquantified entitlements. Consumptive use on Lower Palo Verde Mesa lands assumed to be equal to 2007 Palo Verde Irrigation District request.
[2]The difference between Metropolitan's diversion and CU is 100 percent of its return flow credit.
[3]A portion of this Seven Party Agreement entitlement is shown below in the PPR priority.
[4]Incorporation of Yuma Island pumpers' use within this priority does not represent either a final approval of this use by Reclamation or a final determination of the appropriate Decree accounting for this use; and is not an admission by any Colorado River contractor as to the legality of this use or diversion of Colorado River water. No Water Certificates have been issued for use of water on the Yuma Island in California.
[5]**PPR's are reduced last in the region, in order of priority date, regardless of state lines. It is assumed that each of the PPR holders would divert and consumptively use all of its PPR in 2017. (see PPR Spreadsheet).
~~****Met's return credit ratio was used for this new user.~~

1

S-7

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Reponses to Comment Letter S-7

S-7-1

Your comment is noted. No change to the Final EIS was necessary.

S-7-2

Your comment is noted. No change to the Final EIS was necessary.

S-7-3

Your comment is noted. The modeling assumptions regarding the distribution of shortages (Section 2.2.1), particularly with respect to Stage II shortages were common to all alternatives and permitted a relative comparison of alternatives.

S-7-4

Your comment is noted. No change to the Final EIS was necessary.

S-7-5

Reclamation concurs with your comment. Appropriate modifications have been made to Table E-2 and the attachments to Appendix G.

S-7-6

Reclamation concurs with your comment. Appropriate modifications have been made to Table E-2 and the attachments to Appendix G.

S-7-7

Your comment is noted. No change to the Final EIS was necessary.

S-7-8

The alternatives were formulated to enable the evaluation a wide range of operational conditions. This modeling assumption was included in some alternatives to evaluate the trade-offs associated with this assumption.

S-7-9

Your comment is noted. The natural flow data for 2005 has been added to the historic hydrology record that was used as input for the hydrologic modeling of the alternatives (Section 4.2 in the Final EIS).

S-7-10 and S-7-11

Your comment is addressed in the general response pertaining to climate changes and hydrologic variability in the introduction to Volume IV of the Final EIS. Section 4.2 of the Final EIS has been enhanced and two new appendices (Appendix T and Appendix U) have been added to provide additional information regarding the potential impacts of climate change and hydrologic variability.

S-7-12 through S-7-14

Your comment is noted. No change to the Final EIS was necessary. A detailed analysis of potential air quality impacts associated with voluntary or involuntary land fallowing is not possible as it is unknown which specific lands would be affected. Such an analysis would require information associated with the lands that would be fallowed including specific location, affected acreage, soils type, and prevailing wind data.

S-7-15

Your comment is noted. Information presented in the Draft EIS has been modified in the Final EIS (Appendix H) to include a discussion of the positive and negative effects of a voluntary conservation program.

S-7-16

See response to comment S-7-12.

S-7-17

See response to Comment No. S-2-11.

S-7-18 to S-7-19

Your comment is noted. No change to the Final EIS was necessary.

S-7-20 to S-7-22

Reclamation concurs with these comments. The referenced sections have been revised in the Final EIS.

S-7-23 through S-7-26

Your comment is noted. No change to the Final EIS was necessary. The narrative in Section 2.4 and the detailed modeling assumptions in Appendix M sufficiently explain these two aspects of the Conservation Before Shortage proposal.

S-7-27

Your comment is noted. No change to the Final EIS was necessary.

S-7-28 through S-7-31

Your comments are noted. No change to the Final EIS was necessary.

S-7-32 through S-7-37

Your comments are noted. Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that include a modification of Section 5 of the ISG regarding California's agricultural use benchmarks.

S-7-38

Your comment is noted. No change to the FEIS was necessary.

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The States of Arizona, California, Colorado, Nevada,
New Mexico, Utah and Wyoming
Governors' Representatives on Colorado River Operations

April 30, 2007

Honorable Dirk Kempthorne, Secretary
Department of the Interior
1849 C. Street, NW
Washington, D.C. 20240

Re: Basin States' Comments on *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

Dear Secretary Kempthorne:

Thank you for the opportunity to comment on the *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* (72 Fed. Reg. 9,026) (Feb. 28, 2007) (hereinafter "DEIS"). The Basin States emphasize that the Basin States' Alternative best meets critical elements of the purpose and need statement articulated in the DEIS. It does so by giving water managers the certainty to engage in meaningful long-range planning while also promulgating programs to increase operational and resource management flexibility on the River. This is particularly important given the impacts of the drought on the Colorado River system over the last seven years and the uncertain hydrology going forward. Thus, the Basin States strongly encourage you to select the Basin States'
Alternative analyzed in the DEIS, together with the modifications outlined in this letter 1
and the included attachments ("Basin States' Proposal"), as the preferred alternative in the Final Environmental Impact Statement ("FEIS") and the selected action in the Record of Decision ("ROD").

<u>Basin States' Proposal</u>

The Basin States have made tremendous progress over the last two years in setting aside contentious issues and reaching agreements regarding operation of the Colorado River system reservoirs. Since the Basin States originally forwarded a Preliminary Proposal and draft Seven States' Agreement to your predecessor on February 3, 2006 ("Preliminary Proposal"), the Basin States have finalized a number of agreements and
proposals. These documents, which are described in detail below, incorporate and give 2
further definition to each of the elements of the Preliminary Proposal and the Basin States' Alternative in the DEIS. The Basin States believe that if all material terms of the
Basin States' Proposal are included in the ROD, it will establish the first comprehensive 3
set of detailed operating guidelines in the history of the Colorado River.

S-8

1

The Basin States' Proposal consists of the following documents:

1. Agreement Concerning Colorado River Management and Operations (Attachment "A"). This agreement among major Colorado River water interests in all seven states that share the River system is the foundation document in the Basin States' Proposal. This agreement memorializes the consensus recommendation to the Secretary for Colorado River management 4 and operations during an interim period, sets forth agreements regarding pursuit of system augmentation and efficiency projects, and establishes a 5 rigorous process for the resolution of claims and controversies between the 6 parties in an effort to set aside long standing disputes on the River.

2. Proposed Interim Guidelines for Colorado River Operations (Attachment "B"). Building upon the Preliminary Proposal, the Basin States have drafted a comprehensive set of guidelines to govern Colorado River operations during the interim period. If adopted, these proposed guidelines would: (1) replace the Interim Surplus Guidelines; (2) establish guidelines for 7 coordinated operations for Lakes Powell and Mead; (3) establish shortage guidelines for use within the United States; and (4) establish parameters for the creation and release of Intentionally Created Surplus ("ICS") and Developed Shortage Supplies ("DSS").

3. Forbearance Agreement (Attachment "C"). This draft agreement among the Lower Division States and major water users within those states recognizes that, in the absence of forbearance by the parties, surplus water is apportioned 8 for use according to the percentages provided in Article II(B)(2) of the Consolidated Decree in *Arizona v. California*. The execution of this 9 agreement will facilitate implementation of the ICS program.

4. Shortage Sharing Agreement between Arizona and Nevada (Attachment "D"). As anticipated by the Basin States' February 3, 2006 Preliminary Proposal, Arizona and Nevada have executed a Shortage Sharing Agreement premised upon the Secretary's reductions in deliveries within the United States of 10 333,000, 417,000 and 500,000 acre-feet per year based upon specific Lake Mead elevations.

5. Delivery Agreement. It will be necessary for the Secretary to enter into one or more agreements that enable and obligate the United States to deliver ICS and DSS to entities that create ICS or DSS in conformance with relevant 11 provisions of the Guidelines and the Forbearance Agreement. At this time, the Basin States are developing a draft delivery agreement for the Department of the Interior's ("Interior") consideration and look forward to working with 12 Interior on drafting one or more agreements that can be executed concurrently with the issuance of the ROD. The Basin States request that the U.S. Bureau of Reclamation ("Reclamation") include appropriate analysis of the 13

S-8

2

anticipated execution of one or more agreements to deliver ICS or DSS within the preferred alternative in the FEIS and the selected action in the ROD. 13

Implementation of any alternative that does not include all material terms of the Basin States' Proposal will carry with it a significant degree of uncertainty given that the Basin States' Agreement, Forbearance Agreement and Arizona-Nevada Shortage Sharing 14 Agreement are each contingent upon the issuance of a ROD that is consistent with the material terms of those agreements. These agreements make it possible for components of the proposed action, such as coordinated management of Lakes Mead and Powell and the creation and release of ICS, to be implemented without adversarial actions involving the Basin States and major water users on the Colorado River.

Reduced Deliveries to Mexico

Recent negotiations among the Basin States and major water users in those states have involved multiple issues of critical importance to the Basin States. However, in the course of these negotiations no issue has surpassed the importance of how the United States exercises its authority to reduce the quantity of water allotted to Mexico under 15 Article 10(a) of the Mexican Water Treaty of 1944.

In the Preliminary Proposal the Basin States recommended that the Secretary reduce deliveries from Lake Mead by 400,000, 500,000 and 600,000 acre-feet per year within the United States and Mexico at certain Lake Mead elevations. In accordance with the Preliminary Proposal, Arizona and Nevada have executed a Shortage Sharing Agreement premised upon the imposition by the Secretary of shortages within the United States of 16 333,000, 417,000 and 500,000 acre-feet per year at the same Lake Mead elevations contained in the Preliminary Proposal. For the first 600,000 acre-feet per year of any reductions in deliveries in any year due to a declared shortage, the Basin States have 17 agreed that Arizona and Nevada will not take more than 500,000 acre-feet per year in aggregate and California will not take any reductions. The DEIS substantially incorporates the assumptions contained in the Preliminary Proposal, the Basin States' Agreement and the Shortage Sharing Agreement into its consideration and analysis of the Basin States' Alternative.

Due to the critical nature of this issue, the Basin States believe that the Secretary should include these assumptions as part of the preferred alternative in the FEIS and the selected 18 action in the ROD. The Basin States strongly urge the United States to exercise its authority to reduce the quantity of water allotted to Mexico in years in which the Secretary imposes shortages in deliveries of water from Lake Mead in the United States 19 in a quantity consistent with the assumptions in the DEIS, and in other appropriate circumstances.

Mexican Participation in ICS Program

The Basin States support the concept of Mexico participating in the ICS program at some time in the future, provided that its participation is addressed in the context of other river 20 21

S-8

operation matters and is part of a comprehensive arrangement between the two nations 21
that incorporates, at a minimum, the material terms of the Basin States' Proposal. The
Basin States stand ready to discuss this comprehensive arrangement. 22

Colorado River Augmentation Projects

Implementation of projects to augment the long-term supply of the Colorado River is of
utmost importance not only to the Basin States and the millions of people who live here,
but to the nation as a whole. While no specific augmentation projects are included in the 23
current Basin States' Proposal, the need to develop a process to implement augmentation
projects must remain at the forefront of the Basin States' and Interior's agendas.
Changes to existing or new federal regulations may be necessary to effectuate 24
augmentation projects.

The Preliminary Proposal outlined a concept for water users in Arizona, California, or
Nevada to secure additional water supplies by funding the development of a
non-Colorado River System water supply in one Lower Division State for use in another 25
Lower Division State by exchange. Through the cooperation of the International
Boundary and Water Commission, United States and Mexico, similar arrangements could
be established by which non-Colorado River System water supplies in Mexico could be 26
developed for use in the United States by exchange.

The Basin States view the inclusion in the DEIS of a quantitative analysis of the impacts
to the Colorado River resulting from the implementation of future augmentation projects
as a positive step and encourage you to include the same analysis in the FEIS in order to 27
begin to establish the environmental compliance framework for future augmentation
projects.

Conclusion

In closing, the Basin States thank you for your leadership and urge Interior to adopt a 28
ROD that includes all of the material terms of the Basin States' Proposal.

S-8

Herbert R. Guenther
Director
Arizona Department of Water Resources

Patricia Mulroy
General Manager
Southern Nevada Water Authority

Dana B. Fisher, Jr.
Chairman
Colorado River Board of California

John R. D'Antonio, Jr.
Secretary
New Mexico Interstate Stream Commission

Scott Balcomb
Governor's Representative
State of Colorado

Dennis J. Strong
Director
Utah Division of Water Resources
Utah Interstate Stream Commissioner

Rod Kuharich
Director
Colorado Water Conservation Board

Patrick T. Tyrrell
State Engineer
State of Wyoming

Richard W. Bunker
Chairman
Colorado River Commission of Nevada

Attachments

c: Robert W. Johnson, Commissioner, U. S. Bureau of Reclamation
Rick Gold, Regional Director, U. S. Bureau of Reclamation, Upper Colorado Regional Office
Jayne Harkins, Acting Regional Director, U. S. Bureau of Reclamation, Lower Colorado Regional Office
Larry Walkoviak, Deputy Regional Director, U. S. Bureau of Reclamation, Lower Colorado Regional Office

S-8

ATTACHMENT A

AGREEMENT CONCERNING COLORADO RIVER MANAGEMENT AND OPERATIONS

This Agreement is entered into effective as of April 23, 2007, by and among the Arizona Department of Water Resources; Colorado River Board of California; Colorado Water Conservation Board; Governor's Representative for the State of Colorado; Colorado River Commission of the State of Nevada; Southern Nevada Water Authority; New Mexico Interstate Stream Commission; Utah Division of Water Resources; Utah Interstate Stream Commissioner; and Wyoming State Engineer.

RECITALS

A. Parties.

1. Arizona.

   a. The Arizona Department of Water Resources, through its Director, is the successor to the signatory agency of the State for the 1922 Colorado River Compact, and the 1944 Contract for Delivery of Water with the United States, both authorized and ratified by the Arizona Legislature, A.R.S. §§ 45-1301 and 1311. Pursuant to A.R.S. §§ 45-107, the Director is authorized and directed, subject to the limitations in A.R.S. §§ 45-106, for and on behalf of the State of Arizona, to consult, advise and cooperate with the Secretary of the Interior of the United States with respect to the exercise by the Secretary of Congressionally authorized authority relative to the waters of the Colorado River (including but not limited to the Boulder Canyon Project Act, 43 U.S.C. § 617, and the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1501) and with respect to the development, negotiation and execution of interstate agreements. Additionally, under A.R.S. § 45-105(A)(9), the Director is authorized to "prosecute and defend all rights, claims and privileges of this state respecting interstate streams."

   b. Under A.R.S. § 11-951 et. seq., the Director is authorized to enter into Intergovernmental Agreements with other public agencies, which includes another state; departments, agencies, boards and commissions of another state; and political subdivisions of another state.

2. California. The Chairman of the Colorado River Board of California, acting as the Colorado River Commissioner pursuant to California Water Code section 12525, has the authority to exercise on behalf of California every right and power granted to California by the Boulder Canyon Project Act, and to do and perform all other things necessary or expedient to carry out the purposes of the Colorado River Board.

S-8

3. Colorado.

   a. Section 24-1-109, Colorado Revised Statutes (2005) provides that "Interstate compacts authorized by law shall be administered under the direction of the office of the governor." This includes the Colorado River Compact and the Upper Colorado River Basin Compact. Section 37-60-109 provides that "the governor from time to time, with approval of the board, shall appoint a commissioner, who shall represent the state of Colorado upon joint commissions to be composed of commissioners representing the state of Colorado and another state or other states for the purpose of negotiating and entering into compacts or agreements between said states…" By letter dated April 12, 2006, the Governor appointed Upper Colorado River Commissioner Scott Balcomb to represent the State of Colorado.

   b. Section 37-60-106, subsections (e) and (i), C.R.S. (2005), authorize the Colorado Water Conservation Board to "cooperate with the United States and the agencies thereof, and with other states for the purpose of bringing about the greater utilization of the water of the state of Colorado and the prevention of flood damages," and "to confer with and appear before the officers, representatives, boards, bureaus, committees, commissions, or other agencies of other states, or of the federal government, for the purpose of protecting and asserting the authority, interests, and rights of the state of Colorado and its citizens with respect to the waters of the interstate streams in this state." Therefore, by statute the Director of the Colorado Water Conservation Board is authorized to negotiate with and enter into agreements with other state entities within the Colorado River Basin.

4. Nevada.

   a. The Colorado River Commission of Nevada (CRCN) is an agency of the State of Nevada, authorized generally by N.R.S. §§ 538.041 and 538.251. CRCN is authorized by N.R.S. § 538.161 (6), (7) to enter into this Agreement. The CRCN, in furtherance of the State of Nevada's responsibility to promote the health and welfare of its people in Colorado River matters, makes this Agreement to supplement the supply of water in the Colorado River which is available for use in Nevada, augment the waters of the Colorado River, and facilitate the more flexible operation of dams and facilities by the Secretary of the Interior of the United States. The Chairman of the Commission, signatory hereto, serves as one of the Governor's representatives as contemplated by Section 602(b) of the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1552(b) and the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act.

S-8

b. The Southern Nevada Water Authority (SNWA) is a Nevada joint powers agency and political subdivision of the State of Nevada, created by agreement dated July 25, 1991, as amended November 17, 1994 and January 1, 1996, pursuant to N.R.S. §§ 277.074 and 277.120. SNWA is authorized by N.R.S. § 538.186 to enter into this Agreement and, pursuant to its contract issued under section 5 of the Boulder Canyon Project Act of 1928, SNWA has the right to divert "supplemental water" as defined by NRS § 538.041 (6). The General Manager of the SNWA, signatory hereto, serves as one of the Governor's Representatives as contemplated by Section 602(b) of the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1552(b) and the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act.

5. New Mexico. Pursuant to NMSA 1978, 72-14-3, the New Mexico Interstate Stream Commission is authorized to investigate water supply, to develop, to conserve, to protect and to do any and all other things necessary to protect, conserve and develop the waters and stream systems of the State of New Mexico, interstate or otherwise. The Interstate Stream Commission also is authorized to institute or cause to be instituted in the name of the State of New Mexico any and all negotiations and/or legal proceedings as in its judgment are necessary. By Resolution dated January 24, 2007, the Interstate Stream Commission authorizes the execution of this Agreement.

6. Utah. The Division of Water Resources (DWR) is the water resource authority for the State of Utah. Utah Code Ann. § 73-10-18. The Utah Department of Natural Resources Executive Director (Department), with the concurrence of the Utah Board of Water Resources (Board), appoints the DWR Director (Director). § 63-34-6(1). The Board makes DWR policy. § 73-10-1.5. The Board develops, conserves, protects, and controls Utah waters, § 73-10-4(4), (5), and, in cooperation with the Department and Governor, supervises administration of interstate compacts, § 73-10-4, such as the Colorado River Compact, §§ 73-12a-1 through 3, and the Upper Colorado River Basin Compact, § 73-13-10. The Board, with Department and Gubernatorial approval, appoints a Utah Interstate Stream Commissioner, § 73-10-3, currently the DWR Director, to represent Utah in interstate conferences to administer interstate compacts. §§ 73-10-3 and 73-10-4. These delegations of authority authorize the Utah Interstate Stream Commissioner/DWR Director to sign this document. He acts pursuant to a Board resolution, acknowledged by the Department, dated March 7, 2007.

7. Wyoming. Water in Wyoming belongs to the state. Wyo. Const. Art. 8 § 1. The Wyoming State Engineer is a constitutionally created office and is Wyoming's chief water official with general supervisory authority over the waters of the state. Wyo. Const. Art. 8 § 5. The Wyoming legislature conferred upon Wyoming officers the authority to cooperate with and assist

S-8

3

like authorities and entities of other states in the performance of any lawful power, duty, or authority. Wyo. Stat. Ann. § 16-1-101 (2005). Wyoming and its State Engineer represent the rights and interests of all Wyoming appropriators with respect to other states. *Wyoming v. Colorado*, 286 U.S. 494 (1922). See *Hinderlider v. La Plata River & Cherry Creek Ditch Co.*, 304 U.S. 92 (1938). In signing this Agreement, the State Engineer intends that this Agreement be mutually and equally binding between the Parties.

B. Background.

1. Federal law and practice (including Section 16 of the Boulder Canyon Project Act, 43 U.S.C § 617o and Section 602(b) of the 1968 Colorado River Basin Project Act, 43 U.S.C. § 1552(b), and the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act), contemplate that in the operation of Lakes Powell and Mead, the Secretary of the Interior consults with the States through Governors' Representatives, who represent the Governors and their respective state agencies. Through this law and practice, the Governors' Representatives and state agencies have in the past reached agreements among themselves and with the Secretary on various aspects of Colorado River reservoir operation. This Agreement is entered into in furtherance of this law and practice.

2. On January 16, 2001, the Secretary adopted Colorado River Interim Surplus Guidelines (ISG) based on an alternative prepared by the Colorado River Basin States, for the purposes of determining annually the conditions under which the Secretary would declare the availability of surplus water for use within the states of Arizona, California and Nevada in accordance with and under the authority of the Boulder Canyon Project Act of 1928 (45 Stat. 1057) and the Decree of the United States Supreme Court in *Arizona v. California*, 376 U.S. 340 (1964), as amended and supplemented. The ISG are effective through calendar year 2015 (through preparation of the 2016 Annual Operating Plan).

3. In the years following the adoption of the ISG, drought conditions in the Colorado River Basin caused a significant reduction in storage levels in Lakes Powell and Mead, and precipitated discussions by and among the Parties, and between the Parties and the United States through the Department of the Interior and the Bureau of Reclamation. The Parties recognize that the Upper Division States have not yet developed their full apportionment under the Colorado River Compact. Although the Secretary has not imposed any shortage in the Lower Basin, the Parties also recognize that with additional Upper Basin development and in drought conditions, the Lower Division States may be required to suffer shortages in deliveries of water from Lake Mead. Therefore, these discussions focused on ways to improve the management of water in Lakes Powell and Mead so as to enhance the

S-8

protection afforded to the Upper Basin by Lake Powell, and to delay the onset and minimize the extent and duration of shortages in the Lower Basin.

4. On May 2, 2005, the Secretary announced her intent to undertake a process to develop Lower Basin shortage guidelines and explore management options for the coordinated operation of Lakes Powell and Mead. On June 15, 2005, the Bureau of Reclamation published a notice in the Federal Register, announcing its intent to implement the Secretary's direction. The Bureau of Reclamation has proceeded to undertake scoping and develop alternatives pursuant to the National Environmental Policy Act (the NEPA Process), which the Parties anticipate will form the basis for a ROD to be issued by the Secretary by December 2007.

5. On August 25, 2005, the Parties wrote a letter to the Secretary expressing conceptual agreement in the development and implementation of three broad strategies for improved management and operation of the Colorado River: Coordinated Reservoir Management and Lower Basin Shortage Guidelines; System Efficiency and Management; and Augmentation of Supply.

6. On February 3, 2006, the Parties transmitted to the Secretary their recommendation for the scope of the NEPA Process (Preliminary Proposal), which refined many of the elements outlined in the August 25, 2005 letter.

7. In February 2007, the Secretary issued a Draft Environmental Impact Statement (DEIS) pursuant to the NEPA Process. The DEIS includes an alternative, called the Basin States' Alternative, that is based on the recommendations of the Parties.

8. At the request of the Secretary, the Parties have continued their discussions relative to the areas of agreement outlined in the letters of August 25, 2005 and February 3, 2006, and the DEIS, and have agreed on: a) additional actions for their mutual benefit designed to augment the supply of water available for use in the Colorado River System and improve the management of water in the Colorado River; b) recommendations to the Secretary for adoption as the preferred alternative in the Final Environmental Impact Statement and in the ROD; and c) consultation processes among themselves, and consultation recommendations to the Secretary for incorporation into the ROD.

C. Purpose. The Parties intend that the actions by them contemplated in this Agreement will: improve cooperation and communication among them; provide additional security and certainty in the water supply of the Colorado River System for the benefit of the people served by water from the Colorado River System; and avoid circumstances which could otherwise form the basis for claims or controversies over interpretation or implementation of the Colorado River Compact and other applicable provisions of the law of the river.

S-8

AGREEMENT

In consideration of the above recitals and the mutual covenants contained herein, and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the Parties agree as follows:

1. Recitals. The Recitals set forth above are material facts that are relevant to and form the basis for the agreements set forth herein.

2. Definitions. As used in this Agreement, the following terms have the following meanings:

A. Colorado River System. This term shall have the meaning as defined in the Colorado River Compact.

B. ISG. The Colorado River Interim Surplus Guidelines adopted by the Secretary on January 16, 2001, as modified by the ROD.

C. NEPA Process. The decision-making process pursuant to the National Environmental Policy Act, 42 U.S.C. §§ 4321 through 4347, beginning with the Bureau of Reclamation's Notice to Solicit Comments and Hold Public Meetings, 70 Fed. Reg. 34794 (June 15, 2005) and culminating in a Record of Decision.

D. Party or Parties. Any party or parties to this Agreement.

E. Parties' Recommendation. The Seven Basin States' comments on the DEIS transmitted to the Secretary of the Interior on or before April 30, 2007.

F. ROD. The Record of Decision anticipated to be issued by the Secretary after completion of the NEPA Process including but not limited to any interim guidelines promulgated pursuant thereto.

G. Secretary. The Secretary of the Interior or the Bureau of Reclamation, as applicable.

H. State or States. Any of the states of Arizona, California, Colorado, Nevada, New Mexico, Utah or Wyoming, as context requires.

3. Support for Parties' Recommendation.

A. After considering a number of alternatives, each Party has determined that the Parties' Recommendation is in the best interests of that Party, and promotes the health and welfare of that Party and of the Colorado River Basin States. The Parties support the Secretary's incorporation of the Parties'

S-8

Recommendation and this Agreement into the ROD, as appropriate to effectuate the material terms of the Parties' Recommendation. If during the course of the NEPA Process any new information becomes available which causes any Party, in its sole and absolute discretion, to reassess any provision of the Parties' Recommendation and this Agreement, that Party shall immediately notify all other Parties in writing. The Parties shall jointly consult and, if they agree to any modification of the Parties' Recommendation or this Agreement, shall consult with the Secretary to advise him/her of such modification and request the adoption thereof in the ROD.

B. If after such consultations it is apparent there is an irreconcilable conflict between the Parties as to such modification, then any Party may upon written notice to the other Parties withdraw from this Agreement, and in such event this Agreement shall no longer be effective or binding upon such withdrawing Party. All withdrawing Parties hereby reserve all rights upon withdrawal from this Agreement to take such actions, including support of or challenges to the ROD, as they in their sole and absolute discretion deem necessary or appropriate. In the event of the withdrawal of any one or more Parties from this Agreement, this Agreement shall continue in full force and effect as to the remaining Parties. The remaining Parties may consult to determine whether to continue this Agreement in effect, to amend this Agreement, or to terminate this Agreement. In the event of termination, all Parties shall be relieved from the terms hereof, except as provided in Paragraph 10, and this Agreement shall be of no further force or effect.

4. ROD Consistent with the Parties' Recommendation and this Agreement. In the event the Secretary adopts a ROD in substantial conformance with the Parties' Recommendation and this Agreement, the Parties shall take all necessary actions to implement the terms of the ROD, including the approval and execution of agreements necessary for such implementation.

5. ROD Inconsistent with the Parties' Recommendation and this Agreement. In the event the Secretary adopts a ROD that any Party, in its sole and absolute discretion, determines is not in substantial conformance with the Parties' Recommendation and this Agreement, such Party shall immediately notify all other Parties of such determination in writing. The Parties shall jointly consult, and consult with the Secretary as necessary, in order to determine whether the ROD is in substantial conformance with the Parties' Recommendation and this Agreement, or whether any action, including the amendment of this Agreement, may resolve such concern. If after such consultation it is apparent there is an irreconcilable conflict between the ROD and the concerns of such Party, then such Party may upon written notice to the other Parties withdraw from this Agreement, and in such event this Agreement shall no longer be effective or binding upon such withdrawing Party. All withdrawing Parties hereby reserve all rights upon withdrawal from this Agreement to take such actions, including support of or challenges to the ROD, as they in their sole and absolute discretion deem necessary or appropriate. In the event of the withdrawal of any one or more Parties from this Agreement, this Agreement shall

S-8

continue in full force and effect as to the remaining Parties. The remaining Parties may consult to determine whether to continue this Agreement in effect, to amend this Agreement, or to terminate this Agreement. In the event of termination, all Parties shall be relieved from the terms hereof, except as provided in Paragraph 10, and this Agreement shall be of no further force or effect.

6. Additions to the ROD. The Parties hereby request that the Secretary recognize the specific provisions of this Agreement as part of the NEPA Process and include in the ROD specific provisions that reference this Agreement as a basis for the ROD. The Parties also hereby request that the Secretary include in the ROD the following specific provisions:

A. The Secretary will first consult with all the States before making any substantive modification to these guidelines.

B. Upon a request by a State for modification of these guidelines, or upon a request by a State to resolve any claim or controversy arising under: i) the Agreement Concerning Colorado River Management and Operations; ii) these Guidelines; iii) the operations of Lakes Powell and Mead pursuant to these guidelines; or, iv) any other applicable provision of federal law, regulation, criteria, policy, rule or guideline, or the Mexican Water Treaty of 1944, the Secretary shall invite the Governors of all the Basin States, or their designated representatives, to consult with the Secretary in an attempt to resolve such claim or controversy by mutual agreement.

C. In the event projections included in any Bureau of Reclamation monthly 24 Month Study indicates Lake Mead elevations may approach an elevation that would trigger shortages in deliveries of water from Lake Mead in the United States, the Secretary shall consult with all the States on how the United States shall reduce the quantity of water allotted to Mexico.

7. Consultation on Operations. After the Secretary commences operating Lakes Powell and Mead pursuant to the ROD, the Parties shall consult among themselves as necessary, but at least annually, to assess such operations. Any Party may request consultation with the other Parties on a proposed adjustment or modification of such operations, based on changed circumstances, unanticipated conditions, or other factors. Upon such request, the Parties shall consult in good faith with each other to resolve any such issues, and based thereon may request consultation by the States with the Secretary on adjustments to or modifications of operations under the ROD. In any event, the Parties shall initiate consultations before December 31, 2020, to determine whether to extend this Agreement and recommend that the Secretary continue operations under the ROD for an additional period, or modify this Agreement and recommend that the Secretary modify operations under the ROD, or terminate this Agreement and recommend that the Secretary not continue operations under the ROD after the expiration thereof. Any extension of this Agreement and any recommendation by the Parties to the Secretary to extend or modify operations under the ROD shall be made by unanimous

S-8

consent of the Parties. If such extension and recommendation are not made, this Agreement shall terminate in accordance with Paragraph 16.

8. Development of Interim Water Supplies, System Augmentation, System Efficiency and Water Enhancement Projects. The Parties agree to diligently pursue interim water supplies, system augmentation, system efficiency and water enhancement projects within the Colorado River System. The term "system augmentation" includes the quantifiable addition of new sources of supply to the Colorado River Basin, including importation from outside the Basin or desalination of ocean water or brackish water. The term "system efficiency" includes efficiency projects in the Lower Basin that will result in the more efficient use of existing supplies, such as in-system storage and enhanced management. The term "water enhancement" includes projects that may increase available system water, including cloud seeding and non-native vegetation management. Due to the critical importance of implementing these projects in reducing the potential for shortages, the Parties shall continue to jointly pursue the study and implementation of such projects, and to regularly consult on the progress of such projects.

Specifically, the Parties agree to cooperatively pursue an interim water supply of at least a cumulative amount of 280,000 acre-feet for use in Nevada while long-term augmentation projects are being pursued. It is anticipated that this interim water supply will be made available in return for Nevada's funding of the Drop 2 Reservoir mandated for construction by the Bureau of Reclamation by P.L. 109-432 § 396. Annual recovery of this interim water supply by Nevada will not exceed 40,000 acre-feet.

In consideration of the Parties' diligent pursuit of long-term augmentation and the availability of the interim water supply, the Southern Nevada Water Authority (SNWA) agrees that it will withdraw right-of-way Application No. N-79203 filed with the Bureau of Land Management on October 1, 2004 for the purpose of developing Permit No. 58591 issued by the Nevada State Engineer in Ruling No. 4151.

The SNWA will not re-file such right-of-way application or otherwise seek to divert the water rights available under Permit No. 58591 from the Virgin River prior to 2014 so long as Nevada is allowed to utilize its pre-Boulder Canyon Project Act Virgin and Muddy River rights in accordance with the Parties' Recommendation, and the interim water supply made available to Nevada is reasonably certain to remain available. The SNWA will not re-file such right-of-way application or otherwise seek to divert the water rights available under Permit No. 58591 from the Virgin River after 2014 so long as diligent pursuit of system augmentation is proceeding to provide or has provided Nevada an annual supply of 75,000 acre-feet by the year 2020. Prior to re-filing any applications with the Bureau of Land Management, SNWA and Nevada will consult with the other Basin States.

This agreement is without prejudice to any Party's claims, rights or interests in the Virgin or Muddy River systems.

S-8

9. Consistency with Existing Law. The Parties' Recommendation has been developed with the intent to be consistent with existing law. The Parties expressly agree, for purposes of this Agreement, that the storage of water in and release of water from Lakes Powell and Mead pursuant to a ROD issued by the Secretary in substantial conformance with the Parties' Recommendation and this Agreement, and any agreements, rules and regulations adopted by the Secretary or the parties to implement such ROD, shall not constitute a violation of Article III(a)-(e) inclusive of the Colorado River Compact, or Sections 601 and 602(a) of the Colorado River Basin Project Act of 1968 (43 U.S.C. §§ 1551 and 1552(a)), and all applicable rules and regulations promulgated thereunder.

10. Resolution of Claims or Controversies Not Related to Reductions in Deliveries to Mexico under the Mexican Water Treaty of 1944. The Parties recognize that judicial or administrative proceedings are not preferred alternatives to the resolution of claims or controversies concerning the law of the river. In furtherance of this Agreement, the Parties desire to avoid judicial or administrative proceedings, and agree to pursue a consultative approach to the resolution of any claim or controversy. In the event that any Party becomes concerned that there may be a claim or controversy under this Agreement, the ROD, Article III(a)-(e) inclusive of the Colorado River Compact, or Sections 601 and 602(a) of the Colorado River Basin Project Act of 1968 (43 U.S.C. §§ 1551 and 1552(a)), and all applicable rules and regulations promulgated thereunder, such Party shall notify all other Parties in writing, and the Parties shall in good faith meet in order to resolve such claim or controversy by mutual agreement prior to initiating any judicial or administrative proceeding. No Party shall initiate any judicial or administrative proceeding against any other Party or against the Secretary under Article III (a)-(e) inclusive of the Colorado River Compact, or Sections 601 and 602(a) of the Colorado River Basin Project Act of 1968 (43 U.S.C. §§ 1551 and 1552(a)), or any other applicable provision of federal law, regulation, criteria, policy, rule or guideline, and no claim thereunder shall be ripe, until such consultation has been completed. All States shall comply with any request by the Secretary for consultation in order to resolve any claim or controversy. In addition, any State may invoke the provisions of Article VI of the Colorado River Compact. Notwithstanding anything in this Agreement to the contrary, the terms of this Paragraph shall survive for a period of five years following the termination or expiration of this Agreement, and shall apply to any withdrawing Party after withdrawal for such period.

11. Resolution of Claims and Controversies Related to Reductions in Deliveries to Mexico under the Mexican Water Treaty of 1944 and Limitations on Reductions to Lower Division States.

A. The United States has the authority to reduce the quantity of water allotted to Mexico under Article 10(a) of the Mexican Water Treaty of 1944. The timing and quantity of such reductions will directly affect the quantity of water stored in Lakes Powell and Mead, and the timing and quantity of both present and future shortages in deliveries of water from Lake Mead in the United States imposed by the Secretary. A material consideration in the

S-8

development of the Parties' Recommendation is the assumption that the United States will reduce the quantity of water allotted to Mexico in years in which the Secretary imposes shortages in deliveries of water from Lake Mead in the United States. The Basin States' Preliminary Proposal of February 3, 2006, proposed that total shortages of 400,000, 500,000 and 600,000 acre-feet per year should be imposed within the United States and Mexico at certain Lake Mead elevations. In accordance with the Preliminary Proposal, Arizona and Nevada have executed a Shortage Sharing Agreement premised upon the imposition by the Secretary of shortages within the United States of 333,000, 417,000 and 500,000 acre-feet per year at the same Lake Mead elevations contained in the Preliminary Proposal. The DEIS substantially incorporates these assumptions into its consideration and analysis of the Basin States' alternative. For the first 600,000 acre-feet per year of any reductions in deliveries in any year due to a declared shortage, the Basin States have agreed that Arizona and Nevada will not take more than 500,000 acre-feet per year in aggregate and California will not take any reductions. The Parties recognize that there may be other circumstances in which the United States may reduce the amount of water allotted to Mexico under the 1944 Treaty.

B. Each of the Parties to this Agreement takes the affirmative position that in years in which the Secretary imposes shortages in deliveries of water from Lake Mead in the United States, the United States must reduce the quantity of water allotted to Mexico under Article 10(a) of the Mexican Water Treaty of 1944. In the event that any Party becomes concerned that there may be a claim or controversy regarding the United States' delivery of water allotted to Mexico under Article 10(a) of the Mexican Water Treaty of 1944, such Party shall notify all other Parties in writing. Pursuant to such notification, the Parties shall in good faith meet to consult and formulate a uniform position regarding such claim or controversy. If the Parties are successful in formulating a uniform position regarding such claim or controversy, then the Parties shall cooperate in taking any and all actions appropriate to the resolution of such claim or controversy.

C. Once consultation and any subsequent actions agreed by each Party to be taken following completion of such consultation are completed, any Party may initiate litigation or other appropriate challenge against the United States relative to any action or inaction of the United States pursuant to the Mexican Water Treaty of 1944 or the modification of the ROD. Any adverse position taken by any Party to any position taken by any other Party under this Paragraph 11. C. shall not constitute a breach of this Agreement, and all of the other terms and conditions contained in this Agreement shall remain in full force and effect.

12. Reservation of Rights. Notwithstanding the terms of this Agreement and the Parties' Recommendation, in the event that for any reason this Agreement is terminated,

S-8

or that the term of this Agreement is not extended, or upon the withdrawal of any Party from this Agreement, the Parties reserve, and shall not be deemed to have waived, any and all rights, including any claims or defenses, they may have as of the date hereof or as may accrue during the term hereof, under any existing federal or state law or administrative rule, regulation or guideline, including without limitation the Colorado River Compact, the Upper Colorado River Basin Compact, the Consolidated Decree in *Arizona v. California*, the Colorado River Basin Project Act of 1968, the Mexican Water Treaty of 1944, and any other applicable provision of federal law, rule, regulation, or guideline. Nothing in this Agreement shall be utilized against any other Party in any administrative, judicial or other proceeding, except for the sole purpose of enforcing the terms of this Agreement. Notwithstanding anything in this Agreement to the contrary, the terms of this Paragraph shall survive the termination or expiration of this Agreement, and shall apply to any withdrawing Party after withdrawal.

13. No Third-Party Beneficiaries. This Agreement is made for the benefit of the Parties. No Party to this Agreement intends for this Agreement to confer any benefit upon any person or entity not a signatory upon a theory of third-party beneficiary or otherwise.

14. Joint Defense Against Third Party Claims. In the event the Secretary adopts a ROD in substantial conformance with the Parties' Recommendation as set forth herein, the Parties will have certain common, closely parallel, or identical interests in supporting, preserving and defending the ROD and this Agreement. The nature of this interest and the relationship among the Parties present common legal and factual issues and a mutuality of interests. Because of these common interests, the Parties will mutually benefit from an exchange of information relating to the support, preservation and defense of the ROD and this Agreement, as well as from a coordinated investigation and preparation for discussion of such interests. In furtherance thereof, in the event of any challenge by a third party as to the ROD or this Agreement (including claims by any withdrawing Party), the Parties will cooperate to proceed with reasonable diligence and to use reasonable best efforts in the support, preservation and defense thereof, including any lawsuit or administrative proceeding challenging the legality, validity or enforceability of any term of the ROD or this Agreement, and will to the extent appropriate enter into such agreements, including joint defense or common interest agreements, as are necessary therefor. Each Party shall bear its own costs of participation and representation in any such defense.

15. Reaffirmation of Existing Law. Nothing in this Agreement or the Parties' Recommendation is intended to, nor shall this Agreement be construed so as to, diminish or modify the right of any Party under existing law, including without limitation the Colorado River Compact, the Upper Colorado River Basin Compact, the Consolidated Decree in *Arizona v. California*, or the Mexican Water Treaty of 1944. The Parties hereby affirm the entitlement and right of each State under such existing law to use and develop the water of the Colorado River System.

S-8

16. Term. This Agreement shall be effective as of the date of the first two signatories hereto, and shall be effective as to any additional Party as of the date of execution by such Party. Unless earlier terminated, this Agreement shall be effective for so long as the ROD and the ISG are in effect, and shall terminate on December 31, 2025 or upon the termination of the ROD and the ISG, whichever is earlier.

17. Authority. The persons and entities executing this Agreement on behalf of the Parties are recognized by the Parties as representing the respective States in matters concerning the operation of Lakes Powell and Mead, and as those persons and entities authorized to bind the respective Parties to the terms hereof. Each person executing this Agreement has the full power and authority to bind the respective Party to the terms of this Agreement. No Party shall challenge the authority of any person or Party to execute this Agreement and bind such Party to the terms hereof, and the Parties waive the right to challenge such authority.

[Signatures begin on following page.]

S-8

Herbert R. Guenther
Director
Arizona Department of Water Resources

Dana B. Fisher, Jr.
Chairman
Colorado River Board of California

Scott Balcomb
Governor's Representative
State of Colorado

Rod Kuharich
Director
Colorado Water Conservation Board

Richard W. Bunker
Chairman
Colorado River Commission of Nevada

Patricia Mulroy
General Manager
Southern Nevada Water Authority

John R. D'Antonio, Jr.
Secretary
New Mexico Interstate Stream Commission

Dennis J. Strong
Director
Utah Division of Water Resources
Utah Interstate Stream Commissioner

Patrick T. Tyrrell
State Engineer
State of Wyoming

S-8

ATTACHMENT B

Proposed Interim Guidelines for Colorado River Operations

The Basin States propose the following Guidelines to be implemented and used for determinations made pursuant to the *Criteria for Coordinated Long-Range Operation of the Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (LROC)* during the period identified in Section 9[1]:

Section 1. Definitions

A. Each of the following terms shall have the meaning provided herein. All defined terms are identified by initial letter capitalization.

1. "Basin States" shall mean the Colorado River Basin States of Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming.

2. "Certification Report" shall mean the written documentation provided by a Contractor pursuant to Section 5.D.5 that provides the Secretary with sufficient information to verify the quantity of ICS created and that the creation was consistent with the approved project.

3. "Colorado River System" shall have the same meaning as defined in the 1922 Colorado River Compact.

4. "Consolidated Decree" shall mean the Consolidated Decree entered by the United States Supreme Court in *Arizona v. California*, 126 S. Ct. 1543, 547 U.S. 150 (2006).

5. "Contractor" shall mean a Boulder Canyon Project Act Section 5 Contractor or an entity receiving Mainstream water pursuant to other applicable federal statutes or the Consolidated Decree.

6. "Delivery Agreement" shall mean an agreement consistent with these guidelines entered into between the Parties to the Forbearance Agreement, one or more Contractors creating ICS, and the Secretary of the Interior.

7. "Developed Shortage Supply ("DSS")" shall mean water available for use by a Contractor under the terms and conditions of a Delivery Agreement and Section 6.

8. "Direct Delivery Domestic Use" shall mean direct delivery of water to domestic end users or other municipal and industrial water providers within the contractor's area of normal service, including incidental regulation of Colorado River water supplies within the Year of operation but not including Off-stream Banking. For the Metropolitan Water District of Southern California (MWD), Direct Delivery Domestic Use shall include delivery of water to end users within its area of normal service, incidental regulation of Colorado River water

[1] Unless otherwise specified, references to "Section" or "Sections" in these Guidelines are in reference to sections of these Guidelines.

S-8

supplies within the Year of operation and Off-stream Banking only with water delivered through the Colorado River Aqueduct.

9. "Domestic Use" shall have the same meaning as defined in the 1922 Colorado River Compact.

10. "Forbearance Agreement" shall mean the Lower Colorado River Intentionally Created Surplus Forbearance Agreement, to be entered into among the Lower Division States, and certain Contractors in the Lower Division States.

11. "Intentionally Created Surplus ("ICS")" shall mean intentionally created surplus available for use under the terms and conditions of the Forbearance Agreement and a Delivery Agreement.

    a. ICS created through extraordinary conservation, as provided for in Section 5.D.1, shall be referred to as "Extraordinary Conservation ICS."

    b. ICS created through tributary conservation, as provided for in Section 5.D.2, shall be referred to as "Tributary Conservation ICS."

    c. ICS created through system efficiency projects, as provided for in Section 5.D.3, shall be referred to as "System Efficiency ICS."

    d. ICS created through the importation of non-Colorado River System Water, as provided for in Section 5.D.4, shall be referred to as "Imported ICS."

12. "ICS Account" shall mean records established by the Secretary.

13. "ICS Declaration" shall mean a declaration by the Secretary that ICS is available for release.

14. "Interim Period" refers to the effective period as described in Section 9.

15. "Lower Division States" shall mean the Colorado River Basin States of Arizona, California, and Nevada.

16. "Mainstream" shall have the same meaning as defined in the Consolidated Decree.

17. "Off-stream Banking" shall mean the diversion of Colorado River water to underground storage facilities for use in subsequent Years from the facility used by a Contractor diverting such water.

18. "Parties" shall mean all of the signatories to the Forbearance Agreement.

19. "ROD" shall mean the Record of Decision issued by the Secretary for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.

S-8

20. "Upper Division States" shall mean the Colorado River Basin States of Colorado, New Mexico, Utah, and Wyoming.

21. "Water Year" shall mean October 1 through September 30 of the following calendar year.

22. "Year" shall mean calendar year.

Section 2. Allocation of Unused Basic Apportionment Water under Article II(B)(6)

A. Introduction

Article II(B)(6) of the Consolidated Decree allows the Secretary to allocate water that is apportioned to one Lower Division State, but is for any reason unused in that State, to another Lower Division State. This determination is made for one Year only, and no rights to recurrent use of the water accrue to the state that receives the allocated water.

B. Application to Unused Basic Apportionment

Before making a determination of a surplus condition under these Guidelines, the Secretary will determine the quantity of apportioned but unused water from the basic apportionments under Article II(B)(6), and will allocate such water in the following order of priority:

1. Meet the Direct Delivery Domestic Use requirements of MWD and Southern Nevada Water Authority (SNWA), allocated as agreed by said agencies;

2. Meet the needs for Off-stream Banking activities in California by MWD and in Nevada by SNWA, allocated as agreed by said agencies; and

3. Meet the other needs for water in California in accordance with the California Seven-Party Agreement as supplemented by the Quantification Settlement Agreement.

Section 3. Coordinated Operation of Lakes Powell and Mead During the Interim Period

A. During the Interim Period, the Secretary shall coordinate the operations of Lake Powell and Lake Mead according to the strategy set forth in this Section 3.

B. The objective of the operation of Lakes Powell and Mead as described herein is to avoid curtailment of uses in the Upper Basin, minimize shortages in the Lower Basin and not adversely affect the yield for development available in the Upper Basin.

C. The August 24-month study projections for the January 1 system storage and reservoir water surface elevations, for the following Water Year, would be used to determine the applicability of the coordinated operation of Lakes Powell and

S-8

Mead. Equalization or balancing of storage in Lakes Powell and Mead shall be achieved by the end of each Water Year.

Powell Elevation (feet)	Powell Operation	Powell Live Storage (maf)
3700	Equalize, avoid spills or 8.23 maf	**24.32**
3636 - 3666 (see table below)	8.23 maf; if Mead < 1075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	**15.54 - 19.29** (2008 - 2026)
3575	7.48 maf 8.23 maf if Mead < 1025 feet	**9.52**
3525	Balance contents with a min/max release of 7.0 and 9.5 maf	**5.93**
3370		**0**

S-8

4

Lake Powell Equalization Elevation Table

In each of the following Water Years, the Lake Powell Equalization Elevation will be as follows:

Water Year	Elevation (feet)
2008	3636
2009	3639
2010	3642
2011	3643
2012	3645
2013	3646
2014	3648
2015	3649
2016	3651
2017	3652
2018	3654
2019	3655
2020	3657
2021	3659
2022	3660
2023	3662
2024	3663
2025	3664
2026	3666

1. Equalization: In Water Years when Lake Powell content is projected on January 1 to be at or above the elevation stated in the Lake Powell Equalization Elevation Table, an amount of water will be released from Lake Powell to Lake Mead at a rate greater than 8,230,000 acre-feet per Water Year to the extent necessary to avoid spills, or equalize storage in

S-8

the two reservoirs, or otherwise to release 8,230,000 acre-feet from Lake Powell.

2. Upper Elevation Balancing: In Water Years when Lake Powell content is projected on January 1 to be below the elevation stated in the Lake Powell Equalization Elevation Table and at or above 3575 feet, the Secretary shall release 8,230,000 acre-feet from Lake Powell if the projected elevation of Lake Mead is at or above 1075 feet. If the projected elevation of Lake Mead is below 1075 feet, the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release no more than 9,000,000 acre-feet and no less than 7,000,000 acre-feet from Lake Powell.

3. Mid-Elevation Releases: In Water Years when Lake Powell content is projected on January 1 to be below 3575 feet and at or above 3525 feet, the Secretary shall release 7,480,000 acre-feet from Lake Powell if the projected elevation of Lake Mead is at or above 1025 feet. If the projected elevation of Lake Mead is below 1025 feet, the Secretary shall release 8,230,000 acre-feet from Lake Powell.

4. Lower Elevation Balancing: In Water Years when Lake Powell content is projected on January 1 to be below 3525 feet, the Secretary shall balance the contents of Lake Mead and Lake Powell, but shall release no more than 9,500,000 acre-feet and no less than 7,000,000 acre-feet from Lake Powell.

5. When determining lake elevations and contents under this Section 3, no adjustment shall be made for ICS.

Coordinated Operation of Lakes Powell and Mead as described herein will be presumed to be consistent with the Section 602(a) storage requirement contained in the Colorado River Basin Project Act.

Section 4. Determination of Lake Mead Operation during the Interim Period

A. Normal Conditions

In Years when Lake Mead elevation is projected on January 1 to be at or above elevation 1075 feet and below 1145 feet, the Secretary shall determine a normal operating condition, unless there is an ICS Surplus under Section 4.B.5.

B. Surplus Conditions

1. Domestic Surplus (Lake Mead above Elevation 1145 feet and below 70R Strategy) in Effect through December 31, 2015 (through preparation of 2016 Annual Operating Plan for the Colorado River System Reservoirs ("AOP"))

In Years when Lake Mead content is projected to be above elevation 1145 feet, but less than the amount which would initiate a Surplus under Section B.3 70R Strategy or Section B.4 Flood Control Surplus on January 1, the

S-8

6

Secretary shall determine a Domestic Surplus. The amount of such Surplus shall equal:

a. For Direct Delivery Domestic Use by MWD, 1.250 million acre-feet (maf) reduced by the amount of basic apportionment available to MWD.

b. For use by SNWA, the Direct Delivery Domestic Use within the SNWA service area in excess of the State of Nevada's basic apportionment.

c. For use in Arizona, the Direct Delivery Domestic Use in excess of Arizona's basic apportionment.

2. Domestic Surplus (Lake Mead above Elevation 1145 feet and below 70R Strategy) in Effect from January 1, 2016 through December 31, 2025 (through preparation of 2026 AOP)

In Years when Lake Mead content is projected to be above elevation 1145 feet, but less than the amount which would initiate a Surplus under Section B.3 70R Strategy or Section B.4 Flood Control Surplus on January 1, the Secretary shall determine a Domestic Surplus. The amount of such Surplus shall equal:

a. For use by MWD, 250,000 acre-feet per Year in addition to the amount of California's basic apportionment available to MWD;

b. For use by SNWA, 100,000 acre-feet per Year in addition to the amount of Nevada's basic apportionment available to SNWA;

c. For use by Arizona, 100,000 acre-feet per Year in addition to the amount of Arizona's basic apportionment available to Arizona contractors.

3. Quantified Surplus (70R Strategy)

In Years when the Secretary determines that water should be released for beneficial consumptive use to reduce the risk of potential reservoir spills based on the 70R Strategy, the Secretary shall determine and allocate a Quantified Surplus sequentially as follows:

a. Establish the volume of the Quantified Surplus. For the purpose of determining the existence, and establishing the volume, of Quantified Surplus, the Secretary shall not consider any volume of ICS as defined in these Guidelines.

S-8

b. Allocate and distribute the Quantified Surplus 50% to California, 46% to Arizona and 4% to Nevada, subject to c. through e. that follow.

c. Distribute California's share first to meet basic apportionment demands and MWD's demands, and then to California Priorities 6 and 7 and other surplus contracts. Distribute Nevada's share first to meet basic apportionment demands and SNWA demands. Distribute Arizona's share to surplus demands in Arizona including Off-stream Banking and interstate banking demands. Arizona, California and Nevada agree that Nevada would get first priority for interstate banking in Arizona.

d. Distribute any unused share of the Quantified Surplus in accordance with Section 2, Allocation of Unused Basic Apportionment Water Under Article II(B)(6).

e. Determine whether MWD, SNWA and Arizona have received the amount of water they would have received under Sections 4.B.1 or 4.B.2 if a Quantified Surplus had not been determined. If they have not, then determine and meet all demands provided for in Sections 4.B.1 or 4.B.2.

4. Flood Control Surplus

In Years in which the Secretary makes space-building or flood control releases pursuant to the February 8, 1984 Field Working Agreement between Reclamation and the Army Corps of Engineers, the Secretary shall determine a Flood Control Surplus for the remainder of that Year or the subsequent Year as specified in Section 12. In such Years, releases will be made to satisfy all beneficial uses within the United States, including unlimited Off-Stream Banking. Under current practice, surplus declarations under the Treaty for Mexico are declared when flood control releases are made. Modeling assumptions used in the FEIS are based on this practice. These Guidelines are not intended to identify, or change in any manner, conditions when Mexico may schedule up to an additional 0.2 maf.

5. ICS Surplus

a. In Years in which Lake Mead's elevation is projected on January 1 to be above elevation 1075 feet and ICS has been requested for release, the Secretary shall determine an ICS Surplus.

b. In Years in which a Quantified Surplus or a Domestic Surplus is available to a Contractor, the Secretary shall first deliver the Quantified Surplus or Domestic Surplus before delivering any requested ICS to that Contractor. If Quantified Surplus or Domestic Surplus is insufficient or unavailable to meet a Contractor's

S-8

demands, the Secretary may release ICS available in that Contractor's ICS Account at the request of the Contractor.

c. The Secretary shall release ICS as described in Section 5.

C. Allocation of Colorado River Water and Forbearance Arrangements

Under these Guidelines, Colorado River water will continue to be allocated for use among the Lower Division States in a manner consistent with the provisions of the Consolidated Decree. It is expected that Lower Division States and individual Contractors for Colorado River water have or will adopt arrangements that will affect utilization of Colorado River water during the Interim Period. It is expected that water orders from Colorado River Contractors will be submitted to reflect forbearance arrangements by Lower Division States and individual Contractors. The Secretary will deliver Colorado River water to Contractors in a manner consistent with these arrangements. Surplus water will be delivered only to entities with contracts that are eligible to receive surplus water. ICS will be delivered pursuant to Section 5.D.6.

D. Shortage Conditions

1. Reductions in deliveries to the Lower Division States during declared shortages shall be implemented in the following manner:

   a. Step One reduction: In Years when Lake Mead content is projected on January 1 to be at or below elevation 1075 feet and at or above 1050 feet, a quantity of 333,000 acre-feet shall not be released or delivered in the Lower Division States.

   b. Step Two reduction: In Years when Lake Mead content is projected on January 1 to be below elevation 1050 feet and at or above 1025 feet, a quantity of 417,000 acre-feet shall not be released or delivered in the Lower Division States.

   c. Step Three reduction: In Years when Lake Mead content is projected on January 1 to be below 1025 feet, a quantity of 500,000 acre-feet shall not be released or delivered in the Lower Division States.

2. In the event projections included in any Bureau of Reclamation monthly 24-Month Study indicate Lake Mead elevations may approach an elevation that would trigger shortages in deliveries of water from Lake Mead in the United States, the Secretary shall consult with the Basin States on how the United States shall reduce the quantity of water allotted to Mexico.

3. Whenever Lake Mead is below elevation 1025 feet, the Secretary shall consult with the Basin States annually to determine whether Colorado River hydrologic conditions, together with the anticipated delivery of water to the Lower Division States and Mexico, will cause the elevation of Lake

S-8

Mead to fall below 1000 feet. Upon such a determination, the Secretary shall consult with the Basin States to discuss further measures that may be undertaken. If increased reductions are required, the Secretary shall implement the reductions consistent with the law of the river.

4. Subject to the provisions of Section 4.D.3, the Lower Division States shall not take shortages in excess of those provided in Section 4.D.1 Arizona and Nevada have agreed to share all reductions, described in Section 4.D.1 based on the Arizona-Nevada Shortage Sharing Agreement dated February 9, 2007. California shall not be required to share in any reductions described in Section 4.D.1.

5. The Secretary shall consult with the Basin States to evaluate actions at critical elevations that may avoid shortage determinations as reservoir elevations approach critical thresholds.

6. During declared Shortages described in Section 4.D.1, the Secretary may release Developed Shortage Supply, subject to the provisions in Sections 5 and 6.

Section 5. System Efficiency, Extraordinary Conservation, Tributary Conservation and Importation of Non-Colorado River System Water for the Purpose of Developing Intentionally Created Surplus

A. Findings

ICS may be created through projects that create water system efficiency, extraordinary conservation, tributary conservation, and the importation of non-Colorado River System water into the Colorado River Mainstream. ICS is consistent with the concept that the States will take actions to augment storage of water in the Lower Colorado River Basin. The ICS shall be released to the Contractor that created it pursuant to both Article II(B)(2) of the Consolidated Decree and agreements among various Contractors to forbear from taking water that they otherwise would be able to request. Implementation under these Guidelines shall be predicated upon the execution of a Forbearance Agreement and a Delivery Agreement, as further provided for below.

B. Purposes

The purposes of ICS are to:

1. Encourage the efficient use and management of Colorado River water, and to increase the water supply in Colorado River system reservoirs, through the creation, release, and use of ICS;

2. Help avoid shortages to the Lower Basin;

3. Benefit both Lake Mead and Lake Powell;

4. Increase the surface elevations of both Lakes Powell and Mead to higher levels than would have otherwise occurred; and

S-8

5. Assure any Contractor that invests in conservation or augmentation to create ICS that no Contractor within another state will claim the ICS created by the Contractor.

C. Statement of Consistency with the Law of the River and Consequential Limitations on ICS Guidelines

In Years in which the Secretary determines that sufficient Mainstream water is available for release to satisfy annual consumptive use in the Lower Division States in excess of 7,500,000 acre-feet, Article II(B)(2) of the Consolidated Decree authorizes the Secretary to apportion surplus Mainstream water 50% for use in California, 46% for use in Arizona, and 4% for use in Nevada. The Boulder Canyon Project Act and Articles II(B)(2) and II(B)(6) of the Consolidated Decree, taken together, authorize the Secretary to apportion surplus water and to release one Lower Division State's unused apportionment for use in another Lower Division State. Pursuant to such authority and for the purpose of increasing the efficiency, flexibility, and certainty of Colorado River management and thereby helping satisfy the regional water demands that exist, the Secretary has the authority to promulgate guidelines to establish a procedural framework for facilitating the creation and release of ICS.

In the absence of forbearance, surplus water is apportioned for use according to the percentages provided in Article II(B)(2) of the Consolidated Decree. The Forbearance Agreement, as approved by the Parties, will provide the basis for such forbearance. The Parties will forbear only with respect to ICS created by projects described in exhibits attached to the Forbearance Agreement or added thereto by written consent of all Parties. It is hereby recognized that the creation, release and use of ICS pursuant to these Guidelines shall not be administered in such a way as to violate the Consolidated Decree, including Articles II(B)(2) and II(B)(6) therein. These Guidelines regarding ICS shall have no force or effect absent the existence and effectiveness of the Forbearance Agreement.

D. Creation and Release of ICS

1. Extraordinary Conservation ICS

A Contractor may create Extraordinary Conservation ICS through the following activities:

a. Fallowing of land that currently is, historically was, and otherwise would have been irrigated in the next Year.

b. Canal lining programs.

c. Desalination programs in which the desalinated water is used in lieu of Mainstream water.

d. Extraordinary conservation programs that existed on January 1, 2006.

e. Extraordinary Conservation ICS demonstration programs pursuant to a letter agreement entered into between the United States Bureau of

S-8

11

Reclamation and the Contractor prior to the effective date of these Guidelines.

f. Tributary Conservation ICS created under Section 5.D.2 and not released in the Year created.

g. Imported ICS created under Section 5.D.4 and not released in the Year created.

h. Other extraordinary conservation measures, including development and acquisition of a non-Colorado River System water supply used in lieu of Colorado River Mainstream water within the same state, in consultation with the Basin States, and as agreed upon by the Parties pursuant to the Forbearance Agreement.

2. Tributary Conservation ICS

A Contractor may create Tributary Conservation ICS by purchasing documented water rights on Colorado River System tributaries upstream of Hoover Dam within the Contractor's state if there is documentation that the water rights have been used for a significant period of Years and that the water rights were perfected prior to June 25, 1929 (the effective date of the Boulder Canyon Project Act). The quantity of Tributary Conservation ICS shall be limited to the quantity of water set forth in Exhibits incorporated in the Forbearance Agreement, and shall in no event be more than the quantity of such water the Secretary verifies actually flows into Lake Mead. Any Tributary Conservation ICS not released pursuant to Section 5.D.6 or deducted pursuant to Section 5.D.5.c in the Year it was created will, at the beginning of the following Year, be converted to Extraordinary Conservation ICS at the request of the Contractor and will thereafter be subject to all provisions applicable to Extraordinary Conservation ICS. Tributary Conservation ICS may be released for Domestic Use only.

3. System Efficiency ICS

A Contractor may make contributions of capital to the Secretary for use in Secretarial projects designed to realize system efficiencies that save water that would otherwise be lost from the Colorado River Mainstream in the United States. An amount of water equal to a portion of the water saved may be made available to contributing Contractor(s) by the Secretary as System Efficiency ICS. System efficiency projects are intended only to provide temporary water supplies. System Efficiency ICS will not be available for permanent use. System Efficiency ICS will be released to the contributing Contractor(s) on a predetermined schedule of annual deliveries for a period of Years as agreed by the Parties. The Secretary, in consultation with the Basin States, will identify potential system efficiency projects, terms for capital participation in such projects, and types and amounts of benefits the Secretary should provide in consideration of non-federal capital contributions to system efficiency projects, including identification of a portion of the water saved by such projects.

S-8

4. Imported ICS

A Contractor may create Imported ICS by introducing non-Colorado River System water in that Contractor's state into the Mainstream. Contractors proposing to create Imported ICS shall make arrangements with the Secretary, contractual or otherwise, to ensure no interference with the Secretary's management of Colorado River system reservoirs and regulatory structures. Any arrangement shall provide that the Contractor must obtain appropriate permits or other authorizations required by state law and that the actual amount of water introduced to the Mainstream shall be reported to the Secretary on an annual basis. Any Imported ICS not released pursuant to Section 5.D.6 or deducted pursuant to Section 5.D.5.c in the Year it was created will be converted, at the beginning of the following Year, to Extraordinary Conservation ICS at the request of the Contractor and thereafter will be subject to all provisions applicable to Extraordinary Conservation ICS.

5. Creation of ICS

A Contractor may create ICS subject to the following conditions:

a. A Contractor shall submit a plan for the creation of ICS to the Secretary and the Basin States demonstrating how all requirements of these Guidelines will be met in the Contractor's creation of ICS. Until such plan is reviewed and approved by the Secretary in consultation with the other Basin States, such plan, or any ICS purportedly created through it, shall not be a basis for an ICS Declaration. A Contractor may modify its plan for creation of ICS during any Year, subject to approval by the Secretary in consultation with the Basin States. System Efficiency ICS with an approved multi-Year plan shall not require annual approval by the Secretary or consultation with the Basin States.

b. A Contractor that creates ICS shall submit a Certification Report to the Secretary demonstrating the amount of ICS created and that its creation was consistent with the Forbearance Agreement, these Guidelines, and a Delivery Agreement executed by the Secretary. The Secretary shall verify the information in the Certification Report in consultation with the Basin States, and provide a final written decision to the Contractor, the Parties and the Basin States. The Contractor or any Party or Basin State may appeal the Secretary's verification of the Certification Report through administrative and judicial processes.

c. There shall be a one-time deduction of five percent (5%) from the amount of ICS in the Year of its creation. This deduction results in additional water in storage in Lake Mead for future use in accordance with the Consolidated Decree and these Guidelines. This provision shall not apply to:

S-8

13

(1) System Efficiency ICS created pursuant to Section 5.D.3 because a large portion of the water saved by this type of project will increase the quantity of water in storage.

(2) Extraordinary Conservation ICS created by conversion of Tributary Conservation ICS that was not released in the Year created, pursuant to Section 5.D.1.f because 5% of the ICS is deducted at the time the Tributary Conservation ICS is created.

(3) Extraordinary Conservation ICS created by conversion of Imported ICS that was not released in the Year created, pursuant to Section 5.D.1.g because 5% of the ICS is deducted at the time the Imported ICS is created.

d. The records of any Contractor relating to the creation of ICS shall be open to inspection by the Secretary or any Contractor, Party or Basin State.

e. In addition to the conditions described above, creation of Extraordinary Conservation ICS is subject to the following conditions:

(1) Except as provided in Sections 5.D.2 and 5.D.4, Extraordinary Conservation ICS can only be created if such water would have otherwise been beneficially used.

(2) The maximum total amount of Extraordinary Conservation ICS that can be created during any Year is limited to the following:

(a) 400,000 acre-feet for California Contractors;

(b) 125,000 acre-feet for Nevada Contractors; and

(c) 100,000 acre-feet for Arizona Contractors.

(3) The maximum quantity of Extraordinary Conservation ICS that may be accumulated in all ICS Accounts, at any time, is limited to the following:

(a) 1,500,000 acre-feet for California Contractors;

(b) 300,000 acre-feet for Nevada Contractors; and

(c) 300,000 acre-feet for Arizona Contractors.

(4) Except as provided in Sections 5.D.2 and 5.D.4, no category of surplus water can be used to create Extraordinary Conservation ICS.

(5) The quantity of Extraordinary Conservation ICS remaining in an ICS Account at the end of each Year shall be diminished by annual evaporation losses of 3%. Losses shall be applied

S-8

annually to the end-of-the-Year balance of Extraordinary Conservation ICS beginning in the Year after the ICS is created and continuing until no Extraordinary Conservation ICS remains in Lake Mead. No evaporation losses shall be assessed during a Year in which the Secretary has declared a shortage.

(6) Extraordinary Conservation ICS from a project within a state may be credited to the ICS Account of a Contractor within that state that has funded or implemented the project creating ICS, or to the ICS Account of a Contractor within the same state as the funding entity and project and with written agreement of the funding entity.

(7) A Contractor must notify Reclamation by September 15 of the amount of Extraordinary Conservation ICS it wishes to create for the subsequent Year. If conditions during the Year change due to weather or other unforeseen circumstances, a Contractor may request a mid-Year modification of its water order to reduce the amount of ICS created during that Year. A Contractor cannot increase the amount of ICS it had previously scheduled to create during the Year.

6. Release of ICS

The release of ICS shall be pursuant to the terms of a Delivery Agreement entered into among the Secretary, the Parties to the Forbearance Agreement and any Contractor creating ICS. The Secretary shall not release ICS to a Contractor unless that Contractor is a party to a Delivery Agreement. A Contractor that has created ICS may request release of its ICS as is provided within such Delivery Agreement and subject to the following conditions:

a. ICS shall be released pursuant to an ICS Declaration.

b. If a Contractor has an overrun payback obligation, as described in the October 10, 2003 Inadvertent Overrun and Payback Policy or Exhibit C to the October 10, 2003 Colorado River Water Delivery Agreement, the Contractor must pay the overrun payback obligation in full before requesting or receiving a release of any ICS. The Contractor's ICS account shall be reduced by the amount of the overrun payback obligation in order to pay the overrun payback obligation.

c. If more ICS is released to a Contractor than is actually available for release to the Contractor in that Year, then the excess ICS released shall be treated as an inadvertent overrun until it is fully repaid.

d. A Contractor may reduce its request for release of ICS during the Year for any reason, including reduction in water demands. A Contractor may increase its request for release of ICS during the Year only if extraordinary weather conditions or water emergencies occur.

S-8

e. In addition to the conditions described above, the release of Extraordinary Conservation ICS is subject to the following conditions:

(1) The total amount of Extraordinary Conservation ICS that may be released in any Year is limited to the following:

(a) 400,000 acre-feet for California Contractors;

(b) 300,000 acre-feet for Nevada Contractors; and

(c) 300,000 acre-feet for Arizona Contractors.

(2) If the May 24-month study for that Year indicates that a shortage condition would be declared in the succeeding Year if the requested amounts for the current Year under Section 5.D.6.e.(1) were released, the Secretary may release less than the amounts of ICS requested to be released.

(3) If the Secretary releases Flood Control Surplus water, Extraordinary Conservation ICS accumulated in ICS Accounts shall be reduced by the amount of the Flood Control Surplus on an acre-foot for acre-foot basis until no Extraordinary Conservation ICS remains. The reductions to the ICS Accounts shall be shared on a pro-rata basis among all Contractors that have accumulated Extraordinary Conservation ICS.

E. Accounting Procedure for ICS

In consultation with the Basin States, the Secretary shall develop a water accounting procedure to annually establish separate ICS Accounts to account for, at a minimum, the following:

1. For each Contractor that creates Extraordinary Conservation ICS:

a. The quantity of Extraordinary Conservation ICS created by the Contractor.

b. The releases of Extraordinary Conservation ICS to the Contractor.

c. The amount of Extraordinary Conservation ICS no longer available for release to the Contractor due to releases for flood control purposes.

d. The amount of Extraordinary Conservation ICS deducted pursuant to Section 5.D.5.c.

e. The amount of Extraordinary Conservation ICS no longer available for release to the Contractor due to annual evaporation losses pursuant to Section 5.D.5.e.(5).

S-8

f. The amount of Extraordinary Conservation ICS remaining available for release to the Contractor.

2. For each Contractor that creates Tributary Conservation ICS:

a. The quantity of Tributary Conservation ICS created by the Contractor.

b. The releases of Tributary Conservation ICS to the Contractor.

c. The amount of Tributary Conservation ICS deducted pursuant to Section 5.D.5.c.

d. The amount of Tributary Conservation ICS converted to Extraordinary Conservation ICS, if any.

3. For each Contractor that creates System Efficiency ICS:

a. The quantity of System Efficiency ICS created by the Contractor.

b. The releases of System Efficiency ICS to the Contractor.

c. The amount of System Efficiency ICS no longer available for release to the Contractor for any reason.

d. The amount of System Efficiency ICS remaining available for release to the Contractor.

4. For each Contractor that creates Imported ICS:

a. The quantity of Imported ICS created by the Contractor.

b. The releases of Imported ICS to the Contractor.

c. The amount of Imported ICS deducted pursuant to Section 5.D.5.c.

d. The amount of Imported ICS converted to Extraordinary Conservation ICS, if any.

F. Delivery Agreement

The Secretary shall release ICS to a Contractor only after entering into a Delivery Agreement with the Contractor and the Parties to the Forbearance Agreement. Any Delivery Agreement shall be consistent with these Guidelines and the Forbearance Agreement, and shall include the following:

1. A procedure for the annual schedule for the submission and approval of the plans for the creation of ICS, required by Section 5.D.5.a.

2. Procedures for demonstrating and verifying the creation of ICS, including a description of the contents of the Certification Report, required by Section 5.D.5.b.

S-8

3. A procedure for the release of ICS, in accordance with Section 5.D.6.

4. An accounting procedure, pursuant to Section 5.E.

Section 6. Creation and Release of Developed Shortage Supply

A. During any Year in which the Secretary declares a shortage within the United States, Developed Shortage Supply may be created by:

1. Purchasing documented water rights on Colorado River System tributaries upstream of Hoover Dam within the Contractor's state if there is documentation that the water rights have been used for a significant period of Years and that the water rights were perfected prior to June 25, 1929 (the effective date of the Boulder Canyon Project Act), provided that the quantity of such Developed Shortage Supply shall be limited to the quantity of water set forth in Exhibits incorporated in the Forbearance Agreement, and shall in no event be more than the quantity of such water the Secretary verifies actually flows into Lake Mead; and/or

2. Introducing non-Colorado River System water in that Contractor's state into the Colorado River Mainstream, making sufficient arrangements with the Secretary, contractual or otherwise, to ensure no interference with the Secretary's management of Colorado River system reservoirs and regulatory structures. Any arrangement shall provide that the Contractor must obtain appropriate permits or other authorizations required by state law and reporting the actual amount of water introduced to the Colorado River Mainstream to the Secretary on an annual basis.

B. Developed Shortage Supply may only be created by a project that is approved for creation of ICS prior to the declared Shortage.

C. Except as provided in Sections 6.D through 6.F, Developed Shortage Supply is subject to all conditions set forth in Section 5 relating to creation and release of ICS.

D. Any Developed Shortage Supply not released pursuant to Section 6.E in the Year it is created may not be converted to Extraordinary Conservation ICS.

E. The Secretary shall release Developed Shortage Supply during a declared shortage. The following conditions shall apply to the release of Developed Shortage Supply:

1. Developed Shortage Supply shall be released pursuant to a Shortage Declaration.

2. Release of Developed Shortage Supply shall not cause the total deliveries within the Lower Division States to reach or exceed 7.5 million acre-feet in any Year. If the volume of Developed Shortage Supply requested to be released in any Year would cause the total deliveries within the Lower Division States to reach or exceed 7.5 million acre-feet for that Year, the Secretary shall consult with all Contractors requesting the release of Developed Shortage Supply and release so much thereof as will not cause

S-8

total deliveries in the Lower Division States to reach or exceed 7.5 million acre-feet in that Year.

F. The Secretary shall account for the creation and release of Developed Shortage Supply through the AOP and the Article V Consolidated Decree accounting processes.

G. Delivery Agreement

For a Contractor seeking to create and use Developed Shortage Supply, the Delivery Agreement for ICS executed by the Secretary, the Contractor and the Parties to the Forbearance Agreement shall also include the following:

1. A procedure for the annual schedule for the submission and approval of the plans for the creation of Developed Shortage Supply, required by Sections 6.C and 5.D.5.a.

2. Procedures for demonstrating and verifying the creation of Developed Shortage Supply, including a description of the contents of the Certification Report, required by Sections 6.C and 5.D.5.b.

3. A procedure for the release of Developed Shortage Supply, in accordance with Sections 6.C, 6.E, and 5.D.6.

4. An accounting procedure, pursuant to Section 6.F.

Section 7. Implementation of Guidelines

During the effective period of these Guidelines the Secretary shall utilize the currently established process for development of the AOP and use these Guidelines to make determinations regarding Normal, Surplus and Shortage conditions for the operation of Lake Mead, allocation of apportioned but unused water, the coordinated operations of Lakes Mead and Powell, and the administration of Developed Shortage Supply and contractor accounts for ICS.

The operation of the other Colorado River System reservoirs and determinations associated with development of the AOP shall be in accordance with the Colorado River Basin Project Act of 1968, these Guidelines, and other applicable federal law.

In order to allow for better overall water management during the Interim Period, the Secretary shall undertake a "mid-Year review" pursuant to Section 1(2) of the LROC, allowing for the revision of the current AOP, as appropriate, if actual runoff conditions are greater than projected or demands are lower than projected. The Secretary shall revise the determination for the current Year only to allow for additional deliveries. Any revision in the AOP, including reductions in the amount of ICS released, may occur only after a re-initiation of the AOP consultation process as required by law.

As part of the AOP process during the effective period of these Guidelines, California shall report to the Secretary on its progress in implementing its California Colorado River Water Use Plan.

S-8

The Secretary will base annual determinations of surplus, normal and shortage conditions on these Guidelines, unless extraordinary circumstances arise. Such circumstances could include operations necessary for safety of dams or other emergency situations, or other unanticipated or unforeseen activities arising from actual operating experience.

Section 8. Consultation

In addition to the circumstances described in Section 4.D.2, the Secretary shall consult with the Basin States in the following circumstances:

A. The Secretary will first consult with all the Basin States before making any substantive modification to these Guidelines.

B. Upon a request by a State for modification of these Guidelines, or upon a request by a State to resolve any claim or controversy arising under these Guidelines or under the operations of Lakes Powell and Mead pursuant to these guidelines or any other applicable provision of federal law, regulation, criteria, policy, rule, or guideline, or the Mexican Water Treaty of 1944, the Secretary shall invite the Governors of all the Basin States, or their designated representatives, to consult with the Secretary in an attempt to resolve such claim or controversy by mutual agreement.

Section 9. Effective Period & Termination

A. Effective Period

These guidelines will be in effect 30 days from the publication of the ROD in the Federal Register and will, unless subsequently modified, remain in effect through December 31, 2025 (through preparation of the 2026 AOP), except that during the effective period of the Forbearance Agreement defined in Section 5.C:

1. Any ICS remaining in an ICS Account on December 31, 2025, may be released as provided herein until December 31, 2035.

2. Tributary Conservation ICS described in Section 5.D.2 and Imported ICS described in Section 5.D.4 shall continue in full force and effect until fifty years from the date of the execution of the Forbearance Agreement.

3. Developed Shortage Supply described in Section 6 shall continue in full force and effect until fifty years from the date of the execution of the Forbearance Agreement.

B. Termination of Guidelines

Except as provided in Section 9.A, these Guidelines shall terminate on December 31, 2025 (through preparation of the 2026 AOP). At the conclusion of the effective period of these Guidelines, the operating criteria for Lake Powell and Lake Mead are assumed to revert to the operating criteria used to model baseline conditions in the Final Environmental Impact Statement for the Interim Surplus Guidelines

S-8

dated December 2000 (i.e., modeling assumptions are based upon a 70R strategy for the period commencing January 1, 2026 (for preparation of the 2027 AOP)).

C. Review of Guidelines

Beginning no later than December 31, 2020, the Secretary shall initiate a formal review for purposes of evaluating the effectiveness of these Guidelines. The Secretary shall consult with the Basin States in initiating this review.

Section 10. California's Colorado River Water Use Plan Implementation Progress

The California agricultural (Palo Verde Irrigation District (PVID), Yuma Project Reservation Division (YPRD), Imperial Irrigation District (IID), and Coachella Valley Water District (CVWD)) usage plus 14,500 acre-feet of Present Perfected Right (PPR) use would need to be at or below the following amounts at the end of the Year indicated in Years of Quantified Surplus (for Decree accounting purposes all reductions must be within 25,000 acre-feet of the amounts stated):

Benchmark Date (Year)	Benchmark Quantity (California Agricultural Usage & 14,500 af of PPR Use in maf)
2009	3.53
2012	3.47

In the event that California has not reduced its use in amounts to equal the above Benchmark Quantities, the surplus determinations under Sections 4.B.1 or 4.B.2 will be suspended and will instead be based upon the 70R Strategy, for up to the remainder of the term of these Guidelines. If however, California meets the missed Benchmark Quantity before the next Benchmark Date, or after 2012, the surplus determinations under Sections 4.B.1 or 4.B.2 shall be reinstated as the basis for the surplus determinations under the AOP for the next following Year(s).

Section 11. Authority

These Guidelines are issued pursuant to the authority vested in the Secretary by federal law, including the Boulder Canyon Project Act of 1928 (28 Stat. 1057) (the "BCPA"), and the Consolidated Decree and shall be used to implement Article III of the Criteria for the Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Pub. L. No. 90-537), amended March 21, 2005.

Section 12. Modeling and Data

The August 24-Month Study projections for the January 1 system storage and reservoir water surface elevations, for the following Year, will be used to determine the applicability of these Guidelines.

In preparation of the AOP, Reclamation will utilize the 24-Month Study and/or other modeling methodologies appropriate for the determinations and findings necessary in the AOP.

S-8

Reclamation will utilize the best available data and information, including National Weather Service forecasting to make these determinations.

S-8

22

ATTACHMENT C

Lower Colorado River Basin Intentionally Created Surplus Forbearance Agreement

The State of Arizona, acting through the Arizona Department of Water Resources ("ADWR"); the Palo Verde Irrigation District ("PVID"); the Imperial Irrigation District ("IID"); The City of Needles; the Coachella Valley Water District ("CVWD"); The Metropolitan Water District of Southern California ("MWD"); the Southern Nevada Water Authority ("SNWA"); and the Colorado River Commission of Nevada enter into this Lower Colorado River Basin Intentionally Created Surplus Forbearance Agreement ("Forbearance Agreement") as follows:

Recitals

A. The purposes of this Forbearance Agreement are to:

1. Encourage the efficient use and management of Colorado River water, and to increase the water supply in Colorado River system reservoirs, through the creation, release, and use of Intentionally Created Surplus ("ICS");

2. Help avoid shortages to the Lower Basin;

3. Benefit both Lake Mead and Lake Powell; and

4. Increase the surface elevations of both Lakes Powell and Mead to higher levels than would have otherwise occurred.

5. Assure any Contractor that invests in conservation or augmentation to create ICS under this Forbearance Agreement that no Contractor within another state will claim the ICS created by the Contractor.

S-8

B. The Parties to the Forbearance Agreement and their respective authority to forbear are as follows:

1. The Arizona Department of Water Resources, through its Director, is the successor to the signatory agency of the State for the 1922 Colorado River Compact, and the 1944 Contract for Delivery of Water with the United States, both authorized and ratified by the Arizona Legislature, A.R.S. §§ 45-1301 and 1311. Pursuant to A.R.S. § 45-107, the Director is authorized and directed, subject to the limitations in A.R.S. § 45-106, for and on behalf of the State of Arizona, to consult, advise and cooperate with the Secretary of the Interior of the United States ("Secretary") with respect to the exercise by the Secretary of Congressionally authorized authority relative to the waters of the Colorado River (including, but not limited to, the Boulder Canyon Project Act of 1928, 43 U.S.C. § 617, and the Colorado River Basin Project Act of 1968, 43 U.S.C. § 1501) and with respect to the development, negotiation and execution of interstate agreements. Additionally, under A.R.S. § 45-105(A)(9), the Director is authorized to "prosecute and defend all rights, claims and privileges of this state respecting interstate streams."

2. SNWA is a Nevada joint powers agency and political subdivision of the State of Nevada, created by agreement dated July 25, 1991, as amended November 17, 1994, and January 1, 1996, pursuant to N.R.S. §§ 277.074 and 277.120. SNWA is authorized by N.R.S. § 538.186 to enter into this Forbearance Agreement and, pursuant to its contract issued under Section 5 of the Boulder Canyon Project Act of 1928, SNWA has the right to divert ICS released by the Secretary for use within the State of Nevada pursuant to the Consolidated Decree.

3. The Colorado River Commission of the State of Nevada (CRCN) is an agency of the State of Nevada, authorized generally by N.R.S. §§ 538.041 and 538.251. CRCN is authorized by N.R.S. § 538.161 (6), (7) to enter into this

S-8

Agreement. The CRCN, in furtherance of the State of Nevada's responsibility to promote the health and welfare of its people in Colorado River matters, makes this Agreement to supplement the supply of water in the Colorado River which is available for use in Nevada, augment the waters of the Colorado River, and facilitate the more flexible operation of dams and facilities by the Secretary.

4. PVID is an irrigation district created under the Palo Verde Irrigation District Act, codified at Section 33-1 et seq. of the Appendix to the California Water Code, and delivers Colorado River water in Riverside and Imperial Counties, California, pursuant to its contract issued under Section 5 of the Boulder Canyon Project Act of 1928.

5. IID is an irrigation district created under the California Irrigation District Law, codified at Section 20500 *et seq.* of the California Water Code, and delivers Colorado River water in Imperial County, California, pursuant to its contract issued under Section 5 of the Boulder Canyon Project Act of 1928.

6. CVWD is a county water district created under the California County Water District Law, codified at Section 30000 *et seq.* of the California Water Code, and delivers Colorado River water to portions of its service area in Imperial, Riverside, and San Diego Counties, California, pursuant to its contract issued under Section 5 of the Boulder Canyon Project Act of 1928 and the California Quantification Settlement Agreement.

7. MWD is a metropolitan water district created under the California Metropolitan Water District Act, codified at Section 109-1 *et seq.* of the Appendix to the California Water Code; and delivers Colorado River water to portions of its service area in Los Angeles, Orange, Riverside, San Bernardino, San Diego and Ventura Counties, California, pursuant to its contracts issued under Section 5 of the Boulder Canyon Project Act of 1928.

S-8

8. The City of Needles is a charter city duly authorized and existing under and by virtue of the laws of the State of California and delivers Colorado River water, either directly or by exchange, to portions of Imperial, Riverside, and San Bernardino Counties, California, pursuant to its contracts issued under Section 5 of the Boulder Canyon Project Act of 1928,

NOW, THEREFORE, in consideration of the mutual covenants herein contained, the Parties hereby agree as follows:

Article 1
Definitions and Term

1.1 Definitions.

The definitions in the Interim Surplus Guidelines ("ISG") described in the Record of Decision dated January 16, 2001, and modified by the ROD are hereby incorporated in this Forbearance Agreement. In addition, each of the following terms shall have the meaning defined here. All defined terms shall be identified by initial letter capitalization.

A. "Certification Report" shall mean the written documentation provided by a Contractor pursuant to Article 2.5(B) that provides the Secretary with sufficient information to verify the quantity of ICS created and that the creation was consistent with the approved project exhibit, this Forbearance Agreement, the Delivery Agreement, and the ROD.

B. "Colorado River System" shall have the same meaning as defined in the 1922 Colorado River Compact.

S-8

C. “Consolidated Decree” shall mean the Consolidated Decree entered by the United States Supreme Court in *Arizona v. California*, 126 S.Ct. 1543, 547 U.S. ____ (2006).

D. “Contractor” shall mean a Boulder Canyon Project Act Section 5 Contractor or an entity receiving Mainstream water pursuant to other applicable federal statute or the Consolidated Decree.

E. “Delivery Agreement” shall mean the agreement entered into by the Parties to this Agreement and the Secretary of the Interior contemporaneously with this Forbearance Agreement.

F. “Forbearance Agreement” shall mean this Lower Colorado River Basin Intentionally Created Surplus Forbearance Agreement.

G. “ICS” shall mean intentionally created surplus available for use under the terms and conditions of this Forbearance Agreement and the Delivery Agreement.

1. ICS created through extraordinary conservation, as provided for in Article 2.1 herein, shall be referred to as “Extraordinary Conservation ICS.”

2. ICS created through tributary conservation, as provided for in Article 2.2 herein, shall be referred to as “Tributary Conservation ICS.”

3. ICS created through system efficiency projects, as provided for in Article 2.3 herein, shall be referred to as “System Efficiency ICS.”

S-8

4. ICS created through the importation of non-Colorado River System Water, as provided for in Article 2.4 herein, shall be referred to as "Imported ICS."

H. "ICS Account" shall mean a record established by the Secretary under the terms of this Forbearance Agreement, the Delivery Agreement, and the ROD.

I. "ICS Declaration" shall mean a declaration of ICS made by the Secretary pursuant to the ROD, the Delivery Agreement and the provisions of this Forbearance Agreement.

J. "Lower Division States" shall mean the Colorado River Basin States of Arizona, California, and Nevada.

K. "Mainstream" shall have the same meaning as defined in the Consolidated Decree.

L. "Parties" shall mean all of the signatories to this Forbearance Agreement.

M. "ROD" shall mean the Record of Decision issued by the Secretary for the Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead, Particularly Under Low Reservoir Conditions, and including the policy for implementation of ICS.

N. "Year" shall mean calendar year.

1.2 Term of the Forbearance Agreement.

This Forbearance Agreement shall commence on the date of execution by all Parties and shall terminate December 31, 2025; provided, however, that any ICS remaining in an ICS

S-8

Account on December 31, 2025, may be released as provided herein until December 31, 2035.

1.3 Extended Term for Tributary Conservation ICS and Imported ICS.

Notwithstanding Article 1.2, the provisions of this Forbearance Agreement for creation, and release in the Year of creation, of Tributary Conservation ICS under Article 2.2 and Imported ICS under Article 2.4, shall continue in full force and effect after termination of this Forbearance Agreement until the earlier of (1) the termination of the period provided in the ROD for the creation, release, and use of Tributary Conservation ICS and Imported ICS, or (2) fifty years from the date of execution of this Forbearance Agreement. The amount of Tributary Conservation ICS and Imported ICS that may be created, released, and used through the end of the extended term provided by this Article 1.3 shall not exceed the amount shown in, and shall be consistent with, the attached Exhibits ___ and ___ for Tributary Conservation ICS and Imported ICS. Such ICS may be released during the extended term as provided herein. The obligations of the Parties under Articles 2.5, 2.6, 3, 4, and 5 shall continue with regard to such ICS.

1.4 Seven Colorado River Basin States' Agreement

Notwithstanding Articles 1.2 and 1.3 above, if one or more states withdraw from the agreement dated ____, executed by the seven Colorado River Basin states, the Parties to this Forbearance Agreement shall consult to determine whether to continue this Forbearance Agreement in effect or to amend or terminate this Forbearance Agreement. In such event, the terms of this Forbearance Agreement shall continue in effect until the Parties have consulted and agreed to continue, amend, or terminate this Forbearance Agreement. In the event of termination, all Parties shall be relieved from the terms hereof and this Forbearance Agreement shall be of no further force or effect.

S-8

Article 2

Creation and Release of ICS

2.1 Extraordinary Conservation ICS

Pursuant to procedures set forth in the ROD, the Delivery Agreement, and this Forbearance Agreement, Extraordinary Conservation ICS may be created only through the following activities:

A. Fallowing of land that currently is, historically was, and otherwise would have been irrigated in the next Year.

B. Canal lining programs.

C. Desalination programs in which the desalinated water is used in lieu of Mainstream water.

D. Extraordinary conservation programs that existed on January 1, 2006.

E. Demonstration Extraordinary Conservation ICS programs pursuant to a letter agreement entered into between the United States Bureau of Reclamation and the Contractor prior to the effective date of the ROD.

F. Tributary Conservation ICS created under Article 2.2 hereto and not released in the Year created.

G. Imported ICS created under Article 2.4 hereto and not released in the Year created.

H. Other extraordinary conservation measures, including development and acquisition of a non-Colorado River System water supply used in lieu of Mainstream water within the same state, as agreed upon by the Parties pursuant to this Forbearance Agreement.

2.2 Tributary Conservation ICS

Pursuant to procedures set forth in the ROD, a Contractor may create Tributary Conservation ICS by purchasing documented water rights on Colorado River System tributaries within the

Contractor's state if there is documentation that the water rights have been used for a significant period of years and that the water rights were perfected prior to June 25, 1929 (the effective date of the Boulder Canyon Project Act of 1928). The quantity of Tributary Conservation ICS that may be created shall be limited to the quantity of water set forth in Exhibits __ and __, and shall in no event be more than the quantity of such water the Secretary verifies actually flows into Lake Mead. Any Tributary Conservation ICS not released or deducted pursuant to Article 2.5(C) in the Year it was created will be converted to Extraordinary Conservation ICS at the request of the Contractor and will be subject to all provisions of this Forbearance Agreement applicable to Extraordinary Conservation ICS.

2.3 System Efficiency ICS

Pursuant to procedures set forth in the ROD, a Contractor may make contributions of capital to the Secretary for use in Secretarial projects designed to realize efficiencies that save water that would otherwise be lost from the Mainstream in the United States. An amount of water equal to a portion of the water saved may be made available to contributing Contractors by the Secretary as System Efficiency ICS. System efficiency projects are only intended to provide temporary water supplies and System Efficiency ICS will not be available for permanent use. The System Efficiency ICS will be released to the capital contributor on a predetermined schedule of annual deliveries for a period of years as agreed by the Parties.

2.4 Imported ICS

Pursuant to procedures set forth in the ROD, a Contractor may create Imported ICS by introducing non-Colorado River System water in that Contractor's state into the Mainstream. Contractors proposing to create Imported ICS shall make sufficient arrangements with the Secretary, contractual or otherwise, to guarantee that the creation of Imported ICS shall cause no harm to the Secretary's management of the Colorado River System. These arrangements shall provide that the Contractor must obtain appropriate permits or other authorizations required by state law and that the actual amount of water introduced to the Mainstream would be reported to the Secretary on an annual basis. Any Imported ICS not released or

S-8

deducted pursuant to Article 2.5(C) in the Year it was created will be converted to Extraordinary Conservation ICS at the request of the Contractor and will be subject to all provisions of this Forbearance Agreement applicable to Extraordinary Conservation ICS.

2.5 Creation of ICS

A Contractor may create ICS subject to the following conditions:

A. Pursuant to procedures set forth in the ROD, a Contractor shall submit a plan for the creation of ICS to the Secretary and the Lower Division States demonstrating how all requirements of this Forbearance Agreement will be met in the Contractor's creation of ICS. System Efficiency ICS with an approved multi-year plan shall not require annual approval by the Secretary or consultation with the Lower Division States. Until such plan is reviewed and approved by the Secretary annually in consultation with the Lower Division States, such ICS plan, or any ICS purportedly created through it, cannot be a basis for an ICS Declaration. A Contractor may modify its plan for creation of ICS during any Year, subject to approval by the Secretary in consultation with the Lower Division States.

B. Pursuant to procedures set forth in the ROD, a Contractor that creates ICS shall submit a Certification Report to the Secretary demonstrating the amount of ICS created and that its creation was consistent with this Forbearance Agreement and the ROD. The Secretary shall verify the information in the Certification Report in consultation with the Lower Division States, and provide a final written decision to the Parties. Any Party may appeal the Secretary's verification of the Certification Report through administrative and judicial processes.

C. There shall be a one-time deduction of five percent (5%) from the amount of ICS in the Year of its creation. This deduction results in additional water in storage in Lake Mead for future use in accordance with the Consolidated Decree, the Interim Surplus Guidelines, and the ROD. This provision shall not apply to:

S-8

1. System Efficiency ICS created pursuant to Article 2.3 of this Forbearance Agreement because a large portion of the water saved by this type of project will increase the quantity of water in storage.
2. Extraordinary Conservation ICS created by conversion of Tributary Conservation ICS that was not released in the Year created, pursuant to Article 2.1(E) of this Forbearance Agreement, because 5% of the ICS is deducted at the time the Tributary Conservation ICS is created.
3. Extraordinary Conservation ICS created by conversion of Imported ICS that was not released in the Year created, pursuant to Article 2.1(F) of this Forbearance Agreement, because 5% of the ICS is deducted at the time the Imported ICS is created.

D. In addition to the conditions described above, creation of Extraordinary Conservation ICS is subject to the following conditions:

1 Except as provided in Articles 2.2 and 2.4, Extraordinary Conservation ICS can only be created if such water would have otherwise been beneficially used.

2. The maximum total amount of Extraordinary Conservation ICS that can be created during any Year is limited to the following:
   a. 400,000 acre-feet for California Contractors;
   b. 125,000 acre-feet for Nevada Contractors; and
   c. 100,000 acre-feet for Arizona Contractors.

3. The maximum quantity of Extraordinary Conservation ICS that may be accumulated in all ICS Accounts, at any time, is limited to the following:
   a. 1,500,000 acre-feet for California Contractors;
   b. 300,000 acre-feet for Nevada Contractors; and
   c. 300,000 acre-feet for Arizona Contractors.

4. Except as provided in Articles 2.2 and 2.4, no category of surplus water can be used to create Extraordinary Conservation ICS.

5. The quantity of Extraordinary Conservation ICS remaining in an ICS Account at the end of each Year shall be diminished by annual

S-8

evaporation losses, as determined by the Secretary in consultation with the Lower Division States, provided that such losses shall not exceed three percent (3%). Losses shall be applied annually to the end-of-the-Year balance of Extraordinary Conservation ICS beginning in the Year after the ICS is created and continuing until no Extraordinary Conservation ICS remains in Lake Mead. No evaporation losses shall be assessed during a Year in which the Secretary has declared a shortage.

6. Extraordinary Conservation ICS from a project within a state may only be credited to the ICS Account of a Contractor within that state that has funded or implemented the project creating the ICS, or to the ICS Account of a Contractor within the same state as the funding entity and project and with written agreement of the funding entity.

2.6 <u>Request for Release of ICS</u>

A Contractor that has created ICS may request that the Secretary release its ICS subject to the following conditions:

A. If a Contractor has an overrun payback obligation, as described in the October 10, 2003 Inadvertent Overrun and Payback Policy or Exhibit C to the October 10, 2003 Colorado River Water Delivery Agreement, the Contractor must pay the overrun payback obligation in full before requesting or receiving a release of any ICS. The Contractor may request that the amount of ICS in the Contractor's ICS Account be reduced by the amount of the overrun payback obligation in order to pay the overrun payback obligation.

B. ICS shall only be released pursuant to an ICS Declaration.

C. In addition to the conditions described above, a Contractor's request for release of Extraordinary Conservation ICS is subject to the following conditions:

S-8

1. The total amount of Extraordinary Conservation ICS that may be released in any Year is limited to the following:
   a. 400,000 acre-feet for California Contractors;
   b. 300,000 acre-feet for Nevada Contractors; and
   c. 300,000 acre-feet for Arizona Contractors;
2. If the May, 24-month study for that Year indicates that a shortage condition would be declared in the succeeding Year if the requested amounts for the current Year under Article 2.6 were released, the Secretary may release less than the amounts of ICS requested to be released.
3. If the Secretary releases Flood Control Surplus water, Extraordinary Conservation ICS accumulated in ICS Accounts shall be reduced by the amount of the Flood Control Surplus on an acre-foot for acre-foot basis until no Extraordinary Conservation ICS remains. The reductions to the ICS Accounts shall be shared on a pro-rata basis among all Contractors that have accumulated Extraordinary Conservation ICS unless otherwise agreed to by the Contractors.

2.7 Additional Terms Regarding Creation and Release of ICS

It is the specific intent of the Parties that the terms, conditions and procedures regarding the creation and release of ICS contained in this Article 2 will be applied in conformance with additional terms, conditions and procedures governing the creation and release of ICS contained in the Delivery Agreement.

Article 3
Forbearance

3.1 In the absence of forbearance, surplus water is apportioned for use according to the percentages provided in Article II(B)(2) of the Consolidated Decree. The Parties respectively agree as follows:

S-8

13

A. ADWR hereby forbears:

1. Any right the State of Arizona may have to delivery of any ICS released in accordance with the terms and conditions set forth in this Forbearance Agreement and the Delivery Agreement for use within the State of California or the State of Nevada.

2. Any right the State of Arizona may have to the release and delivery of water for direct delivery domestic use to entities in California or Nevada under a Domestic Surplus as described in the Delivery Agreement and the ROD.

B. PVID, IID, CVWD, the City of Needles and MWD hereby forbear:

1. Any right they may have to delivery of any ICS released in accordance with the terms and conditions set forth in this Forbearance Agreement and the Delivery Agreement for use within the State of Arizona or the State of Nevada.

2. Any right they may have to the release and delivery of water for direct delivery domestic use to entities in Arizona or Nevada under a Domestic Surplus as described in the Delivery Agreement and the ROD.

C. SNWA and CRCN hereby forbear:

1. Any right SNWA or the State of Nevada may have to delivery of any ICS released in accordance with the terms and conditions set forth in this Forbearance Agreement and the Delivery Agreement for use within the State of Arizona or the State of California.

2. Any right SNWA or the State of Nevada may have to the release and delivery of water for direct delivery domestic use to entities in Arizona or California under a Domestic Surplus as described in the Delivery Agreement and the ROD.

3.2 Notwithstanding the foregoing forbearance of ICS, the Parties only forbear with respect to ICS that is created pursuant to exhibits attached to and incorporated within this Forbearance Agreement. This Forbearance Agreement incorporates Exhibits A through ___as of the date of execution. Additional exhibits may be

S-8

added to this Forbearance Agreement after written approval of all of the Parties. Such approval shall not be unreasonably withheld.

3.3 The Parties do not forbear any right to the release or delivery of any water that is not described in Article 3.1.

3.4 Forbearance of all Parties is conditioned on the following:

A. The execution, by all of the Parties and the Secretary, of a Delivery Agreement that will be a companion to this Forbearance Agreement.

B. The adoption by the Secretary of a ROD implementing an ICS program in substantial conformance with the provisions of this Forbearance Agreement and its companion Delivery Agreement.

C. The continued implementation of an ICS program that is in substantial conformance with this Forbearance Agreement and its companion Delivery Agreement, including:

1. The availability of the verification and appeal process described in Article 2.5(B);
2. The establishment and use of an ICS accounting procedure by the Secretary consistent with this Forbearance Agreement and the Delivery Agreement;
3. The Secretary's annual declaration of Normal, Surplus (other than Quantified Surplus), or Shortage conditions based on conditions in Lake Mead with consideration of the amount of ICS accumulated by the Parties. The determination of the amount of Quantified Surplus shall not include the volume of accumulated Extraordinary Conservation ICS; and
4. The termination of Partial Domestic Surplus as defined in the Record of Decision dated January 16, 2001, upon issuance of the ROD.

Article 4

General Provisions

S-8

4.1 The records of any Party to this Forbearance Agreement that relate to the creation of ICS shall be open to inspection by any other Party.

4.2 The Parties to this Forbearance Agreement are hereby notified of A.R.S. § 38-511.

4.3 The Parties agree to comply with all applicable federal or state laws relating to equal opportunity and non-discrimination.

4.4 Except as provided in Article 3, including additional exhibits agreed upon by the Parties pursuant to Article 3.2, nothing in this Forbearance Agreement shall be deemed to diminish or waive the rights of any Party. The failure of any Party to enforce a provision of this Forbearance Agreement shall not be deemed to constitute a waiver of that provision. The execution of, and forbearance in compliance with, this Forbearance Agreement shall not be admissible against any Party in any action except for an action to enforce the terms of this Forbearance Agreement or the companion Delivery Agreement.

4.5 No Party to this Forbearance Agreement shall be considered to be in default in the performance of any obligations under this Forbearance Agreement when a failure of performance shall be due to uncontrollable forces. The term "uncontrollable force" shall mean any cause beyond the control of the party unable to perform such obligation, including but not limited to failure or threat of failure of facilities, flood, earthquake, storm, fire, lightning, and other natural catastrophes, epidemic, war, civil disturbance or disobedience, strike, labor dispute, labor or material shortage, sabotage, restraint by order of a court or regulatory agency of competent jurisdiction, and action or non-action by, or failure to obtain the necessary authorizations or approvals from, a federal governmental agency or authority, which by exercise of due diligence and foresight such party could not reasonably have been expected to overcome. Nothing contained herein shall be

S-8

construed to require any party to settle any strike or labor dispute in which it is involved.

Article 5
Notices

5.1 Notices and Requests

A. All notices and requests required or allowed under the terms of this Forbearance Agreement shall be in writing and shall be mailed first class postage paid to the following entities at the following addresses:

CRCN:
Colorado River Commission of Nevada
555 E. Washington Ave., Suite 3100
Las Vegas, NV 89101
Attn: Executive Director, Colorado River Commission

SNWA:
Southern Nevada Water Authority
1001 S. Valley View Boulevard
Las Vegas, NV 89153
Attn: General Manager

PVID:
Palo Verde Irrigation District
180 West 14th Avenue
Blythe, CA 92225
Attn: General Manager

IID:

S-8

Imperial Irrigation District
333 E. Barioni Boulevard
Imperial, CA 92251
Attn: General Manager

CVWD:
Coachella Valley Water District
P. O. Box 1058
Coachella, CA 92236
Attn: General Manager/Chief Engineer

City of Needles:
City of Needles
817 Third Street
Needles, CA 92363-2933
Attention: City Manager

MWD:
The Metropolitan Water District of Southern California
700 North Alameda Street
Los Angeles, CA 90012
Attn: General Manager

State of California:
Colorado River Board of California
770 Fairmont Avenue, Suite 100
Glendale, CA 91203-1068
Attn: Executive Director

State of Arizona:
Arizona Department of Water Resources

S-8

3550 North Central Avenue
Phoenix, AZ 85012
Attn: Director

B. Any Party may, at any time, change its mailing address by notice to the other Parties.

5.2 Notices and Requests by Facsimile

A. Notices and requests may be given by facsimile among the Parties in lieu of first class mail as provided in Article 5.1. Such facsimiles shall be deemed complete upon a receipt from the sender's facsimile machine indicating that the transmission was satisfactorily completed and after phone communication with administrative offices of the recipient notifying the recipient that a facsimile has been sent.

B. The facsimile numbers of the entities listed in Article 5.1(A) are as follows:

State of Arizona:	(602) 771-8681 (Attn: Director)
SNWA	
CRCN	(702) 486-2670 (Attn: Executive Director, Colorado River Commission)
PVID	(760) 922-8294 (Attn: General Manager)
IID	(760) 339-9392 (Attn: General Manager)
CVWD	(760) 398-3711 (Attn: General Manager/Chief Engineer)
City of Needles	
MWD	(213) 217-5704 (Attn: General Manager)
CRB	(818) 543-4685 (Attn: Executive Director)

S-8

19

C. Any Party may, at any time, change its facsimile number by notice to the other Parties.

In Witness of this Forbearance Agreement, the Parties affix their official signatures below, acknowledging execution of this document on the ________ day of _________________, 2007.

Attest:	THE STATE OF ARIZONA acting through the ARIZONA DEPARTMENT OF WATER RESOURCES
By: ____________________________ Title	By: ________________________________ Director
Approved as to form:	
By: ____________________________ Title	
Attest:	PALO VERDE IRRIGATION DISTRICT
By: ____________________________ General Manager	By: ________________________________ Chair
Approved as to form:	
By: ____________________________ Title	

S-8

Attest:	IMPERIAL IRRIGATION DISTRICT
By: ______________________________ General Manager	By: _________________________________ Chair
Approved as to form:	
By: ______________________________ Title	
Attest:	THE CITY OF NEEDLES
By: ______________________________ Title	By: _________________________________ City Manager
Approved as to form:	
By: ______________________________ Title	
Attest:	COACHELLA VALLEY WATER DISTRICT
By: ______________________________ General Manager	By: _________________________________ Chair
Approved as to form:	
By: ______________________________	

S-8

21

Attest:	THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
By: ______________________________ Title	By: ______________________________ General Manager
Approved as to form:	
By: ______________________________ Title	
Attest:	SOUTHERN NEVADA WATER AUTHORITY
By: ______________________________ Executive Director	By: ______________________________ Chair
Approved as to form:	
By: ______________________________ Title	
Attest:	THE COLORADO RIVER COMMISSION OF NEVADA
By: ______________________________ Title	By: ______________________________ Chair

Approved as to form:

By: ______________________________
Title

23

S-8

ATTACHMENT D

Arizona-Nevada Shortage-Sharing Agreement

This Agreement is entered into among the Arizona Department of Water Resources ("Arizona"), the Arizona Water Banking Authority ("AWBA"), the Colorado River Commission of Nevada ("CRC") and the Southern Nevada Water Authority ("SNWA"). For convenience, Arizona, AWBA, CRC and SNWA are at times herein referred to individually as "Party" and collectively as "Parties" and CRC and SNWA are referred to as "Nevada".

Preamble

The 1944 Mexican Water Treaty, the 1964 U.S. Supreme Court Decree in *Arizona v. California*, and the 1968 Colorado River Basin Project Act authorize and guide the Secretary of the Interior ("Secretary") in the determination of water deliveries to the Republic of Mexico and from the mainstream of the Colorado River within the Lower Basin during shortage conditions. However, there remain significant differences of opinion between Arizona and Nevada regarding how much water would be delivered to each state within the Lower Colorado River Basin during a shortage declared by the Secretary. Arizona and Nevada have now, therefore, agreed on how Secretarial shortage declarations of up to 500,000 acre-feet within the United States would be shared between them during an Interim Period. This Agreement is conditioned upon the inclusion of all material terms from the *Seven Basin States' Preliminary Proposal Regarding Colorado River Interim Operations* (Seven States' Proposal) that was forwarded to the Secretary on February 3, 2006, as it may be modified, within the Record of Decision for *Colorado River Reservoir Operations: Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions* ("Record of Decision"). If shortage declarations within the United States exceed 500,000 acre-feet, the Secretary would consult with representatives from the seven Colorado River Basin states before allocating additional shortage reductions. That consultation would be initiated anytime that the water surface elevation of Lake Mead is at or below water surface elevation 1025 feet.

AGREEMENT

Now, therefore, based upon the mutual covenants and promises contained herein, the receipt and sufficiency of which are hereby acknowledged, the Parties hereto do agree as follows:

1. Definitions:

a. Interim Period. The period beginning on the date the Secretary issues a Record of Decision and ending on December 31, 2025 (through preparation of the 2026 Annual Operating Plan).

b. Shortage. Any shortage within the United States declared by the Secretary pursuant to Article II(B)(3) of the Decree during the Interim Period.

S-8

2. Reduction in Mexican Deliveries. The Parties have entered into this Agreement based on the presumption that the United States will reduce deliveries to Mexico as described in the Seven States' Proposal. In the event that the United States does not reduce deliveries to Mexico in accordance with paragraph (3)(F)(5) of the Seven States' Proposal, the Parties have agreed only to the shortage allocations described in Section 3 of this Agreement.

3. Shortage Sharing Between Arizona and Nevada. During the Interim Period the Parties agree that shortages shall be allocated between Arizona and Nevada in the following quantities:

A. In years when Lake Mead content is projected on January 1 to be at or below elevation 1075 ft. and at or above 1050 ft., then Nevada's share of the shortage within the United States shall equal 13,000 acre-feet and Arizona's share of the shortage within the United States shall equal 320,000 acre-feet.

B. In years when Lake Mead content is projected on January 1 to be below elevation 1050 ft. and at or above 1025 ft., then Nevada's share of the shortage within the United States shall equal 17,000 acre-feet and Arizona's share of the shortage within the United States shall equal 400,000 acre-feet.

C. In years when Lake Mead content is projected on January 1 to be below 1025 ft., then Nevada's share of the shortage within the United States shall equal 20,000 acre-feet and Arizona's share of the shortage within the United States shall equal 480,000 acre-feet.

4. Agreement Limited to Maximum Shortage Volume of 500,000 Acre-feet Within the United States. This Agreement and the Parties relative obligations hereunder are specifically limited to a maximum shortage volume of 500,000 acre-feet within the United States in any year during the Interim Period. Should Lower Basin total shortage volume exceed 500,000 acre-feet within the United States, then the Parties will consult with the Secretary concerning shortage sharing beyond 500,000 acre-feet within the United States.

5. Shortage Assistance. For the purpose of assisting Arizona in offsetting impacts from shortages that may occur during the Interim Period, SNWA agrees to provide to the Arizona Water Banking Authority the sum of $8,000,000.00 (Eight Million Dollars) ("the Funds"). The Arizona Water Banking Authority will use the Funds to purchase and/or store water supplies. This sum shall be paid to Arizona within 60 days of the date the Secretary issues a Record of Decision, unless otherwise agreed in writing by the SNWA and Arizona. Neither the payment nor the use of the Funds are conditioned on the occurrence of a shortage during the Interim Period, and the Funds shall be nonrefundable.

6. Condition Precedent to Effectiveness of Agreement. The Parties agree, as an express condition precedent to the effectiveness and enforceability of this Agreement, S-8

2

that the Secretary must issue a Record of Decision that is consistent with all material terms included in the Seven States' Proposal, including this Agreement, by July 1, 2008, unless otherwise agreed to in writing by the Parties. If such condition precedent does not occur by the date set forth herein or as extended or modified by written agreement of the Parties, this Agreement shall be of no force or effect among the Parties.

7. Nevada's Use of Tributary Conservation Water and Nevada State Groundwater During Declared Shortage Condition. The Parties anticipate that following the issuance of the Record of Decision, Nevada will be able to create Intentionally Created Surplus ("ICS") by introducing into the Colorado River mainstream Nevada State Groundwater ("Imported ICS") and Virgin and Muddy River water pursuant to Nevada water rights that pre-date the Boulder Canyon Project Act ("Tributary Conservation ICS"). Pursuant to a mutually agreed upon forbearance agreement, the Secretary will deliver such ICS for municipal and industrial uses within Nevada. The Parties have agreed that the water that would be used to create Tributary Conservation ICS and Imported ICS during non-shortage years will be available during declared shortages. It is anticipated by the Parties that the Record of Decision will establish guidelines whereby the Secretary of Interior, through the Bureau of Reclamation, may enter into agreements to verify and deliver ICS to the party that created it.

Arizona agrees that if in any year, pursuant to Article II (B)(3) of the Decree, there is insufficient mainstream water available to satisfy the consumptive use of 7.5 maf in the lower division states, then Arizona will not object to the delivery by the Secretary to Nevada of water that would otherwise qualify for creation and release of Tributary Conservation ICS or Imported ICS during a non-shortage year nor otherwise claim a right to use such water in any form or fashion. Arizona's agreement not to object to any secretarial delivery of and Nevada's diversion of such water shall be binding on Arizona only to the extent that such delivery does not cause the total deliveries within the lower division states to exceed 7.5 maf in any year in which the Secretary has declared a shortage. Furthermore, Arizona's agreement is conditioned on application of the same provisions for verification that would apply to the creation of Tributary Conservation ICS or Imported ICS under the Seven States' Proposal.

8. Reservation of Rights. Notwithstanding the terms of this Agreement, in the event that for any reason this Agreement is terminated, or that the term of this Agreement is not extended, or upon the withdrawal of any Party from this Agreement, the Parties reserve, and shall not be deemed to have waived, any and all rights, including any claims or defenses, they may have as of the date hereof or as may accrue during the term hereof, including specifically the respective legal positions of Nevada and Arizona regarding how the delivery of water under a shortage declaration by the Secretary would be administered within the Lower Colorado River Basin and any other rights, claims or defenses under any existing federal or state law or administrative rule, regulation or guideline, including without limitation the Colorado River Compact, the Decree in *Arizona v. California* (the "Decree"), the Colorado River Basin Project Act of 1968, and any other applicable provision of federal law, rule, regulation, or guideline.

S-8

In Witness of this Agreement, the Parties affix their official signatures below, this 9th day of February, 2007.

Herbert R. Guenther
Director
Arizona Department of Water Resources

Herbert R. Guenther
Chairman
Arizona Water Banking Authority

Richard Bunker
Chairman
Colorado River Commission of Nevada

Patricia Mulroy
General Manager
Southern Nevada Water Authority

S-8

4

Reponses to Comment Letter S-8

S-8-1 through S-8-12

Your comment is noted. No change to the Final EIS was necessary.

S-8-13

Your comment is noted. The Preferred Alternative as identified in the Final EIS appropriately analyzes the creation and delivery of ICS and DSS.. Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that discuss the administration of Intentionally Created Surplus (ICS).

S-8-14 through S-8-15

Your comment is noted. No change to the Final EIS was necessary.

S-8-16 and S-8-18

Your comment is noted. Appropriate modeling assumptions used in the Final EIS were consistent with the shortage-sharing agreement between Arizona and Nevada. In addition, Reclamation has included draft operational guidelines in the Final EIS (Appendix S) consistent with that agreement.

S-8-19

Your comment is noted. No change to the Final EIS was necessary. Also see response to F-5-2.

S-8-20 through S-8-22

Your comments are noted. No change to the Final EIS was necessary. Also see response to comment F-5-5.

S-8-23 and S-28

Your comments are noted. No change to the Final EIS was necessary.

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SOUTHERN NEVADA WATER AUTHORITY

STATE OF NEVADA

COLORADO RIVER COMMISSION OF NEVADA

April 27, 2007

Honorable Dirk Kempthorne, Secretary
Department of the Interior
1849 C Street, NW
Washington, D.C. 20240

Re: Nevada's Comments on *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

Dear Secretary Kempthorne:

Thank you for the opportunity to comment on the *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* (72 Fed. Reg. 9,026) (Feb. 28, 2007) (hereinafter "DEIS"). The Southern Nevada Water Authority ("SNWA") and Colorado River Commission of Nevada ("CRC") (together hereinafter jointly referred to as "Nevada") submit these comments related to Nevada-specific items
in the DEIS. Additionally, Nevada supports the comments made jointly by the Seven Basin States
that are sent under separate cover. The following comments are presented according to the order in 1
which the subjects related to the comment appear in the DEIS.

<u>Basin States' Proposal</u>

Nevada points out that some consideration needs to be given to the fact that implementation of any
alternative other than the Basin States' Proposal will carry with it a significant degree of 2
uncertainty. The Basin States' Agreement, Forbearance Agreement and Arizona-Nevada Shortage
Sharing Agreement are each contingent upon the issuance of a Record of Decision that is consistent 3
with the material terms of those agreements. The several compromises agreed to by the parties to
these agreements make it possible for components of the proposed action, such as coordinated
management of Lakes Mead and Powell and the creation and release of the Intentionally Created 4
Surplus (ICS), to be implemented without adversarial proceedings between the Basin States and
major water users on the Colorado River.

Southern Nevada Water Authority
1001 S. Valley View Blvd., Las Vegas, Nevada 89153

Colorado River Commission of Nevada
555 E. Washington Ave., Suite 3100, Las Vegas, Nevada 89101

S-9

Honorable Dirk Kempthorne
Page 2
April 27, 2007

In this same context, Nevada does not agree with all of the legal interpretations and modeling
assumptions used in the DEIS. However, it has agreed to set these disagreements aside for the 5
Interim Period to support a compromise agreement among the Basin States that Nevada believes to
be in the best interests of the entire Colorado River community. Because the several compromises
in the Basin States' Proposal would not be preserved if an alternative other than the Basin States'
alternative is selected, Nevada strongly urges the selection of the Basin States' Proposal as the 6
Preferred Alternative in the Final Environmental Impact Statement ("FEIS") and the
implementation of the material terms of that proposal in the Record of Decision.

Analysis of Nevada Projects in the DEIS

As the Secretary is aware, Nevada is currently pursuing three separate projects to develop System
Efficiency, Tributary Conservation and Imported ICS, as those terms are defined in the Basin States
Proposal, with delivery taken by SNWA from Lake Mead. Each of these projects has been agreed
to among the parties to the Forbearance Agreement and final details regarding these projects will be 7
set forth in exhibits to the Forbearance Agreement. During shortages, water from projects that
would otherwise qualify as Tributary Conservation ICS and Imported ICS would be available for
creation, release and delivery as Developed Shortage Supply. Nevada also anticipates that a
Delivery Agreement between the United States, Nevada and possibly other Lower Basin entities 8
that provides for delivery of water from these three projects will be executed concurrently with the
ROD and requests that Reclamation include such analysis of the proposed Delivery Agreement in
the FEIS as is necessary to allow for the Delivery Agreements execution concurrent with the 9
issuance of the ROD.

The first of these three projects is participation in the Drop 2 Reservoir Storage Project in Imperial
County, California, which would provide efficiencies in use of Lower Colorado River system water.
This project is discussed at section 5.1.27 in the DEIS. Reclamation should issue a Final
Environmental Assessment (EA) for this project shortly. The second project is construction of the
Coyote Spring Well and Moapa Transmission System Project, in Clark County, Nevada that will 10
convey groundwater from Coyote Spring Valley into the Muddy River. This project is discussed at
section 5.1.22 of the DEIS. The Bureau of Land Management is anticipated to issue a Final EA for
this project shortly. Project specific impacts are being analyzed under separate NEPA processes for
these projects, and the DEIS sufficiently analyzes environmental effects to the Colorado River from
the implementation of these projects. Therefore additional analysis by Reclamation in the FEIS, if
any, should be sufficient to allow for the execution of a Delivery Agreement, concurrent with 11
issuance of the ROD, authorizing Nevada to utilize water available from these two projects.

The third project that will be included within both the Forbearance Agreement and a Delivery
Agreement is Tributary Conservation along the Virgin and Muddy Rivers. This project will either
develop Tributary Conservation ICS that will be delivered within the same year that it is created, or 12
develop Extraordinary Conservation ICS that can be stored in Lake Mead. The modeling used in

S-9

Honorable Dirk Kempthorne
Page 3
April 27, 2007

the DEIS has included Nevada's estimates for Virgin and Muddy River tributary conservation (as
described in Appendix M, Chapter M.3.1.3), and the potential environmental impacts within the 13
Colorado River system are described in the document. Proposed Interim Guidelines forwarded by
the Basin States to the Secretary include the accounting and verification process for Tributary 14
Conservation projects. In order to provide a full environmental evaluation, the FEIS should also
evaluate potential effects within the Virgin and Muddy River systems and of execution of the
proposed Delivery Agreement so that a Delivery Agreement that authorizes Nevada to utilize water 15
from these projects can be executed concurrent with the ROD. In order to assist Reclamation with
this analysis, Nevada has included a summary of the water rights involved as well as certain 16
hydrologic and environmental data. This summary is attached as "Attachment A".

<u>General Comments on DEIS Volume One (Chapters 1 through 6)</u>

1. Section 2.3.3, Table 2.3-2, and Table M-2 in the DEIS imply that storage volume and
delivery limitations discussed in those provisions apply to all classifications of Intentionally
Created Surplus. In accordance with the Basin States' Proposal, these storage volumes and
delivery limitations apply only to that classification of ICS termed "Extraordinary 17
Conservation" in the Basin States' Proposal, and specifically do not apply to Tributary
Conservation, System Efficiency, and Imported ICS as those terms are defined in the Basin
States' Proposal.

2. Figure 3.2-1 and Figure ES-1 should be changed to show that SNWA's service territory
includes all of Clark County. Currently the Figures show only the Las Vegas Valley in 18
yellow; it should show all of Clark County in yellow.

3. Section 3.11.7.3 should discuss the Basic Management ("BMI") intake. This intake is
located at 1050 feet msl and serves the industries within the BMI complex, portions of the 19
Lake Las Vegas resort, golf courses, a Nevada Department of Wildlife fish hatchery, and the
City of Henderson's treatment plant. Therefore, these uses served by the BMI intake will be
threatened if Lake Mead levels drop below 1050 feet msl. Most of these impacts could be 20
mitigated through use of SNWP water.

4. Table 3.14-2 reflects agriculture in Clark County. However, the inclusion of this table in the
DEIS is misleading. The agricultural use displayed in this table does not use water from the 21
Colorado River. Therefore, this agricultural use should be removed from the DEIS. As
further discussed above, within Nevada, only those agricultural uses associated with 22
SNWA's Tributary Conservation ICS projects along the Virgin and Muddy Rivers should be
analyzed as part of the DEIS.

5. The statements in section 4.14.3.3 and ES.2.13.2 that "socioeconomic effects on southern 23
Nevada's M&I sector resulting from the proposed alternatives would not be substantial" are

S-9

Honorable Dirk Kempthorne
Page 4
April 27, 2007

misleading. Reductions in water deliveries to Nevada anywhere between 13,000 and 84,290
acre-feet in any given year, as modeled in the DEIS,[1] will at some level begin to cause 24
socioeconomic effects not only within Las Vegas and Clark County, but throughout Nevada.
Unlike the other Basin States, Nevada does not have large agricultural water users to provide a 25
buffer during drought through fallowing. Additionally, Nevada's water demand consists of 26
hard, municipal demands that are not as flexible during drought. SNWA's Drought Plan is
intended to ameliorate those effects and accommodate anticipated reductions in water deliveries.
But the Drought Plan does not provide the type of absolute protection against either 27
socioeconomic impacts or the possibility of interruptions in municipal water supplies that the
DEIS implies.

Nevada feels strongly that, in accordance with the Basin States' Proposal, no reductions in
delivery above 20,000 acre-feet in any year should be imposed upon Nevada without further 28
consultation between the Secretary and the Basin States, and requests that the M&I
socioeconomic impact analysis in the FEIS be refined to more accurately reflect different 29
levels of socioeconomic impacts to M&I water users, including health and human safety
concerns, for any reductions in deliveries above 20,000 acre-feet in any year.

6. Chapter 5, Section 5.1.21 should be modified to show that SNWA's commitment not to
proceed with the Virgin River pipeline project remains in effect only if the Basin States' 30
Proposal is implemented.

General Comments on Volume Two of the DEIS

1. Table D-3 should be modified to reflect that SNWP is not the only user of Colorado River
water in Nevada upstream of Hoover Dam. Other users, such as BMI and PABCO, should 31
be represented in Table D-3. Alternatively, the title of the SNWP column could be changed
to "Uses above Hoover Dam," with the notation that "SNWP is the primary user above 32
Hoover Dam."

2. On pages M-3 and M-4, the FEIS should make it clear that evaporation losses are only 33
assessed at the end of the year on what is remaining in an ICS account at that time.
Therefore, no evaporation loss is assessed on ICS that is created and delivered within the 34
same year.

3. Throughout the document, and particularly on page M-6 and in Table M-3, there are
references to the possibility of desalinization being used to augment flows in the Colorado 35
River. However, other system augmentation projects besides desalinization are being
considered, so when this subject is discussed in the FEIS, the word "desalinization" should

S-9

[1] This range does not include modeling within some alternatives that would allow Lake Mead elevations to drop below 1,000 feet msl, leaving SNWA and approximately 2 million people without 90% of the water supply they rely upon.

Honorable Dirk Kempthorne
Page 5
April 27, 2007

be changed to "system augmentation." Also on page M-6, in the first paragraph, the year 2012 should be changed to 2020. 36

4. In Table M-3, storage and delivery schedules for Nevada's Tributary Conservation water need to be updated to include the recovery in years 2025 through 2036 of water banked between 2008 and 2024. 37 Also, the Drop 2 project should be included in this table. 38

5. The first paragraph on page M-6 should be modified as follows: delete first three words, replace with "Nevada state groundwater introduced directly into Lake Mead or wastewater produced by these introductions are assumed to be available during the period from 2009 through 2060." 39 Throughout the paragraph, the term "return flow" should be replaced with "introductions or wastewater produced from introductions." 40 An additional sentence should be added to reflect that Imported ICS may be stored during all water supply conditions except Flood Control Surplus conditions, and may be delivered during Normal, ICS Surplus and Shortage conditions. 41

6. The third paragraph on page M-6 should reflect that Nevada may take Drop 2 Reservoir water at a maximum rate of 40 kaf each year until a total of 500 kaf has been taken (not 300 kaf). 42

In closing, Nevada thanks you for your leadership and urges Interior to adopt a ROD that includes all of the material terms of the Basin States' Proposal. 43

DATE: 4-27-07

Patricia Mulroy
General Manager
Southern Nevada Water Authority

DATE: 4-27-07

Richard W. Bunker
Chairman
Colorado River Commission of Nevada

c: Robert W. Johnson, Commissioner, U. S. Bureau of Reclamation
Rick Gold, Regional Director, U. S. Bureau of Reclamation, Upper Colorado Regional Office
Jayne Harkins, Acting Regional Director, U. S. Bureau of Reclamation, Lower Colorado Regional Office
Larry Walkoviak, Deputy Regional Director, U. S. Bureau of Reclamation, Lower Colorado Regional Office

S-9

ATTACHMENT "A"

Nevada Comments on *Draft Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

SNWA has been purchasing pre-Boulder Canyon Project Act (BCPA) Virgin River and Muddy River water rights in Nevada since 1997. Water rights historically being used for agriculture along these rivers are voluntarily being retired and willingly sold or leased to willing buyers. The following information summarizes the pre-BCPA rights on the Muddy and Virgin Rivers along with the associated beneficial impacts of retiring these rights through the proposed Tributary Conservation program.

Virgin and Muddy River Water Rights Background

Pre-BCPA water rights on the Virgin River have a priority date of pre-1905 and were decreed by the Nevada Supreme Court in 1927. The decree allocated 17,785 acre-feet per year (afy) to the Bunkerville and Mesquite Irrigation Companies. SNWA currently owns shares in the Bunkerville Irrigation Company representing approximately 3,700 afy of surface water rights.

On the Muddy River, water rights were decreed by Nevada's 10^{th} District Court (now 8^{th} District Court) in 1920. The decree allocated the entire flow of the Muddy River. SNWA currently owns shares in the Moapa Valley Irrigation Company representing approximately 7,000 afy of surface water rights.

Between the Virgin and Muddy Rivers, SNWA anticipates acquiring approximately 30,000 afy of pre-BCPA water rights, which is the same quantity analyzed in the DEIS as represented in Table M-3. The water rights that are currently retired or will be retired in the future will be conveyed to Lake Mead via the Overton Arm under the proposed Tributary Conservation program.

Anticipated Tributary Conservation

Agricultural acreage on the Virgin River is currently about 823 acres out of a total of 1,963 decreed acres. The majority of the existing agricultural acreage is in the Bunkerville Irrigation Company. Most of the Mesquite Irrigation Company agricultural lands as identified in the decree have been retired and portions of the agricultural water rights are being willingly sold or leased to willing buyers for non-agricultural uses, such as golf courses, in the area of Mesquite, Nevada.

Agricultural acreage on the Muddy River is currently about 2,253 acres of land located in Lower Moapa Valley and small portions of the upper Muddy River, including the Moapa Band of Paiutes' land. These lands, similar to the Virgin River area, are slowly being retired and the water rights associated with the land are being used for non-agricultural purposes.

S-9

1

Analysis of Impacts to the Virgin and Muddy River from Tributary Conservation

The water rights used for agricultural uses that have been or will be retired will be conveyed to Lake Mead via the Overton Arm in one of two fashions. If the flow volume is required to run through irrigation company ditches to maintain head and avoid fiscal impacts associated with upgrading ditches to accommodate less flow, the water will run through the ditches and return to the mainstem of the Muddy or Virgin River at some downstream return point. Alternatively, the water could be left in the mainstem of the river and not flow through the irrigation company ditches. Since this water is water that historically has composed the flow of the river it will not create any new concerns associated with flood control or channel capacity. In addition, the water left in the mainstem will augment and sustain existing flows in both rivers allowing for assured flows that will benefit recreation, wildlife, and aesthetics. Water quality benefits may also occur due to less agricultural runoff entering the rivers.

Cumulative Impacts

The related environmental programs described in Chapter 4.8.1 and federal statutes and policies in Chapter 5.1 should also include the following programs pertinent to the Virgin River and Muddy River:

Virgin River Habitat Conservation and Recovery Program

The Virgin River Habitat Conservation and Recovery Program (HCRP) is currently under development to satisfy the requirements of the Biological Opinion on the Sale of 10,620 Acres of Public Lands in Clark County, Nevada to the City of Mesquite under the Mesquite Lands Act of 1986, as amended in 1996 and 1999. Covered species proposed for the HCRP include: Virgin River chub (*Gila seminuda*), woundfin (*Plagopterus argentissimus*), southwestern willow flycatcher (*Empidonax trallii extimus*), Yuma clapper rail (*Rallus longirostris yumanensis*), and yellow-billed cuckoo (*Coccyzus americanus*).

Muddy River Recovery Implementation Program

The Muddy River Recovery Implementation Program (RIP) is currently under development to satisfy the requirements of the Intra-Service Programmatic Biological Opinion for the Proposed Muddy River Memorandum of Agreement Regarding the Groundwater Withdrawal of 16,100 Acre-Feet per Year from the Regional Carbonate Aquifer in Coyote Spring Valley and California Wash Basins, and Establish Conservation Measures for the Moapa Dace, Clark County, Nevada. Covered species proposed for the RIP correspond to the species listed in the 1996 Recovery Plan for the Rare Aquatic Species of the Muddy River Ecosystem and include: Moapa dace (*Moapa coriacea*), Virgin River chub (*Gila seminuda*), Moapa speckled dace (*Rhinichthys osculus moapae*), Moapa White River springfish (*Crenichthys baileyi moapae*), Moapa pebblesnail (*Fluminicola*

S-9

avernalis), grated tryonia (*Tryonia clathrata*), Moapa Warm Spring riffle beetle (*Stenelmis moapa*), and Amargosa naucorid (*Pelocoris shoshone shoshone*).

S-9

3

Reponses to Comment Letter S-9

S-9-1 through S-9-6

Your comment is noted. No change to the Final EIS was necessary.

S-9-7 through S-9-16

Your comment is noted. The Final EIS appropriately analyzes the Preferred Alternative including the inclusion of the three projects referenced in the proposed ICS mechanism.

S-9-17

Your comment is noted. No change to the Final EIS was necessary. As noted in Appendix M, the exact timing and magnitude of the storage and delivery of conserved water is not known. However, in order to evaluate the potential effects on environmental resources, certain modeling assumptions were made as detailed in Section M.

S-9-18

Reclamation does not concur with this comment. The geographic scope of the EIS reflects the potentially affected area of the proposed federal action. The potentially affected area within the SNWA service area comprises the existing service area of the SNWA member agencies that receive Colorado River water.

S-9-19 and S-9-20

Your comment is noted. No change to the Final EIS was necessary. The BMI intake is discussed in Section B.2.3.1 of Appendix B in the Final EIS.

S-9-21

Your comment is noted. No change to the Final EIS was necessary. The agricultural data was included for informational purposes and as part of the general discussion of economic activity occurring in the study area. As indicated in Section 4.14 “Socioeconomics” agricultural production within the Nevada study area would not be affected by implementing the interim guidelines.

S-9-22

Reclamation concurs with this comment. Appropriate information on potential impacts to agricultural lands along the Virgin and Muddy Rivers is included in Section 4.16 of the Final EIS.

S-9-23 through S-9-27

Your comments are noted. Additional information with regard to SNWA's Water Resource Plan has been added in Section 3.4.6.3. As described in Section 4.14.1.2 in the EIS, potential socioeconomic consequences of shortages occurring in the M&I sector were qualitatively assessed since it was not known to what degree a specific economic sector considered an M&I use would be affected. The effects on individual cities or communities are indeterminate for various reasons. Each city or community has a different mix of water supplies and in most cases, have formulated a shortage or drought response plan that is specific to their respective community. Also, individual response plans typically include varying combinations of demand-side and supply-side actions and these differ by community.

S-9-28 and S-9-29

Your comment is noted. No change to the Final EIS was necessary.

S-9-30

Your comment is noted. The referenced section was deleted from the Final EIS.

S-9-31 and S-9-32

Reclamation concurs with this comment. The title on column previously referenced as "SNWP" in the EIS has been changed to read as "Uses above Hoover Dam."

S-9-33 and S-9-34

Reclamation concurs with this comment and clarification has been made in Appendix M.

S-9-35

Reclamation concurs with this comment. Appendix M has been modified to replace the term "desalination" with the term "system augmentation."

S-9-36

Reclamation concurs with this comment. The correction has been made in the Final EIS.

S-9-37

Reclamation concurs with this comment noted. The correction has been made in the Final EIS.

S-9-38

Your comment is noted. No change was necessary in the Final EIS. Although the Drop 2 Storage Reservoir is assumed to be a conservation activity in the Basin States Alternative, it was not added to Table M-3 because it does not follow a storage and delivery schedule similar to the other conservation activities..

S-9-39 and S-9-40

Your comment is noted. Appropriate modifications have been made in Appendix M.

S-9-41

Your comment is noted. No change to the Final EIS was necessary. The assumption used was the best data available at the time of the modeling and analysis for the Final EIS.

S-9-42

Your comment is noted. No change to the Final EIS is necessary. The assumption used was the best data available at the time of the modeling and analysis for the Final EIS.

S-9-43

Your comment is noted. No change to the Final EIS is necessary.

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Comments Submitted By Indian Tribes

This section contains comment letters submitted by the following Indian tribes:

IT-1	Ak-Chin Indian Community of the Maricopa Indian Reservation
IT-2	Fort Mojave Indian Tribe of Arizona, California, and Nevada
IT-3	Quechan Indian Tribe of the Fort Yuima Indian Reservation, California and Nevada
IT-4	Southern Ute Indian Tribe of the Southern Ute Reservation
IT-5	Colorado River Indian Tribes of the Colorado River Indian Reservation, Arizona and California
IT-6	Yavapai-Apache Nation of the Camp Verde Indian Reservation
IT-7	Tonto Apache Tribe of Arizona
IT-8	Pascua Yaqui Tribe of Arizona
IT-9	San Carlos Apache Tribe of the San Carlos Reservation
IT-10	Gila River Indian Community
IT-11	Navajo Nation, Arizona, New Mexico, and Utah

AK-CHIN INDIAN COMMUNITY
Community Government
42507 W. Peters & Nall Road • Maricopa, Arizona 85239 • Telephone: (520) 568-1000 • Fax: (520) 568-4566

Regional Director Lower Colorado Region
U.S. Bureau of Reclamation
Attention: BCOO 1000
P.O. Box 61470
Boulder City, Nevada 89006-1470

COMMENTS BY AK-CHIN INDIAN COMMUNITY REGARDING BUREAU OF RECLAMATION PROPOSED COLORADO RIVER SHORTAGE EIS

Ak-Chin Indian Community, a federally recognized Indian tribe organized pursuant to the Indian Reorganization Act of 1934, appreciates the opportunity to review and comment on the Draft EIS issued by Bureau of Reclamation on February 28, 2007, and dealing with Colorado River Shortage regulations to be promulgated by the Secretary of Interior. Ak-Chin and its legal counsel have carefully reviewed all of the alternatives set forth in the Proposed EIS. Though considerable work has gone into each of the alternatives, and several meetings have been held to consult with Arizona and other Indian tribes, none of the alternatives represents a "Tribal Alternative" aimed specifically at protection of tribal rights to Colorado River water. This is of special concern to Ak-Chin, and we believe, to other tribes receiving Colorado River water. 1
Receipt of such water in most cases has been decreed, or has been set forth in legislation, in settlement of the tribal federal reserved water rights, or *Winters* water rights. In Ak-Chin's case, the Community gave up its right to assert water rights held from "time immemorial" in return for specific provision by the US government of water from the Central Arizona Project (CAP) system, and from the Yuma Mesa Division of Gila Project. Ak-Chin's comments therefore stress the continuing viability of its water settlement legislation, including the specific provisions for treatment of scarcity set forth in its 1984 settlement act, and the requirement of the Secretary to protect tribal trust assets, including tribal water.

Ak-Chin's 1978 Water Settlement Act provided as follows:

"As a part of the contract referred to Section 2(b) of this Act, the Secretary shall provide for, commencing as soon as possible, but in no event later than the expiration of the twenty-five-year period following the date of the enactment of this Act, the permanent delivery, on an annual basis, to the lands comprising the Ak-Chin Indian Reservation, of eighty-five thousand acre-feet of water suitable for irrigation on the reservation."

In return for this provision of water, and "as consideration on the part of the Ak-Chin Indian Community for entering into any contract

IT-1

> or agreement pursuant to Section 2(b), the Ak-Chin Indian Community shall agree to waive, in a manner satisfactory to the Secretary, any and all claims of water rights or injuries to water rights of the Ak-Chin Indian Community, including both groundwater and surface water from time immemorial to the present, which it might have against the United States, the State of Arizona or agency thereof, or any other person, corporation, or municipal corporation, arising out of the laws of the United States or the State of Arizona." Sections 3 and 4(a), Public Law 95-328 (July 28, 1978).

The initial Water Settlement Act of 1978 contemplated delivery of water to Ak-Chin from off-reservation groundwater supplies. As it became apparent that that plan was not feasible, Ak-Chin and the federal government negotiated the 1984 Water Settlement Act. That Act required that "As soon as possible but not later than January 1, 1988, the Secretary shall deliver annually a permanent water supply from the main project works of the Central Arizona Project to the southeast corner of the Ak-Chin Indian Reservation of not less than seventy-five thousand acre-feet of surface water suitable for agricultural use except as otherwise provided under Subsections (b) and (c)."

Under Section 2(b) of the 1984 statute, the Secretary is required to "deliver such additional quantity of water as is requested by the Community not to exceed ten thousand acre-feet," if the Secretary makes a determination that there is "sufficient capacity available in the main project works of the Central Arizona Project to deliver such additional quantity."

Section 2(c) contains a provision for reduction of Ak-Chin's entitlement "in time of shortage." That Section provides that "If the aggregate supply of water referred to in Subsection (f) is not sufficient to deliver seventy-five thousand acre-feet, the Secretary may deliver a lesser quantity but in no event less than seventy-two thousand acre-feet."

Section 2(c) defines "time of shortage" as "a calendar year for the which the Secretary determines that a shortage exists pursuant to Section 301(b) of the Colorado River Basin Project Act of September 30, 1968 (Public Law 90-537), such that there is not sufficient Central Arizona Project water in that year to supply up to a limit of three hundred ninety thousand eight hundred twenty-eight acre-feet of water for Indian uses, and up to a limit of five hundred ten thousand acre-feet of water for non-Indian municipal and industrial uses."

According to Section 2(d) of the Act, the Secretary is required to deliver such water at a flow rate meeting "the seasonal requirements for agricultural use on the Reservation," not to exceed three hundred cubic feet per second.

IT-1

Section 2(f) contains the sources of water to be used to satisfy the government's obligation under the Act.

Fifty thousand acre-feet of the surface water comes from water authorized by the Act of July 30, 1947 (61 Stat. 628) for beneficial consumptive use on the lands of the Yuma Mesa Division of the Gila Project. The balance of the water to satisfy the requirements of the statute comes from the Central Arizona Project, at CAP priority.

Under Section 2(j) of the Act, "The Ak-Chin Indian Community shall have the right to devote permanent water supply provided for by this Act to any use, including but not limited to agricultural, municipal, industrial, mining or recreational use."

Whereas the water legislation was initially crafted to diminish the possibility of groundwater depletion, the Act and resulting 1985 contract with the United States provide that, if shortages exist preventing delivery of water to Ak-Chin from either of the two surface water sources listed in the Act, Ak-Chin may pump groundwater sufficient to make up any such deficiency.

Nothing in the proposed EIS or any regulations adopted by the Secretary may vary the provisions of Ak-Chin's water settlement legislation, passed by 2
Congress, including those specific provisions relating to receipt by Ak-Chin of water in time of shortage, or alternative groundwater supplies available to Ak-Chin in times of shortage. Ak-Chin will continue to monitor the treatment of Colorado River water to ensure compliance with all aspects of its settlement 3
legislation.

Since most Arizona tribes receive Colorado River water, in one form or another, in settlement of their "federal reserved water rights" or *Winters* rights, Ak-Chin Indian Community urges the Bureau of Reclamation and the Secretary of Interior to attempt to arrive at regulations which will best protect the rights of 4
the tribes to Colorado River and related water supplies. Water is the lifeblood of the tribes in Arizona and elsewhere in the Southwest, and as part of the Secretary's continuing obligation to protect trust resources of the tribes, special attention should be paid to ensure that no diminution of such trust assets will be 5
caused by any new regulations governing shortage.

We will be happy to discuss Ak-Chin's position on the proposed EIS further with you.

Delia M. Carlyle, Chairman
Ak-Chin Indian Community

Date: 4-20-07

IT-1

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Reponses to Comment Letter IT-1

IT-1-1

Your comment is noted. No change to the Final EIS was necessary. As discussed in Section 4.10 of the Draft EIS and of the Final EIS, no vested water right of any kind, quantified or unquantified, including federally reserved Indian rights to Colorado River water, rights pursuant to the Consolidated Decree or Congressionally-approved water right settlements utilizing CAP water, will be altered as a result of any of the alternatives under consideration.

IT-1-2

Your comment is noted. No change to the Final EIS was necessary.

IT-1-3

Your comment is noted. No change to the Final EIS was necessary.

IT-1-4

Your comment is noted. No change to the Final EIS was necessary..

IT-1-5

Your comment is noted. No change to the Final EIS was necessary. Also see response to Comment No. IT-1-1.

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Fort Mojave Indian Tribe

NORA McDOWELL - Chairperson
SHAN LEWIS - Vice-Chairman
DEBBIE JACKSON - Secretary
COLLEEN GARCIA - Member • MARTHA McCORD - Member
NICHOLE GARCIA - Member • APRIL GARCIA - Member
500 Merriman Avenue • Needles, CA 92363
(760) 629-4591 • FAX (760) 629-5767

April 2, 2007

Terrance Fulp,PhD
US Bureau of Reclamation
Lower Colorado River Region
PO Box 61470
Boulder City, Nevada 89006-1470

Dear Dr Fulp:

First, we wish to complement the Bureau of Reclamation on its efforts to produce the *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* and are impressed by the detail of its contents.

We are disappointed however at the lack of consultation with the Fort Mojave Indian Tribe. Certainly there have been mass meetings often including tribes as far away as the 1
Rio Grande and we have attended a few of these but this hardly constitutes consultation in the usual sense of the word. The Tribe is directly affected by lower flows in the Colorado River as few others are and we would have preferred that, after real consultation, this would have been addressed in the D.E.I.S.

It has long been the position of the Fort Mojave Indian Tribe that, if shortages are 2
inevitable and they apparently are, it is best to start reductions earlier rather than later. The Tribe feels that there are those far more qualified to do the detailed River modeling than we are but, as policy, reductions should begin when reservoir storage is at about 3
50% of capacity and scale up fairly rapidly to avoid a run of the river situation with empty reservoirs.

It is also the position of the Tribe that the free market is a better way of dealing with 4
shortage than involuntary reductions. We like the "Intentionally Created Surplus"
provisions in the Basin States Alternative but a more flexible method of nomination 5
would be more useful to the smaller entitlement holder. Using the Tribe as an example, We grow 4-5,000 acres of cotton. This is not the total of a number of smaller farms, it is the production of our tribal farm and is 100% controlled by the Tribe.

IT-2

Page 2

There are good business reasons why we need to be in the cotton business but our climatic conditions are difficult with a late spring an early fall and a very hot summer. A delayed planting usually results in disappointing profit and nomination of the 20,000 acre feet of water we would use to grow the crop would be a desirable option but it needs to be done quickly in April, not the September before. 6

The term water delivery is often used in these discussions. We would like to point out that the Bureau of Reclamation does not deliver water to the Fort Mojave Indian Tribe. The Bureau delivers water to others and it passes through our Reservation and we have the right to take some of it, if we can, but there is no effort to deliver water. This is the Tribe's main concern. Senior water rights are useless if we cannot reach the water, a fact surely not lost on our friends who may be junior in right but have a nice federally built structure to draw from. 7

The Tribe hopes for and expects the help and cooperation of the Bureau of Reclamation and other concerned agencies in making the intake modifications necessary to deal with a diminished River. 8

The Fort Mojave Indian Tribe appreciates the opportunity to offer these comments.

Sincerely,

John Algots, Director
Department of Physical Resources

IT-2

Reponses to Comment Letter IT-2

IT-2-1

Your comment is noted. No change to the Final EIS was necessary. Reclamation conducted extensive public outreach, held public scoping meetings, and consulted with representatives from the cooperating agencies, Basin States, Indian tribes, non-governmental organizations (NGOs), and other interested parties to obtain input on the scope of the study. The purpose and need for the proposed federal action as well as the action alternatives that were evaluated in the EIS were formulated based on the input that was received throughout the process.

IT-2-2 and IT-2-3

Your comment is noted. No change to the Final EIS was necessary. As discussed in Section 1.1 and 1.3, the tradeoffs between the magnitude and frequency of shortages are considered in EIS. The selection of the Preferred Alternative considers these tradeoffs while still being consistent with the Law of the River.

IT-2-4

Your comment is noted. No change to the Final EIS was necessary.

IT-2-5 and IT-2-6

Your comment is noted. Reclamation has included draft guidelines in the Final EIS (Appendix S), although dates regarding the administration of ICS have not been identified. Such dates will be specified in the final guidelines, anticipated to be implemented by the Record of Decision.

IT-2-7

Your comment is noted. No change to the Final EIS was necessary. While shortage determinations would reduce the annual release from Davis Dam, Section 4.3.6 indicates that Davis Dam releases under the Preferred Alternative are very similar to the No Action Alternative.

IT-2-8

Your comment is noted. No change to the Final EIS was necessary.

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04/30/2007 12:30 FAX 2063867322 MSJM ☑001/003

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April 30, 2007

FACSIMILE TRANSMITTAL SHEET

TO/FAX NO:	Regional Director, Bureau of Reclamation Lower Colorado Regional Office/(702) 293-8156
FROM:	Mason D. Morisset Morisset, Schlosser, Jozwiak & McGaw
REGARDING:	Comments of Quechan Indian Tribe on Draft EIS re Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, **<u>BCOO-1000</u>**
NO. OF PAGES:	3 (including this sheet) CLI/MAT NO: 0267/09751

PLEASE DELIVER TO ADDRESSEE AS SOON AS POSSIBLE. THANK YOU.

T:\WPDOCS\0267\09751\CORRESP\2007\BOR Re Comments on Shortage EIS.FAX.04302007.doc
lk:4/30/07

If you have any problems receiving this transmission, please contact the receptionist at (206) 386-5200.

IT-3

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April 30, 2007

Via Facsimile (702) 293-8156

Regional Director
Bureau of Reclamation
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, Nevada 89006-1470

Re: Comments of Quechan Indian Tribe on Draft EIS re Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, **BCOO-1000**

Dear Regional Director:

On behalf of the Quechan Indian Tribe, we submit the following comments on the Draft Environmental Impact Statement regarding the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, BCOO-1000.

The Quechan Tribe's Fort Yuma Reservation was established at its current site in 1884, which gave the Tribe, under federal law, reserved rights to water in the Colorado River with a priority date of 1884. *See Arizona v. California I*, 376 U.S. 344 (1964); *Arizona v. California II*, 460 U.S. 605 (1983); *Arizona v. California* (consolidated decree), 126 S. Ct. 1543 (2006). Pursuant to the 2006 Supreme Court decree, the Tribe has diversion rights of 71,616 acre-feet per year in California and diversion rights of 6,350 acre-feet per year in Arizona. These rights have a priority date of 1884.

The DEIS correctly states that water deliveries to the Fort Yuma Indian Reservation may not be restricted, due to the senior priority of the Tribe's reserved water rights. *See, e.g., DEIS* at 4-213 ("water deliveries to the . . . Fort Yuma Indian Reservation will not be affected by the proposed federal action due to their early priority dates"). 1 It appears that none of the alternatives analyzed by the Bureau would have a detrimental effect on the exercise or use of the Tribe's reserved water rights. However, as trustee to the Tribe, the Bureau of Reclamation has a continuing obligation to ensure that the Bureau's implementation of shortage guidelines, in practice, has no detrimental impact on the Tribe's water rights or the Tribe's future exercise and use of its water rights. 2 The Tribe requests that the Bureau ensure that shortage guidelines, if 3

IT-3

04/30/2007 12:30 FAX 2063867322 MSJM 003/003

Regional Director, Lower Colorado Region
April 30, 2007
Page 2

adopted, are implemented in a manner consistent with the Tribe's water rights and the Bureau's trust obligation to the Tribe. 3

Although operations under the interim shortage guidelines will not affect water deliveries to the Tribe, variations in flow releases from upstream reservoirs could have an impact on habitat on and around the Fort Yuma Indian Reservation. 4 The current DEIS contains relatively little discussion of potential impacts to habitat between Imperial Dam and the NIB, an area that includes habitat on and around the reservation. 5

The Tribe requests that the Bureau give further consideration to the following issues. First, to what extent will the variation in *timing* of flows have an effect on the vegetation resources that are adjacent to the Colorado River on and nearby the Fort Yuma Indian Reservation? For example, implementation of shortage guidelines may result in variations in the timing and duration of high or low flow events in the area between Imperial Dam and the NIB. 6 Specifically, will there be any variation in the timing of flood flows that could negatively impact the Yuma East Wetlands located along the Fort Yuma Indian Reservation that are currently being restored by the Tribe and other agencies? The health of the riparian wetland areas depends, in large part, on the continued existence of high flow events. 7 Second, to what extent will the variation in flows, both in terms of timing and quantity, impact groundwater on and nearby the Fort Yuma Indian Reservation? 8 There does not appear to be any significant evaluation of potential impacts to groundwater on the reservation in the current DEIS. 9

The Tribe appreciates the opportunity to comment on the Bureau's DEIS. The Tribe requests that the Bureau continue to keep the Tribe directly informed as the proposed development of shortage guidelines moves forward. 10

Sincerely yours,

MORISSET, SCHLOSSER, JOZWIAK & McGAW

Mason D. Morisset

cc: Mike Jackson, Sr., President

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lk:4/29/07

IT-3

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Reponses to Comment Letter IT-3

IT-3-1

Your comment is noted. No change to the Final EIS was necessary.

IT-3-2

Your comment is noted. No change to the Final EIS was necessary.

IT-3-3

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. IT-1-1.

IT-3-4 and IT-3-5

Your comment is noted. No change to the Final EIS was necessary. The information requested is found in Section 4.8.3.7 and Section 4.8.4.7.

IT-3-6 through IT-3-8

Your comment is noted. As discussed in Section 3.3.9 and Section 4.3.8, the proposed federal action will have no effect on the Imperial Dam to NIB river reach.

IT-3-9

Your comment is noted. See response to Comment No. IT-3-6 through IT-3-8.

IT-3-10

Your comment is noted. No change to the Final EIS was necessary.

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OF COUNSEL
PHOEBE ANNE GREYSON

4/27/07

BC001000

April 25, 2007

Regional Director
Lower Colorado Region
Bureau of Reclamation
Attention: BC00-1000
P. O. Box 61470
Boulder City, Nevada 89006-1470

Re: *Draft Environmental Impact Statement - Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*

Dear Sir:

This firm serves as special counsel to the Southern Ute Indian Tribe ("Tribe") on matters related to their water right. We submit the following comments on the Draft Environmental Impact Statement - Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (Feb. 2007) ("DEIS") on the Tribe's behalf:

I. RECLAMATION HAS A TRUST RESPONSIBILITY TO THE SOUTHERN UTE INDIAN TRIBE TO PROTECT THE TRIBE'S WATER RIGHTS

The DEIS states that the proposed federal action will not affect apportionments allocated to the Upper Basin states under the Upper Colorado River Basin Compact of 1948, nor the states' ability to use those apportionments. DEIS at 3-32. In addition, the DEIS describes the geographic scope of the proposed federal action to exclude the Upper Basin states:

> The geographic region that would be affected by the proposed federal action begins with Lake Powell and extends downstream along the Colorado River floodplain to the Southerly International Boundary (SIB) with Mexico. This proposed federal action would also potentially affect interests of organizations and individuals, whose geographic distribution extends beyond the Colorado River floodplain into water districts in the Lower Basin states (Section 1.7).

IT-4

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A Professional Corporation

GREENE, MEYER & McELROY
ATTORNEYS AT LAW

Regional Director
April 25, 2007
Page 2

DEIS at 1-7. Nonetheless, it is unrealistic to assert that in the event the Colorado River Basin is experiencing drought and low reservoir conditions, thus triggering the need for the Secretary of the Interior to reduce the annual amount of water available for consumptive use from Lake Mead to the Lower Basin states below 7.5 million acre-feet, that the Upper Basin states and tribes would not be affected. 1

The Secretary has a variety of responsibilities over the waters of the Colorado River pursuant to the Law of the River as reflected in the documents set forth in Table 1.7-1. DEIS 1-13. Additionally, and to no lesser extent, the Secretary has a fiduciary responsibility to the Tribe to protect tribal trust resources. As an agency of the federal government, the Bureau of Reclamation ("Reclamation") has a trust responsibility to all Indian tribes and tribal members, including the Southern Ute Indian Tribe and its members: 2

> The United States has an Indian trust responsibility (trust responsibility) to protect and maintain rights reserved by or granted to Indian tribes or Indian individuals by treaties, statutes, and executive orders, which rights are sometimes further interpreted through court decisions and regulations. This trust responsibility requires that all Federal agencies, including Reclamation, take all actions reasonably necessary to protect trust assets.

See Attachment 5, Bureau of Reclamation, Indian Trust Asset Policy (Aug. 31, 1994) *in* Protection of Indian Trust Resources (notebook on file with the Department of the Interior).[1]

The Indian Trust Assets entitled to protection under the trust responsibility include water rights. *See id*. Thus, Reclamation has a trust responsibility to take all actions reasonably necessary to protect the Tribe's water rights, including its historic, existing and future use water rights. In fact, the United States' trust responsibility to the Tribe is of "the highest fiduciary standards," *Gila River Pima-Maricopa Indian Community v. United States*, 9 Cl. Ct. 660, 678 (1986), *aff'd*, 877 F.2d 961 (Fed. Cir. 1989),[2] and it does not wane because Congress has imposed upon it additional statutory obligations. *Nevada v. United States*, 463 U.S. 110, 128 (1983). Certainly, the United States may not subordinate its trust responsibility to protect the Tribe's rights by claiming that the interim guidelines for Lower Basin shortages must be enforced. 3 4

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[1]In February 1996, then Secretary of the Interior Babbitt and Assistant Secretary Deer transmitted to Interior employees a compilation of the policies and procedures adopted by the bureaus and offices of the Department of Interior relating to trust protection practices. This compilation notebook in referred to herein as "Protection of Indian Trust Resources."

[2]*See also In re the General Adjudication of all Rights to Use Water in the Gila River System and Source*, 35 P.3d 68, 74 (Ariz. 2001).

IT-4

GREENE, MEYER & McELROY
ATTORNEYS AT LAW

Regional Director
April 25, 2007
Page 3

II. RECLAMATION SHOULD SELECT A PREFERRED ALTERNATIVE

The DEIS provides that:

> Reclamation has not identified a preferred alternative in the Draft EIS. The preferred alternative will be identified following public comments on the Draft EIS and will be expressed in the Final EIS. The preferred alternative may be one of the specific alternatives described below or it may incorporate elements or variations of these alternatives.

DEIS ES-3. By failing to identify a preferred alternative, the federal, state, tribal and local
agencies are unable to provide any comments – an important part of the NEPA full disclosure 5
process. Moreover, the Tribe is unable to determine whether the preferred alternative is in its best
interests. *Jicarilla Apache Tribe v. Supron Energy Corp.*, 728 F.2d 1555, 1567 (10th Cir. 1984)
(Seymour, Jr., concurring in part, dissenting in part), *modified on reh'g*, 782 F.2d 885 (10th Cir.),
modified, 793 F.2d 1171 (10th Cir.) (adopting concurring/dissenting opinion of Seymour, J.), *cert.
denied sub nom. Southern Union v. Jicarilla*, 479 U.S. 970 (1986).

Particularly troubling is Reclamation's assertion that it may cobble together a preferred alternative 6
that "incorporate[s] elements or variations of these alternatives." DEIS at ES-3. Stated another
way, Reclamation may select a preferred alternative upon which no one had an opportunity to 7
comment. It is the federal action as a whole that may have an adverse effect on the natural and/or
human environment, not the constituent elements of various possible federal actions. Indeed, it is
not possible to provide comments on separate pieces of possible federal actions because the
alternatives set forth in the DEIS are not divided up into components, and, therefore, it is entirely
unclear how Reclamation would select "elements or variations" of the identified alternatives in
order to come up with a sixth, and heretofore unidentified, alternative. The "shuffle and deal"
approach to identifying the preferred alternative is contrary to NEPA and Interior's NEPA- 8
implementing regulations.

If Reclamation selects one of the alternatives set forth in the DEIS as its preferred alternative, the
Tribe should nevertheless have an opportunity to provide additional comments at the time when 9
Reclamation makes its selection because then the Tribe will be able to determine whether the
preferred alternative is in its best interests. The Tribe acknowledges that the regulations do not 10
require Reclamation identify a preferred alternative in the DEIS,[3] nevertheless based on the

---

[3]The applicable regulation provides the following:

> This section is the heart of the environmental impact statement. Based on the information and analysis presented in the sections on the Affected Environment . . . and the Environmental Consequences . . . , it should present the environmental

IT-4

GREENE, MEYER & McELROY
ATTORNEYS AT LAW

Regional Director
April 25, 2007
Page 4

Secretary's trust responsibility, the Tribe should be given the opportunity to comment once
Reclamation has selected its preferred alternative well in advance of release of the final 10
environmental impact statement. If, on the other hand, Reclamation devises as its preferred
alternative a new alternative from pieces of the existing alternatives in the DEIS, Reclamation 11
should reissue a new draft environmental impact statement for public comment, since there will
have been no public comment on that federal action.

We appreciate the opportunity to comment on the DEIS and look forward to providing comments on the preferred alternative once it has been either selected or formulated.

Sincerely,

M. Catherine Condon

MCC/dav

cc: Council Member Jimmy Newton
Jim Formea
Chuck Lawler

> impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public. In this section agencies shall:
>
> . . . .
>
> (e) Identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference.

40 C.F.R. § 1502.14(e).

IT-4

Reponses to Comment Letter IT-4

IT-4-1

Reclamation does not concur with this comment. As noted in Section 3.2, reservoirs located upstream of Lake Powell and operated independently of Lake Powell would not be affected by the proposed federal action.

IT-4-2 through IT-4-4

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. IT-1-1.

IT-4-5 through IT-9

Your comment is noted. No change to the Final EIS was necessary. The Council on Environmental Quality (CEQ) regulations for implementing NEPA do not require identification of a Preferred Alternative in the Draft EIS. Reclamation considered all public comments on the Draft EIS in identifying the Preferred Alternative.

IT-4-10

Pursuant to the CEQ regulations, a 30-day review period will commence after the publication of the Final EIS.

IT-4-11

Your comment is noted. No change to the Final EIS was necessary.

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COLORADO RIVER INDIAN TRIBES
Water Resources Department
ROUTE 1, BOX 23-B
PARKER, ARIZONA 85344
TELEPHONE (928) 669-1381 • FAX (928) 669-8678

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KEYWORD		

April 30, 2007

Regional Director, Lower Colorado Region
Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City, Nevada 89006-1470

Dear Director,

The Colorado River Indian Tribes Water Resources Department (the Tribe) has reviewed the February 2007 Draft Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (Guidelines), and can provide the following comments.

1. The Tribe agrees with the Bureau of Reclamation (Reclamation) determination that there will be no impact on the ability of the Tribe to divert its full entitlement of Colorado River (River) water under the Guidelines as presented. This determination is supported by the projected shortage amounts and the Tribe's present perfected rights priority in both Arizona and California. 1

2. Biological Resources within the external boundaries of the Tribe's Reservation may be impacted by the reduction in River flows (Section 4.10.4) because the River is essentially free-running in this reach and shortage flow reductions may lower the River below current and historical levels. 2 Economic Resources may be impacted as well due to a reduced ability to use the River for recreation. 3

3. The Tribe believes the best insurance against shortages is to keep Lake Powell and Lake Mead as full of stored water as possible. 4 This action can be promoted by developing programs and incentives that allow for storage of conserved River water in these Lakes. To be truly successful, such programs and incentives should allow for the retention of the value of this stored water to stay with the storing party. For example, water conserved and stored at a certain cost should be available until used by those who paid for the water, and not be lost by River management actions in the future. 5

Thank you for the opportunity to comment on these Guidelines.

Sincerely,

Gary B. Hansen, Director

IT-5

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Reponses to Comment Letter IT-5

IT-5-1

Reclamation concurs with this comment. No change to the Final EIS was necessary.

IT-5-2 and IT-5-3

The potential impacts to biological resources were analyzed and presented in Section 4.8.3.4 and 4.8.4.6. The potential impacts to socioeconomic resources were analyzed and presented in Section 4.14.

IT-5-4

Your comment is noted. No change to the Final EIS was necessary.

IT-5-5

Your comment is noted. Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that address the administration of the ICS mechanism.

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April 27, 2007

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BUREAU OF RECLAMATION
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Boulder City, Nevada 89006-1470

Re: Comments on the DRAFT Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead - YAVAPAI-APACHE NATION

Dear Regional Director:

This Firm serves as Special Legal Counsel to the Yavapai-Apache Nation ("Nation") and submits the following comments on the *DRAFT Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* ("DEIS"). The Nation previously submitted written comments to the Bureau of Reclamation ("Reclamation") on August 31, 2005, and at meetings during scoping for the preparation of the DEIS. Those comments, including attachments, are incorporated here by reference. 1

The Yavapai-Apache Nation is located in central Arizona, near the communities of Camp Verde and Clarkdale. The Reservation is does not presently have an adequate water supply to serve the requirements of the Nation. 2

The Nation has a Central Arizona Project Indian Water Delivery Contract Between the United States and the Yavapai-Apache Nation dated December 11, 1980 ("CAP Contract"), a copy of which was previously provided in the Nation's letter of August 31, 2005. This CAP Contract provides 1,200 acre-feet of CAP water to the Nation.

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 2

River management strategies or decisions which would increase the frequency of shortages or the participation of others in the shortage pools, or reduce the long-term reliability of the Nation's CAP water by declarations of a "shortage," and other schemes which manipulate "credits", storage rights, and exchanges must be avoided. Several of the alternatives described in the DEIS present shortage sharing scenarios and "conservation" schemes that will substantially reduce the reliability of the Nation's CAP water supply and will materially injure the right of the Nation to receive this water supply under its CAP Contract. 3 4

Section 3.21 of the Nation's CAP Contract defines a **"Time of Shortage" as "a calendar year for which the Secretary determines that a shortage exists pursuant to Section 301(b) of the Basin Project Act, such that there is not sufficient Project Water in that year to supply up to a limit of 309,828 acre feet of water for Indian uses, and up to a limit of 510,000 acre feet of water for non-Indian Municipal and Industrial uses."** Under the Nation's CAP Contract, deliveries of Project Water to the Nation in Times of Shortage may be reduced or terminated in accordance with Section 4.9 of the Nation's CAP Contract. 5

It is paramount that the Secretary of Interior ("Secretary") reject the proposed management strategies for Lake Powell and Lake Mead that would threaten the security or breach the Nation's CAP Contract or breach the Secretary's trust responsibility to properly manage and protect the Nation's CAP water as an Indian Trust Asset. 6

The Nation has always understood the terms of the CAP Contract relating to shortage to mean that delivery of CAP water depends upon the physical situation of the Colorado River and not upon a scheme of management in which some are benefitted while others are not. The Secretary owes the Nation a trust duty to refrain from implementing management strategies which interfere with the Nation's contractual rights and expectation of delivery of CAP water and funding for construction and 7 8

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 3

the payment of OM&R from the power generation revenues and Lower Colorado River Basin
Development Fund under its CAP Contract. 8

The following is a list of the Nation's primary objections and concerns regarding the DEIS:

1. The DEIS Does Not Discuss How Shortages of the Natural Flow of the Colorado River Will Be Shared from Year to Year Between the Upper Basin and Lower Basin States

The DEIS provides no discussion as to how shortages in the annual natural flow of the Colorado
River which is not adequate to meet the 15 m.a.f. of apportionments to the Upper and Lower Basin 9
States will be imposed as between the Upper Basin and Lower Basin. The DEIS must first discuss how
shortages would be borne between the Upper Basin and Lower Basin, before discussing the allocation of
water that is stored in the Colorado River reservoirs. The Secretary must first look to the annual natural
flow of the River to provide the water supply that is to be apportioned. 10

Thereafter, the Secretary may look to the water which is stored in the reservoirs in the Lower Basin to provide the supplemental supply to meet the apportionment entitlements of contractors in the Lower Basin States.

2. The DEIS Cannot Lawfully Place Precedence Upon the Nevada Intake at 1050' Elevation Over the Requirements that the Nations Receive Their Entitlements from the Colorado River to Provide for Their Permanent Tribal Homelands

The DEIS should not place precedence and limit considerations regarding the mark at which
shortages will be declared based upon the location of the State of Nevada's intake at the 1050' elevation 11
in Lake Mead. While Nevada may deepen its intake facilities into Lake Mead to mitigate impacts when
a shortage is declared on the River, the Nations have very few, if any, alternatives to enable them to
obtain access to Colorado River water or replacement water supplies to provide for their Permanent
Tribal Homelands. The DEIS should consider alternatives for shortage based upon the Secretary's 12

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 4

obligation to protect and make available the Colorado River water supply to the Tribes, and to the long term reliability of the water supply for all contractors with rights to the River. The man-made intake facilities at Lake Mead for Nevada may be readily altered to correspond with the possibility of shortage, and thus, should be of little or no concern with regard to the management of the River, as opposed to those who have no other options. 12

The Law of the River does not allow the Lower Basin water supply to be managed primarily to serve one State or interest over another. The sole beneficiary of the Lake Mead scenario is Nevada, to the detriment of others, including the CAP Tribes. The alternatives must be adjusted to provide scenarios with equal consideration of the importance of the delivery of CAP water to the Nation. 13 14

3. The DEIS Erroneously Assumes that the Nation is a Subcontractor of the Central Arizona Water Conservation District

The DEIS erroneously assumes and conveys that the Nation is a subcontractor of CAP water under the Central Arizona Water Conservation District ("CAWCD"), a political arm of the State of Arizona. *See* Appendix E at E-1, showing the CAWCD as the entitlement holder for all CAP water. 15
On the contrary, the Nation has a **direct** contract with the Secretary of Interior for the delivery of its CAP water, and the United States has a **direct** obligation to deliver this water pursuant to the Nation's contract. *See* Nation's CAP Contract. This misstatement should be corrected throughout the DEIS. 16

Since the Nation is a direct contractor with the Secretary, it must be treated on a co-equal level with that of CAWCD and other contractors in other states with direct contracts with the Secretary to receive the waters of the Colorado River. 17
CAWCD also has a direct contract with the Secretary for the delivery of the non-Indian portion of CAP water and an obligation to repay the cost of the non-Indian portion of the CAP project to the United States. 18

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 5

The Nation's water right to CAP water is a portion of Arizona's equitable apportionment under *Arizona v. California* that must be directly protected by the Secretary as an Indian Trust Asset for the Nation. 19 The State of Arizona should have an interest in protecting the Nation's CAP water supply. However, the State's conduct in this matter shows that its sole interest and effort is focused upon committing the Nation's CAP water supply to non-Indian use, preventing the Nation from ever using the "wet" water to which the Nation has a right under its CAP Contract. 20 Its conduct also indicates that the States seeks to take and keep the financial benefits from the CAP water to which the Nation is entitled, which is presently diverted and unlawfully "converted" to use by the State and other non-Indian interests.

4. Use of Reservoirs to Store and Deliver "Conserved" Colorado River System and Non-System Water

The DEIS, at ES-2, lists one of the purposes of the proposed federal actions as to "[a]llow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions." While this purpose appears to be reasonable and foresightful, the method of implementing this purpose, as proposed in certain of the DEIS alternatives, will result in a wholesale taking of the Nation's CAP water, and allow the Nation's water to be committed to use by others. 21 This is a violation of the Law of the River and of the Nation's CAP water rights which are Indian Trust Assets that must be protected by the Secretary.

"The States [in the Basin States Alternative] propose that the Secretary develop a policy and accounting procedure concerning augmentation, extraordinary conservation, and system efficiency projects, including specific extraordinary conservation projects, tributary conservation projects, introduction of non-Colorado River system water, system efficiency improvements and exchange of non-Colorado River System water. The accounting and recovery process would be referred to as

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 6

'Intentionally Created Surplus' consistent with the concept that the States will take actions to augment storage of water in the Lower Colorado River Basin. The water would be distributed pursuant to Section II(B)(2) of the Decree and forbearance agreements between the States. The ICS credits may not be created or released without such forbearance agreements." (Appendix at J-11).

However, substantially all, if not all, of these "policy and accounting procedures" are based on a fiction. All of the Colorado River water, natural flow, storage, and surpluses are committed by contracts with the Secretary and the Treaty with the Republic of Mexico. There are no unallocated or uncommitted amounts of Colorado River water possible, including the fictional "Intentionally Created Surplus." The fictional "Intentionally Created Surplus" is actually an attempt to convert the water that is committed to some other use to another entity. 22

Due to its position, the State of Arizona has a particular interest in "conservation" methods for the Colorado River that would preclude the Arizona Tribes from participation. Once the same Colorado River water is labeled "conserved" by a particular party, the party (such as the State of Arizona) will preclude the Nation from participating in the benefits of the "conserved" Colorado River water. 23

The use of the "conserved" water that will be stored in the reservoirs and claimed exclusively by the State of Arizona (which thereby excludes Arizona Indian Tribe access) will reduce and manipulate the amount of water from the Colorado River and its storage that could be used by the Nation from year to year to fulfill their CAP water orders. This manipulation of the Colorado River water source to preclude its lawful use by the Nation is a violation of the Law of the River and a violation of the Nation's CAP Contract. 24

Furthermore, the States cannot enter into forbearance agreements or shortage sharing agreements amongst themselves where the rights of Arizona Tribes to their share of Arizona's equitable

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 7

apportionment to the Colorado River would be manipulated by the States. *See e.g.* Appendix J-10 ("Arizona and Nevada will share shortages based on a shortage sharing agreement. In the event that no agreement has been reached, Arizona and Nevada will share shortages in accordance with the 1968 Colorado River Basin Project Act, the Decree, other existing law as applicable, and the Interstate Banking Agreement between Arizona and Nevada parties."). The participation of the Arizona Tribes in the forbearance agreements or any other agreements between Arizona and other States, as co-equal water users of Arizona's equitable apportionment, is required by the Law of the River, and by the direct contracts of the Tribes with the Secretary of Interior. 25

The proposed alternatives must be revised so that any "conservation" regime used to reduce the potential conditions which may cause or enable the Secretary to make declarations of shortage on the Colorado River, or used to provide additional waters to Arizona (including Arizona Tribes), include all Arizona CAP Tribes in the mutual "wet water" and financial benefits of such schemes. 26 Otherwise, the Tribes will be subject to significant injury as a result of the manipulation schemes in violation of the Law of the River, and the contractual and constitutional rights of the Tribes.

5. The DEIS Does Not Discuss the Legal Authority for Allowing Credits for Fallowed Lands, Canal Lining and Other "Conservation" Measures

The DEIS does not discuss any legal authority which would permit the States to obtain credits for "fallowing" lands, canal lining and other measures undertaken to purportedly "conserve" Colorado River water. Under the law in Arizona, other western States and Federal Reclamation Law, the waters "conserved" by the fallowing of lands and the lining of canals is committed back to the stream flow to be used by the next water user in the system. 27 *See Phelps Dodge Corp. v. Ariz. Dep't of Water Res.*, 2005 Ariz. App. LEXIS 108 (Ariz. Ct. App. 2005) (observing that water rights in Arizona are ". . .usufructory, to ensure a maximum beneficial use of Arizona's water resources.") (citing *Clough v. Wing*, 2 Ariz. 371, 379-81, 17 P. 453, 455-56 (Terr. 1888)); *Salt River Valley Water Users' Ass'n v. Kovacovich*, 3. Ariz.

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 8

App. 28, 411 P.2d 201, 203 (Ariz. Ct. App. 1966) ("any practice, whether through water-saving procedures or otherwise, whereby [a diverter] may in fact reduce the quantity of water actually taken inures to the benefit of other water users and neither creates a right to use the waters saved as a marketable commodity nor the right to apply same to adjacent property having no appurtenant water rights."); Kinney, *Treatise on the Law of Irrigation and Water Rights and the Arid Region*, (2nd Ed. 1912), §782, 783.

The DEIS must discuss what legal authority would permit the States to commit "conserved" water to inure to the benefit of a single party or particular beneficiary, rather than for the use and benefit of **all** users in the Colorado River system under the Law of the River. 28 Furthermore, if such a "conservation" scheme could be lawfully implemented and used to benefit particular parties or beneficiaries, the Tribes must be permitted to participate, and the Secretary must fully support and protect the Nation's full and unfettered participation and receipt of benefits. 29

6. Use of Surplus by Basin States

The Basin States Alternative also proposes a different scheme for the distribution of surplus. For instance, the Basin States Alternative would "[d]istribute Arizona's share to surplus demands in Arizona including off stream banking and interstate banking demands." *See* Appendix at J-9. The problem is that based upon historical and present practices by Arizona (which is charged with protecting the entire State's equitable apportionment from the Colorado River, including that which is used by the Tribes) the State would nevertheless use this surplus for the benefit of non-Indians, to the exclusion of the Tribes. 30 In fact, the State of Arizona is engaging in this conduct now, through, *inter alia*, the Arizona Water Banking Authority and the interstate water banking agreement with Nevada. The Secretary's approval of the Basin States Alternative would put the weight of authority of the United States behind these wrongful acts by the State of Arizona. 31

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 9

The Secretary should not select the Basin States Alternative or any other alternative, where it
would exclude Tribes from participation in the arrangements made on the Colorado River during times 32
of surplus. In addition, the Secretary must include the Arizona Tribes and ensure that the Arizona Tribes 33
receive the mutual benefits of surplus on the Colorado River.

7. The DEIS Does Not Provide Adequate Details Regarding the Basin States Proposal for Accounting Policy and Procedure for Intentionally Created Surplus

The DEIS does not provide sufficient detail regarding the alternatives for the accounting policy
and procedure that the Secretary would implement for Intentionally Created Surplus or any other
"conserved" water. Without this detail, it is unclear as to how the CAP Tribes would be permitted to 34
participate in the ICS and the impact of the uses of the ICS upon the Tribes. This should be corrected in
the DEIS.

8. The Arizona Water Settlements Act, P.L. 108-451 Is Not Yet Enforceable

The DEIS' underlying assumption and reliance upon the AWSA as defining the characteristics of
the CAP is premature. *See* DEIS at 4-81. The AWSA is not yet enforceable and may never become 35
enforceable. If so, the DEIS or Final EIS intended to be published by December 2007, will require
immediate revision and further public comment. In addition, the existing DEIS should include an 36
impact analysis which compares the impacts under the present characteristics of the CAP with the
impacts under the characteristics which would exist if the AWSA were to become enforceable.

9. There Is No Misunderstanding As To How Shortages Are To Be Distributed Between CAP Indian and M&I Priority Users Within the CAP

The DEIS states that "prior to the enactment of the AWSA, there were differing views as to how mild shortages would be distributed between CAP Indian and M&I priority users." (DEIS at 4-124). While there may be so-called "differing views", the Nation's CAP Contract is very clear regarding how

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 10

shortages are to be implemented as to the Nation. Furthermore, the AWSA did nothing to clarify how such shortages are shared, because the Nation's CAP Contract cannot be affected or modified by the AWSA. The DEIS and its underlying assumptions must be changed to reflect and analyze the true nature of the Nation's CAP entitlement and how shortages within CAP will be implemented as to the Nation. 37

10. The DEIS Does Not List or Discuss the Impacts to the Nation's CAP Entitlements

The Nation has a contractual right to CAP water under a direct contract with the United States. As reflected in the DEIS, the Nation's CAP Contract could be used to satisfy the Nation's *Winter's* or federal reserved water rights. Since this water could be used in this way, the DEIS should analyze the impact of the shortage criteria as an Indian Trust Asset. 38 In addition, since the Nation has a direct contract with the United States on a co-equal basis with CAWCD, the DEIS should analyze the impact of shortage sharing upon the Nation separately from any analysis of shortages which pertains to other CAP water users. 39

11. The DEIS Fails to Adequately Discuss or Analyze the Impacts of the Alternatives Upon the Nation

The DEIS finds that "No vested water right of any kind, quantified or unquantified, including federally reserved Indian rights to Colorado River water, rights pursuant to the Consolidated Decree or Congressionally-approved water right settlements utilizing CAP water, will be altered as a result of any of the alternatives under consideration." DEIS at 4-123. This is incorrect. 40

The DEIS erroneously attempts to delineate between a paper water right and wet water. These are one in the same. 41 Whether or not the paper water right becomes wet water is determined by whether or not the law is followed and whether or not the Secretary undertakes actions (or fails to take actions) which diminish the reliability or injure the ability of the Nation to receive its wet water. The implementation of shortage sharing criteria which would hinder the Nation's ability to receive the water

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 11

to which it is entitled, and the selection of an alternative which would permit waters to be "conserved" and committed to exclusive use by certain parties, alters the reliability of the Nation's entitlement to CAP water. The DEIS cannot distinguish between the effect of the alternative upon the legal entitlement of the Nation versus the effect upon the Nation's receipt of the wet waters pursuant to the legal entitlement. 42

The DEIS proposes alternatives which will impact and diminish the reliability of the CAP water supply and thus, injure the ability of the Nation to receive the wet water to which it is entitled. 43 The Secretary is charged with the responsibility to implement shortage sharing criteria which protect the Nation's receipt of the CAP water supply which is an Indian Trust Asset. The DEIS must analyze the impacts upon the Nation's receipt of the water to which it is entitled, and not merely make a statement that the alternatives will have "no effect" upon the Nation's legal entitlement to the CAP water. 44 A policy which proclaims no impact on the Nation's legal entitlement which results in **no wet water** to fulfill its entitlement is deceptive and amounts to invidious discrimination. The DEIS' avoidance of discussing the true impact of the alternatives upon the Nation must be corrected. 45

12. The DEIS Fails to Discuss How "Voluntary" Shortages Would Be Implemented and Their Resultant Effect Upon the Nation and Its Right to CAP Water

The DEIS mentions that certain "voluntary" shortages could be implemented. DEIS at 4-12. However, the DEIS is unclear as to who would agree to such voluntary shortages. 46 The Secretary cannot permit the State of Arizona to decide whether or not it would enter into a voluntary shortage, where such shortage would diminish the reliability of the Nation's CAP water. This is simply unlawful. 47 Furthermore, the Secretary cannot allow other states to enter into "voluntary" shortages and alternative River management schemes that would create conditions where the Tribes were required to bear shortages that would not otherwise be borne, absent such voluntary agreements or schemes. 48 The DEIS

IT-6

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 12

fails to discuss this in any detail. The DEIS should be revised for clarity and to provide a meaningful
analysis of the impacts of the proposed "voluntary" shortages to the Nation's receipt of its CAP water 49
supply.

13. The DEIS Fails to Discuss the Potential Impact of Any of the Alternatives on Water Quality or Quantity to Which the Republic of Mexico is Entitled Under Treaty

The DEIS fails to discuss the ongoing and potential environmental impacts of any of the
alternatives on the Colorado River delta, including wet lands, and the fact that the delta is one of the 50
primary marine nurseries supporting aquatic life, fisheries and migratory wildlife subject to international
treaties, and the ultimate fish production and annual catch allocated among countries of the Pacific Rim.
The alternatives proposed by the DEIS, with the increase in use of the Colorado River proposed by the 51
alternatives, including the Basin States Alternative, will undoubtedly impact the delta.

Please continue to keep this Firm on your mailing list for all future communications and documents related to this matter.

Yours Truly,

THE SPARKS LAW FIRM, P.C.

Robyn L. Interpreter

RLI/rli

cc: Jamie Fullmer, Chairman
David Kwail, Vice-Chairman
Council Members

I:\INDIAN\YAVAPAI\CAP\ltr to sec on DEIS.wpd

IT-6

Reponses to Comment Letter IT-6

IT-6-1 and IT-6-2

Your comment is noted. No change to the Final EIS was necessary.

IT-6-3

Your comment is noted. No change to the Final EIS was necessary.

IT-6-4

Reclamation does not concur with this comment. As discussed in Section 4.3.4.1 of the Draft EIS (renumbered to Section 4.3.4.2 in the Final EIS), conservation activities resulting from participation in a storage and delivery mechanism results in higher Lake Mead elevations, due to the system assessment whereby a percentage of the conserved water is retained in Lake Mead. Higher Lake Mead elevations would result in a decrease in the risk of shortages and an increase in the reliability of 4^{th} priority Arizona water supplies.

IT-6-5

Your comment is noted. No change to the Final EIS was necessary.

IT-6-6

As noted in Section 4.4.3 of the Draft EIS and of the Final EIS, the proposed federal action will not affect the entitlements to water users within the Lower Division states. However, water deliveries to users within each state may be affected and were analyzed in the EIS.

IT-6-7

Reclamation does not concur with this comment. As noted in Section 1.2, the interim guidelines would be used by the Secretary to determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) (Section 1.7) below 7.5 million acre-feet (maf) (a ‘‘Shortage’’) pursuant to Article II(B)(3) of the Consolidated Decree. Section 301(b) of the Colorado River Basin Project Act clearly states that, under those circumstances, diversions to the CAP would be limited.

An analyses of the trade-offs between incurring more manageable yet more frequent shortages versus incurring no shortages for some period of time resulting in an increased risk of much larger, severe and less manageable shortages at a later date has been performed through the comparison of the alternatives that have been studied in the EIS. The Preferred Alternative proposes more frequent, less severe shortages, reducing the risk of incurring larger more severe shortages at a later date. These analyses included the potential impacts to water deliveries to CAP (Section 4.4.7.1 and Appendix G).

IT-6-8

See response to Comment No. IT-6-6.

IT-6-9 and IT-6-10

Your comment is noted. No change to the Final EIS was necessary. The apportionment to the Upper Basin and Lower Basin is outside the scope of this EIS.

IT-6-11 through IT-6-14

Reclamation does not concur with this comment. Of the alternatives considered in the Draft EIS, the Basin States, Reservoir Storage, and Water Supply alternatives did not assume absolute protection to either of SNWA's intakes (elevations 1,050 feet msl or 1,000 feet msl). In the Final EIS, the Preferred Alternative also does not provide absolute protection to SNWA's intakes.

IT-6-15 and IT-6-16

Your comment is noted. Table E-1 in Appendix E lists Arizona water entitlement holders and priorities and aggregates all CAP water contracts into one entry under the heading Central Arizona Water Conservation District (CAP) for presentation purposes only. It was not intended to suggest that CAP contracts with the Secretary were subcontracts with CAWCD. Table 3.2-2 in the Draft EIS lists the individual AP contractors, including the Indian tribes. In the Final EIS, Appendix G was modified to more clearly explain the CAP framework (Section G.4.8). In the Final EIS, Table G-3 shows the CAP entitlements by priority and Table G-4 shows the CAP priority 2 Indian entitlements by sub-priority. Both tables clearly show the Yavapai-Apache entitlement.

IT-6-17 and IT-6-18

Your comment is noted. No change to the Final EIS was necessary.

IT-6-19

See response to Comment No. IT-6-6.

IT-6-20

Your comment is noted. No change to the Final EIS was necessary.

IT-6-21

This comment does not accurately reflect the information published by Reclamation in the Draft EIS. As described in Section 2.3, Section 2.4, Section 2.5, the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives proposed a storage and delivery mechanism that would encourage and account for augmentation and conservation of water supplies. In the Final EIS, Reclamation has identified the Preferred Alternative that includes a similar mechanism

(ICS). Draft operational guidelines have also been included in the Final EIS (Appendix S) that address the administration of the ICS mechanism.

IT-6-22 to IT-6-24

Reclamation does not concur with these comments. See response to Comment No. IT-6-21.

IT-6-25 and IT-6-26

As noted in Section 1.2 of the Draft EIS, the interim guidelines would be used by the Secretary to allow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead. Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that address the administration of the ICS mechanism.

IT-6-27

See response to Comment No. IT-6-25.

IT-6-28

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. IT-6-25.

IT-6-29

See response to Comment No. IT-6-25.

IT-6-30 and IT-6-32

Reclamation does not concur with these comments. The Basin States proposal (Appendix J) suggests that Arizona's share of surplus under a Quantified Surplus Condition be distributed to "surplus demands in Arizona *including* off stream banking and interstate banking demands" (emphasis added).

IT-6-33

Your comment is noted. Reclamation has included draft operational guidelines in the Final EIS (Appendix S) that address Lake Mead operations including surplus determinations. Inclusion of the statement "Distribute Arizona's share to surplus demands in Arizona including Off-stream Banking and interstate banking demands" in the draft guidelines does not preclude distribution of surplus within Arizona to other surplus demands including Tribal surplus demands.

IT-6-34

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. IT-6-25.

IT-6-35 and IT-6-36

Your comment is noted. No change to the Final EIS was necessary. Reclamation's supplementing guidance states that if other projects in the affected area are likely to occur and the effects are reasonably foreseeable, they should be included and analyzed as part of the action.

IT-6-37

Your comment is noted. No change to the Final EIS was necessary. The Yavapai-Apache Nation is not affected by the shortage-sharing compromise in the AWSA (Section 4.4.7.1) because the compromise affects those entities within the M&I/Indian category with entitlements less firm than the Nation's entitlements.

IT-6-38

Your comment is noted. No change to the Final EIS was necessary. As noted in Section 3.10.1, ITAs are "…'legal interests' in 'assets' held in 'trust' by the federal government for federally recognized Indian tribes or individual Indians" (USBR 1994). For this analysis, the Indian water rights and land assets considered include federally reserved Indian rights to Colorado River water including rights established pursuant to *Arizona v. California;* Colorado River water Tribal delivery contracts where such contracts are part of a congressionally approved water rights settlement; and Indian reservations (Section 3.10.1).

IT-6-39

Your comment is noted. No change to the Final EIS was necessary. However, based on the modeling assumptions used to distribute shortages to CAP users, the shortage to the Nation would be the same whether analyzed separately or included as part of the analysis with other CAP contractors. Appendix G (Attachment B) provides the modeled shortages to the Nation for a range of shortages for selected years.

IT-6-40 through IT-6-42

Reclamation does not concur with these comments. No change to the Final EIS was necessary.

IT-6-43

Reclamation does not concur with this comment. An analyses of the trade-offs between incurring more manageable yet more frequent shortages versus incurring no shortages for some period of time resulting in an increased risk of much larger, severe and less manageable shortages at a later date has been performed through the comparison of the alternatives that have been studied in the EIS. The Preferred Alternative proposes more frequent, less severe shortages, reducing the risk of incurring larger more severe shortages at a later date. These analyses included the potential impacts to water deliveries to users within the CAP (Section 4.4.7.1)

IT-6-44 and IT-6-45

Reclamation does not concur with these comments. See response to Comment No. IT-6-6.

IT-6-46 through IT-6-49

Your comment is noted. No change to the Final EIS was necessary. As noted in Section 2.4, the Conservation Before Shortage Alternative includes voluntary, compensated reductions in water use to minimize involuntary shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin. The specific entities that might participate in a voluntary conservation program are unknown. However, for purposes of environmental analyses, it was assumed that the conservation amounts as specified in Section 2.4 would be achieved. Details of the modeling assumptions are presented in Appendix M.

IT-6-50 and IT-6-51

See response to Comment No. G-6-40.

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BCOO-1000

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April 27, 2007

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Re: Comments on the DRAFT Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead - TONTO APACHE TRIBE

Dear Regional Director:

This Firm serves as Special Legal Counsel to the Tonto Apache Tribe ("Tribe") and submits the following comments on the *DRAFT Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* ("DEIS"). The Tribe previously submitted written comments to the Bureau of Reclamation ("Reclamation") on August 31, 2005, and at meetings during scoping for the preparation of the DEIS. Those comments, including attachments, are incorporated here by reference. 1

The Tonto Apache Tribe is located in eastern Arizona on the Tonto Apache Reservation ("Reservation") near Payson, Arizona. The Reservation is 85 acres and does not have an adequate water supply to serve the Reservation. 2

The Tribe has a Central Arizona Project Indian Water Delivery Contract Between the United States and the Tonto Apache Tribe dated December 11, 1980 ("CAP Contract"), a copy of which was previously provided in the Tribe's letter of August 31, 2005. This CAP Contract provides 125 acre-feet of CAP water to the Tribe.

IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 2

River management strategies or decisions which would increase the frequency of shortages or the
participation of others in the shortage pools, or reduce the long-term reliability of the Tribe's CAP water 3
by declarations of a "shortage," and other schemes which manipulate "credits", storage rights, and
exchanges must be avoided. Several of the alternatives described in the DEIS present shortage sharing
scenarios and "conservation" schemes that will substantially reduce the reliability of the Tribe's CAP 4
water supply and will materially injure the right of the Tribe to receive this water supply under its CAP
Contract.

Section 3.21 of the Tribe's CAP Contract defines a **"Time of Shortage" as "a calendar year for which the Secretary determines that a shortage exists pursuant to Section 301(b) of the Basin Project Act, such that there is not sufficient Project Water in that year to supply up to a limit of 309,828 acre feet of water for Indian uses, and up to a limit of 510,000 acre feet of water for non-Indian Municipal and Industrial uses."** Under the Tribe's CAP Contract, deliveries of Project Water
to the Tribe in Times of Shortage may be reduced or terminated in accordance with Section 4.9 of the 5
Tribe's CAP Contract.

It is paramount that the Secretary of Interior ("Secretary") reject the proposed management
strategies for Lake Powell and Lake Mead that would threaten the security or breach the Tribe's CAP 6
Contract or breach the Secretary's trust responsibility to properly manage and protect the Tribe's CAP
water as an Indian Trust Asset.

The Tribe has always understood the terms of the CAP Contract relating to shortage to
mean that delivery of CAP water depends upon the physical situation of the Colorado River and not 7
upon a scheme of management in which some are benefitted while others are not. The Secretary owes
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IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 3

payment of OM&R from the power generation revenues and Lower Colorado River Basin Development Fund under its CAP Contract. 8

The following is a list of the Tribe's primary objections and concerns regarding the DEIS:

1. The DEIS Does Not Discuss How Shortages of the Natural Flow of the Colorado River Will Be Shared from Year to Year Between the Upper Basin and Lower Basin States

The DEIS provides no discussion as to how shortages in the annual natural flow of the Colorado River which is not adequate to meet the 15 m.a.f. of apportionments to the Upper and Lower Basin 9
States will be imposed as between the Upper Basin and Lower Basin. The DEIS must first discuss how shortages would be borne between the Upper Basin and Lower Basin, before discussing the allocation of water that is stored in the Colorado River reservoirs. The Secretary must first look to the annual natural flow of the River to provide the water supply that is to be apportioned. 10

Thereafter, the Secretary may look to the water which is stored in the reservoirs in the Lower Basin to provide the supplemental supply to meet the apportionment entitlements of contractors in the Lower Basin States.

2. The DEIS Cannot Lawfully Place Precedence Upon the Nevada Intake at 1050' Elevation Over the Requirements that the Tribes Receive Their Entitlements from the Colorado River to Provide for Their Permanent Tribal Homelands

The DEIS should not place precedence and limit considerations regarding the mark at which shortages will be declared based upon the location of the State of Nevada's intake at the 1050' elevation 11
in Lake Mead. While Nevada may deepen its intake facilities into Lake Mead to mitigate impacts when a shortage is declared on the River, the Tribes have very few, if any, alternatives to enable them to obtain access to Colorado River water or replacement water supplies to provide for their Permanent Tribal

IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 4

Homelands. The DEIS should consider alternatives for shortage based upon the Secretary's obligation to
protect and make available the Colorado River water supply to the Tribes, and to the long term reliability 12
of the water supply for all contractors with rights to the River. The man-made intake facilities at Lake
Mead for Nevada may be readily altered to correspond with the possibility of shortage, and thus, should
be of little or no concern with regard to the management of the River, as opposed to those who have no
other options.

The Law of the River does not allow the Lower Basin water supply to be managed primarily to 13
serve one State or interest over another. The sole beneficiary of the Lake Mead scenario is Nevada, to
the detriment of others, including the CAP Tribes. The alternatives must be adjusted to provide 14
scenarios with equal consideration of the importance of the delivery of CAP water to the Tribe.

3. The DEIS Erroneously Assumes that the Tribe is a Subcontractor of the Central Arizona Water Conservation District

The DEIS erroneously assumes and conveys that the Tribe is a subcontractor of CAP water under
the Central Arizona Water Conservation District ("CAWCD"), a political arm of the State of Arizona. 15
See Appendix E at E-1, showing the CAWCD as the entitlement holder for all CAP water. On the
contrary, the Tribe has a **direct** contract with the Secretary of Interior for the delivery of its CAP water, 16
and the United States has a **direct** obligation to deliver this water pursuant to the Tribe's contract. *See*
Tribe's CAP Contract. This misstatement should be corrected throughout the DEIS.

Since the Tribe is a direct contractor with the Secretary, it must be treated on a co-equal level
with that of CAWCD and other contractors in other states with direct contracts with the Secretary to 17
receive the waters of the Colorado River. CAWCD also has a direct contract with the Secretary for the
delivery of the non-Indian portion of CAP water and an obligation to repay the cost of the non-Indian 18
portion of the CAP project to the United States.

IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 5

The Tribe's water right to CAP water is a portion of Arizona's equitable apportionment under *Arizona v. California* that must be directly protected by the Secretary as an Indian Trust Asset for the Tribe. 19 The State of Arizona should have an interest in protecting the Tribe's CAP water supply. However, the State's conduct in this matter shows that its sole interest and effort is focused upon committing the Tribe's CAP water supply to non-Indian use, preventing the Tribe from ever using the "wet" water to which the Tribe has a right under its CAP Contract. 20 Its conduct also indicates that the States seeks to take and keep the financial benefits from the CAP water to which the Tribe is entitled, which is presently diverted and unlawfully "converted" to use by the State and other non-Indian interests.

4. Use of Reservoirs to Store and Deliver "Conserved" Colorado River System and Non-System Water

The DEIS, at ES-2, lists one of the purposes of the proposed federal actions as to "[a]llow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions." While this purpose appears to be reasonable and foresightful, the method of implementing this purpose, as proposed in certain of the DEIS alternatives, will result in a wholesale taking of the Tribe's CAP water, and allow the Tribe's water to be committed to use by others. 21 This is a violation of the Law of the River and of the Tribe's CAP water rights which are Indian Trust Assets that must be protected by the Secretary.

"The States [in the Basin States Alternative] propose that the Secretary develop a policy and accounting procedure concerning augmentation, extraordinary conservation, and system efficiency projects, including specific extraordinary conservation projects, tributary conservation projects, introduction of non-Colorado River system water, system efficiency improvements and exchange of non-Colorado River System water. The accounting and recovery process would be referred to as

IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 6

'Intentionally Created Surplus' consistent with the concept that the States will take actions to augment storage of water in the Lower Colorado River Basin. The water would be distributed pursuant to Section II(B)(2) of the Decree and forbearance agreements between the States. The ICS credits may not be created or released without such forbearance agreements." (Appendix at J-11).

However, substantially all, if not all, of these "policy and accounting procedures" are based on a fiction. All of the Colorado River water, natural flow, storage, and surpluses are committed by contracts with the Secretary and the Treaty with the Republic of Mexico. There are no unallocated or uncommitted amounts of Colorado River water possible, including the fictional "Intentionally Created Surplus." The fictional "Intentionally Created Surplus" is actually an attempt to convert the water that is committed to some other use to another entity. 22

Due to its position, the State of Arizona has a particular interest in "conservation" methods for the Colorado River that would preclude the Arizona Tribes from participation. Once the same Colorado River water is labeled "conserved" by a particular party, the party (such as the State of Arizona) will preclude the Tribe from participating in the benefits of the "conserved" Colorado River water. 23

The use of the "conserved" water that will be stored in the reservoirs and claimed exclusively by the State of Arizona (which thereby excludes Arizona Indian Tribe access) will reduce and manipulate the amount of water from the Colorado River and its storage that could be used by the Tribe from year to year to fulfill their CAP water orders. This manipulation of the Colorado River water source to preclude its lawful use by the Tribe is a violation of the Law of the River and a violation of the Tribe's CAP Contract. 24

Furthermore, the States cannot enter into forbearance agreements or shortage sharing agreements amongst themselves where the rights of Arizona Tribes to their share of Arizona's equitable

IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 7

apportionment to the Colorado River would be manipulated by the States. *See e.g.* Appendix J-10
("Arizona and Nevada will share shortages based on a shortage sharing agreement. In the event that no
agreement has been reached, Arizona and Nevada will share shortages in accordance with the 1968
Colorado River Basin Project Act, the Decree, other existing law as applicable, and the Interstate
Banking Agreement between Arizona and Nevada parties."). The participation of the Arizona Tribes in
the forbearance agreements or any other agreements between Arizona and other States, as co-equal water 25
users of Arizona's equitable apportionment, is required by the Law of the River, and by the direct
contracts of the Tribes with the Secretary of Interior.

The proposed alternatives must be revised so that any "conservation" regime used to reduce the
potential conditions which may cause or enable the Secretary to make declarations of shortage on the 26
Colorado River, or used to provide additional waters to Arizona (including Arizona Tribes), include all
Arizona CAP Tribes in the mutual "wet water" and financial benefits of such schemes. Otherwise, the
Tribes will be subject to significant injury as a result of the manipulation schemes in violation of the
Law of the River, and the contractual and constitutional rights of the Tribes.

5. The DEIS Does Not Discuss the Legal Authority for Allowing Credits for Fallowed Lands, Canal Lining and Other "Conservation" Measures

The DEIS does not discuss any legal authority which would permit the States to obtain credits for
"fallowing" lands, canal lining and other measures undertaken to purportedly "conserve" Colorado River
water. Under the law in Arizona, other western States and Federal Reclamation Law, the waters 27
"conserved" by the fallowing of lands and the lining of canals is committed back to the stream flow to be
used by the next water user in the system. *See Phelps Dodge Corp. v. Ariz. Dep't of Water Res.*, 2005
Ariz. App. LEXIS 108 (Ariz. Ct. App. 2005) (observing that water rights in Arizona are ". . .usufructory,
to ensure a maximum beneficial use of Arizona's water resources.") (citing *Clough v. Wing*, 2 Ariz. 371,
379-81, 17 P. 453, 455-56 (Terr. 1888)); *Salt River Valley Water Users' Ass'n v. Kovacovich*, 3. Ariz.

IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 8

App. 28, 411 P.2d 201, 203 (Ariz. Ct. App. 1966) ("any practice, whether through water-saving procedures or otherwise, whereby [a diverter] may in fact reduce the quantity of water actually taken inures to the benefit of other water users and neither creates a right to use the waters saved as a marketable commodity nor the right to apply same to adjacent property having no appurtenant water rights."); Kinney, *Treatise on the Law of Irrigation and Water Rights and the Arid Region*, (2nd Ed. 1912), §782, 783.

The DEIS must discuss what legal authority would permit the States to commit "conserved" water to inure to the benefit of a single party or particular beneficiary, rather than for the use and benefit of **all** users in the Colorado River system under the Law of the River. 28 Furthermore, if such a "conservation" scheme could be lawfully implemented and used to benefit particular parties or beneficiaries, the Tribes must be permitted to participate, and the Secretary must fully support and protect the Tribe's full and unfettered participation and receipt of benefits. 29

6. Use of Surplus by Basin States

The Basin States Alternative also proposes a different scheme for the distribution of surplus. For instance, the Basin States Alternative would "[d]istribute Arizona's share to surplus demands in Arizona including off stream banking and interstate banking demands." *See* Appendix at J-9. The problem is that based upon historical and present practices by Arizona (which is charged with protecting the entire State's equitable apportionment from the Colorado River, including that which is used by the Tribes) the State would nevertheless use this surplus for the benefit of non-Indians, to the exclusion of the Tribes. 30 In fact, the State of Arizona is engaging in this conduct now, through, *inter alia*, the Arizona Water Banking Authority and the interstate water banking agreement with Nevada. The Secretary's approval of the Basin States Alternative would put the weight of authority of the United States behind these wrongful acts by the State of Arizona. 31

IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 9

The Secretary should not select the Basin States Alternative or any other alternative, where it
would exclude Tribes from participation in the arrangements made on the Colorado River during times 32
of surplus. In addition, the Secretary must include the Arizona Tribes and ensure that the Arizona Tribes 33
receive the mutual benefits of surplus on the Colorado River.

7. The DEIS Does Not Provide Adequate Details Regarding the Basin States Proposal for Accounting Policy and Procedure for Intentionally Created Surplus

The DEIS does not provide sufficient detail regarding the alternatives for the accounting policy
and procedure that the Secretary would implement for Intentionally Created Surplus or any other
"conserved" water. Without this detail, it is unclear as to how the CAP Tribes would be permitted to 34
participate in the ICS and the impact of the uses of the ICS upon the Tribes. This should be corrected in
the DEIS.

8. The Arizona Water Settlements Act, P.L. 108-451 Is Not Yet Enforceable

The DEIS' underlying assumption and reliance upon the AWSA as defining the characteristics of
the CAP is premature. *See* DEIS at 4-81. The AWSA is not yet enforceable and may never become 35
enforceable. If so, the DEIS or Final EIS intended to be published by December 2007, will require
immediate revision and further public comment. In addition, the existing DEIS should include an 36
impact analysis which compares the impacts under the present characteristics of the CAP with the
impacts under the characteristics which would exist if the AWSA were to become enforceable.

9. There Is No Misunderstanding As To How Shortages Are To Be Distributed Between CAP Indian and M&I Priority Users Within the CAP

The DEIS states that "prior to the enactment of the AWSA, there were differing views as to how mild shortages would be distributed between CAP Indian and M&I priority users." (DEIS at 4-124). While there may be so-called "differing views", the Tribe's CAP Contract is very clear regarding how

IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 10

shortages are to be implemented as to the Tribe. Furthermore, the AWSA did nothing to clarify how such shortages are shared, because the Tribe's CAP Contract cannot be affected or modified by the AWSA. The DEIS and its underlying assumptions must be changed to reflect and analyze the true nature of the Tribe's CAP entitlement and how shortages within CAP will be implemented as to the Tribe. 37

10. The DEIS Does Not List or Discuss the Impacts to the Tribe's CAP Entitlements

The Tribe has a contractual right to CAP water under a direct contract with the United States. As reflected in the DEIS, the Tribe's CAP Contract could be used to satisfy the Tribe's *Winter's* or federal reserved water rights. Since this water could be used in this way, the DEIS should analyze the impact of the shortage criteria as an Indian Trust Asset. 38 In addition, since the Tribe has a direct contract with the United States on a co-equal basis with CAWCD, the DEIS should analyze the impact of shortage sharing upon the Tribe separately from any analysis of shortages which pertains to other CAP water users. 39

11. The DEIS Fails to Adequately Discuss or Analyze the Impacts of the Alternatives Upon the Tribe

The DEIS finds that "No vested water right of any kind, quantified or unquantified, including federally reserved Indian rights to Colorado River water, rights pursuant to the Consolidated Decree or Congressionally-approved water right settlements utilizing CAP water, will be altered as a result of any of the alternatives under consideration." DEIS at 4-123. This is incorrect. 40

The DEIS erroneously attempts to delineate between a paper water right and wet water. These are one in the same. 41 Whether or not the paper water right becomes wet water is determined by whether or not the law is followed and whether or not the Secretary undertakes actions (or fails to take actions) which diminish the reliability or injure the ability of the Tribe to receive its wet water. The implementation of shortage sharing criteria which would hinder the Tribe's ability to receive the water to

IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 11

which it is entitled, and the selection of an alternative which would permit waters to be "conserved" and
committed to exclusive use by certain parties, alters the reliability of the Tribe's entitlement to CAP
water. The DEIS cannot distinguish between the effect of the alternative upon the legal entitlement of 42
the Tribe versus the effect upon the Tribe's receipt of the wet waters pursuant to the legal entitlement.

The DEIS proposes alternatives which will impact and diminish the reliability of the CAP water 43
supply and thus, injure the ability of the Tribe to receive the wet water to which it is entitled. The
Secretary is charged with the responsibility to implement shortage sharing criteria which protect the
Tribe's receipt of the CAP water supply which is an Indian Trust Asset. The DEIS must analyze the
impacts upon the Tribe's receipt of the water to which it is entitled, and not merely make a statement 44
that the alternatives will have "no effect" upon the Tribe's legal entitlement to the CAP water. A policy
which proclaims no impact on the Tribe's legal entitlement which results in **no wet water** to fulfill its
entitlement is deceptive and amounts to invidious discrimination. The DEIS' avoidance of discussing 45
the true impact of the alternatives upon the Tribe must be corrected.

12. The DEIS Fails to Discuss How "Voluntary" Shortages Would Be Implemented and Their Resultant Effect Upon the Tribe and Its Right to CAP Water

The DEIS mentions that certain "voluntary" shortages could be implemented. DEIS at 4-12. 46
However, the DEIS is unclear as to who would agree to such voluntary shortages. The Secretary cannot 47
permit the State of Arizona to decide whether or not it would enter into a voluntary shortage, where such
shortage would diminish the reliability of the Tribe's CAP water. This is simply unlawful. Furthermore,
the Secretary cannot allow other states to enter into "voluntary" shortages and alternative River
management schemes that would create conditions where the Tribes were required to bear shortages that 48
would not otherwise be borne, absent such voluntary agreements or schemes. The DEIS fails to discuss

IT-7

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 12

this in any detail. The DEIS should be revised for clarity and to provide a meaningful analysis of the impacts of the proposed "voluntary" shortages to the Tribe's receipt of its CAP water supply. 49

13. The DEIS Fails to Discuss the Potential Impact of Any of the Alternatives on Water Quality or Quantity to Which the Republic of Mexico is Entitled Under Treaty

The DEIS fails to discuss the ongoing and potential environmental impacts of any of the alternatives on the Colorado River delta, including wet lands, and the fact that the delta is one of the primary marine nurseries supporting aquatic life, fisheries and migratory wildlife subject to international treaties, and the ultimate fish production and annual catch allocated among countries of the Pacific Rim. 50 The alternatives proposed by the DEIS, with the increase in use of the Colorado River proposed by the alternatives, including the Basin States Alternative, will undoubtedly impact the delta. 51

Please continue to keep this Firm on your mailing list for all future communications and documents related to this matter.

Yours Truly,

THE SPARKS LAW FIRM, P.C.

Robyn L. Interpreter

RLI/rli

cc: Ivan Smith, Chairman
Kenny Davis, Vice-Chairman
Council Members

I:\INDIAN\TONTO\CAP\GENERAL CAP MATTERS\ltr to sec on DEIS.wpd

IT-7

Reponses to Comment Letter IT-7

IT-7-1 and IT-7-2

Your comment is noted. No change to the Final EIS was necessary.

IT-7-3

Your comment is noted. No change to the Final EIS was necessary.

IT-7-4

See response to Comment No. IT-6-4.

IT-7-5

Your comment is noted. No change to the Final EIS was necessary.

IT-7-6

See response to Comment No. IT-6-6.

IT-7-7

See response to Comment No. IT-6-7.

IT-7-8

See response to Comment No. IT-6-6.

IT-7-9 and IT-7-10

See responses to Comment Nos. IT-6-9 and IT-6-10.

IT-7-11 through IT-7-14

See responses to Comment Nos. IT-6-11 through IT-6-14.

IT-7-15 and IT-7-16

Your comment is noted. No change to the Final EIS was necessary. Table E-1 in Appendix E lists Arizona water entitlement holders and priorities and aggregates all CAP water contracts into one entry under the heading Central Arizona Water Conservation District (CAP) for presentation purposes only. It was not intended to suggest that CAP contracts with the Secretary were subcontracts with CAWCD. Reclamation concurs that the Tribe's CAP contract is a two-party contract between the Nation and the Secretary. In the Final EIS, Appendix G was modified to more clearly explain the CAP framework (Section G.4.8). In the Final EIS, Table G-3 shows the

CAP entitlements by priority and Table G-4 shows the CAP priority 2 Indian entitlements by sub-priority. Both tables clearly show the Tonto-Apache entitlement.

IT-7-17 and IT-18

See responses to Comment Nos. IT-6-17 and IT-6-18.

IT-7-19

See response to Comment No. IT-6-6.

IT-7-20

See response to Comment No. IT-6-20.

IT-7-21

See response to Comment No. IT-6-21.

IT-7-22 through IT-7-24

Reclamation does not concur with these comments. See response to Comment No. IT-6-21.

IT-7-25 and IT-7-26

See responses to Comment Nos. IT-6-25 and IT-6-26.

IT-7-27

See response to Comment No. IT-6-25.

IT-7-28

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. IT-6-25.

IT-7-29

See response to Comment No. IT-6-25.

IT-7-30 through IT-7-32

See responses to Comment Nos. IT-6-30 through IT-6-32.

IT-7-33

See response to Comment No. G-6-33.

IT-7-34

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. IT-6-25.

IT-7-35 and IT-7-36

See responses to Comment Nos. IT-6-35 and IT-6-36.

IT-7-37

Your comment is noted. No change to the Final EIS was necessary. The Tonto-Apache Tribe is not affected by the shortage-sharing compromise in the AWSA (Section 4.4.7.1) because the compromise affects those entities within the M&I/Indian category with entitlements less firm than the Tribe's entitlements.

IT-7-38

Reclamation does not concur with this comment. See response to Comment No. IT-6-38.

IT-7-39

Your comment is noted. No change to the Final EIS was necessary. However, based on the modeling assumptions used to distribute shortages to CAP users, the shortage to the Tribe would be the same whether analyzed separately or included as part of the analysis with other CAP contractors. Appendix G (Attachment B) provides the modeled shortages to the Tribe for a range of shortages for selected years.

IT-7-40 through IT-7-42

See response to Comment No. IT-6-40 through Comment No. IT-6-42.

IT-7-43

See response to Comment No. IT-6-43.

IT-7-44 through IT-7-45

Reclamation does not concur with this comment. See response to Comment No. IT-6-6.

IT-7-46 through IT-7-49

See response to Comment No. IT-6-46 through Comment No. IT-6-49.

IT-7-50 and IT-7-51

See response to Comment No. IT-6-50 and Comment No. IT-6-51.

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April 27, 2007

Via U.S. Mail Certified - Return Receipt Requested
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BUREAU OF RECLAMATION
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P.O. Box 61470
Boulder City, Nevada 89006-1470

Re: Comments on the DRAFT Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead - PASCUA YAQUI TRIBE

Dear Regional Director:

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The Pascua Yaqui Tribe is located in southeastern Arizona near Tucson, Arizona. The Reservation does not have an adequate water supply to serve the Reservation. 2

The Tribe has a Central Arizona Project Indian Water Delivery Contract Between the United States and the Pascua Yaqui Tribe dated December 11, 1980 ("CAP Contract"), a copy of which was previously provided in the Tribe's letter of August 31, 2005. This CAP Contract provides 500 acre-feet of CAP water to the Tribe.

IT-8

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 2

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IT-8

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 3

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IT-8

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 4

Homelands. The DEIS should consider alternatives for shortage based upon the Secretary's obligation to protect and make available the Colorado River water supply to the Tribes, and to the long term reliability of the water supply for all contractors with rights to the River. 12 The man-made intake facilities at Lake Mead for Nevada may be readily altered to correspond with the possibility of shortage, and thus, should be of little or no concern with regard to the management of the River, as opposed to those who have no other options.

The Law of the River does not allow the Lower Basin water supply to be managed primarily to serve one State or interest over another. The sole beneficiary of the Lake Mead scenario is Nevada, to the detriment of others, including the CAP Tribes. 13 The alternatives must be adjusted to provide scenarios with equal consideration of the importance of the delivery of CAP water to the Tribe. 14

3. The DEIS Erroneously Assumes that the Tribe is a Subcontractor of the Central Arizona Water Conservation District

The DEIS erroneously assumes and conveys that the Tribe is a subcontractor of CAP water under the Central Arizona Water Conservation District ("CAWCD"), a political arm of the State of Arizona. *See* Appendix E at E-1, showing the CAWCD as the entitlement holder for all CAP water. 15 On the contrary, the Tribe has a **direct** contract with the Secretary of Interior for the delivery of its CAP water, and the United States has a **direct** obligation to deliver this water pursuant to the Tribe's contract. *See* Tribe's CAP Contract. This misstatement should be corrected throughout the DEIS. 16

Since the Tribe is a direct contractor with the Secretary, it must be treated on a co-equal level with that of CAWCD and other contractors in other states with direct contracts with the Secretary to receive the waters of the Colorado River. 17 CAWCD also has a direct contract with the Secretary for the delivery of the non-Indian portion of CAP water and an obligation to repay the cost of the non-Indian portion of the CAP project to the United States. 18

IT-8

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 5

The Tribe's water right to CAP water is a portion of Arizona's equitable apportionment under *Arizona v. California* that must be directly protected by the Secretary as an Indian Trust Asset for the Tribe. The State of Arizona should have an interest in protecting the Tribe's CAP water supply. 19 However, the State's conduct in this matter shows that its sole interest and effort is focused upon committing the Tribe's CAP water supply to non-Indian use, preventing the Tribe from ever using the "wet" water to which the Tribe has a right under its CAP Contract. Its conduct also indicates that the States seeks to take and keep the financial benefits from the CAP water to which the Tribe is entitled, which is presently diverted and unlawfully "converted" to use by the State and other non-Indian interests. 20

4. Use of Reservoirs to Store and Deliver "Conserved" Colorado River System and Non-System Water

The DEIS, at ES-2, lists one of the purposes of the proposed federal actions as to "[a]llow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions." While this purpose appears to be reasonable and foresightful, the method of implementing this purpose, as proposed in certain of the DEIS alternatives, will result in a wholesale taking of the Tribe's CAP water, and allow the Tribe's water to be committed to use by others. This is a violation of the Law of the River and of the Tribe's CAP water rights which are Indian Trust Assets that must be protected by the Secretary. 21

"The States [in the Basin States Alternative] propose that the Secretary develop a policy and accounting procedure concerning augmentation, extraordinary conservation, and system efficiency projects, including specific extraordinary conservation projects, tributary conservation projects, introduction of non-Colorado River system water, system efficiency improvements and exchange of non-Colorado River System water. The accounting and recovery process would be referred to as

IT-8

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 6

'Intentionally Created Surplus' consistent with the concept that the States will take actions to augment storage of water in the Lower Colorado River Basin. The water would be distributed pursuant to Section II(B)(2) of the Decree and forbearance agreements between the States. The ICS credits may not be created or released without such forbearance agreements." (Appendix at J-11).

However, substantially all, if not all, of these "policy and accounting procedures" are based on a fiction. All of the Colorado River water, natural flow, storage, and surpluses are committed by contracts with the Secretary and the Treaty with the Republic of Mexico. There are no unallocated or uncommitted amounts of Colorado River water possible, including the fictional "Intentionally Created Surplus." The fictional "Intentionally Created Surplus" is actually an attempt to convert the water that is committed to some other use to another entity. 22

Due to its position, the State of Arizona has a particular interest in "conservation" methods for the Colorado River that would preclude the Arizona Tribes from participation. Once the same Colorado River water is labeled "conserved" by a particular party, the party (such as the State of Arizona) will preclude the Tribe from participating in the benefits of the "conserved" Colorado River water. 23

The use of the "conserved" water that will be stored in the reservoirs and claimed exclusively by the State of Arizona (which thereby excludes Arizona Indian Tribe access) will reduce and manipulate the amount of water from the Colorado River and its storage that could be used by the Tribe from year to year to fulfill their CAP water orders. This manipulation of the Colorado River water source to preclude its lawful use by the Tribe is a violation of the Law of the River and a violation of the Tribe's CAP Contract. 24

Furthermore, the States cannot enter into forbearance agreements or shortage sharing agreements amongst themselves where the rights of Arizona Tribes to their share of Arizona's equitable

IT-8

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 7

apportionment to the Colorado River would be manipulated by the States. *See e.g.* Appendix J-10 ("Arizona and Nevada will share shortages based on a shortage sharing agreement. In the event that no agreement has been reached, Arizona and Nevada will share shortages in accordance with the 1968 Colorado River Basin Project Act, the Decree, other existing law as applicable, and the Interstate Banking Agreement between Arizona and Nevada parties."). The participation of the Arizona Tribes in the forbearance agreements or any other agreements between Arizona and other States, as co-equal water users of Arizona's equitable apportionment, is required by the Law of the River, and by the direct contracts of the Tribes with the Secretary of Interior. 25

The proposed alternatives must be revised so that any "conservation" regime used to reduce the potential conditions which may cause or enable the Secretary to make declarations of shortage on the Colorado River, or used to provide additional waters to Arizona (including Arizona Tribes), include all Arizona CAP Tribes in the mutual "wet water" and financial benefits of such schemes. Otherwise, the Tribes will be subject to significant injury as a result of the manipulation schemes in violation of the Law of the River, and the contractual and constitutional rights of the Tribes. 26

5. The DEIS Does Not Discuss the Legal Authority for Allowing Credits for Fallowed Lands, Canal Lining and Other "Conservation" Measures

The DEIS does not discuss any legal authority which would permit the States to obtain credits for "fallowing" lands, canal lining and other measures undertaken to purportedly "conserve" Colorado River water. Under the law in Arizona, other western States and Federal Reclamation Law, the waters "conserved" by the fallowing of lands and the lining of canals is committed back to the stream flow to be used by the next water user in the system. *See Phelps Dodge Corp. v. Ariz. Dep't of Water Res.*, 2005 Ariz. App. LEXIS 108 (Ariz. Ct. App. 2005) (observing that water rights in Arizona are ". . .usufructory, to ensure a maximum beneficial use of Arizona's water resources.") (citing *Clough v. Wing*, 2 Ariz. 371, 379-81, 17 P. 453, 455-56 (Terr. 1888)); *Salt River Valley Water Users' Ass'n v. Kovacovich*, 3. Ariz. 27

IT-8

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 8

App. 28, 411 P.2d 201, 203 (Ariz. Ct. App. 1966) ("any practice, whether through water-saving procedures or otherwise, whereby [a diverter] may in fact reduce the quantity of water actually taken inures to the benefit of other water users and neither creates a right to use the waters saved as a marketable commodity nor the right to apply same to adjacent property having no appurtenant water rights."); Kinney, *Treatise on the Law of Irrigation and Water Rights and the Arid Region*, (2nd Ed. 1912), §782, 783.

The DEIS must discuss what legal authority would permit the States to commit "conserved"
water to inure to the benefit of a single party or particular beneficiary, rather than for the use and benefit 28
of **all** users in the Colorado River system under the Law of the River. Furthermore, if such a
"conservation" scheme could be lawfully implemented and used to benefit particular parties or 29
beneficiaries, the Tribes must be permitted to participate, and the Secretary must fully support and
protect the Tribe's full and unfettered participation and receipt of benefits.

6. Use of Surplus by Basin States

The Basin States Alternative also proposes a different scheme for the distribution of surplus. For
instance, the Basin States Alternative would "[d]istribute Arizona's share to surplus demands in Arizona
including off stream banking and interstate banking demands." *See* Appendix at J-9. The problem is 30
that based upon historical and present practices by Arizona (which is charged with protecting the entire
State's equitable apportionment from the Colorado River, including that which is used by the Tribes) the
State would nevertheless use this surplus for the benefit of non-Indians, to the exclusion of the Tribes.
In fact, the State of Arizona is engaging in this conduct now, through, *inter alia*, the Arizona Water
Banking Authority and the interstate water banking agreement with Nevada. The Secretary's approval of 31
the Basin States Alternative would put the weight of authority of the United States behind these
wrongful acts by the State of Arizona.

IT-8

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 9

The Secretary should not select the Basin States Alternative or any other alternative, where it would exclude Tribes from participation in the arrangements made on the Colorado River during times 32 of surplus. In addition, the Secretary must include the Arizona Tribes and ensure that the Arizona Tribes 33 receive the mutual benefits of surplus on the Colorado River.

7. The DEIS Does Not Provide Adequate Details Regarding the Basin States Proposal for Accounting Policy and Procedure for Intentionally Created Surplus

The DEIS does not provide sufficient detail regarding the alternatives for the accounting policy and procedure that the Secretary would implement for Intentionally Created Surplus or any other "conserved" water. Without this detail, it is unclear as to how the CAP Tribes would be permitted to 34 participate in the ICS and the impact of the uses of the ICS upon the Tribes. This should be corrected in the DEIS.

8. The Arizona Water Settlements Act, P.L. 108-451 Is Not Yet Enforceable

The DEIS' underlying assumption and reliance upon the AWSA as defining the characteristics of the CAP is premature. *See* DEIS at 4-81. The AWSA is not yet enforceable and may never become 35 enforceable. If so, the DEIS or Final EIS intended to be published by December 2007, will require immediate revision and further public comment. In addition, the existing DEIS should include an 36 impact analysis which compares the impacts under the present characteristics of the CAP with the impacts under the characteristics which would exist if the AWSA were to become enforceable.

9. There Is No Misunderstanding As To How Shortages Are To Be Distributed Between CAP Indian and M&I Priority Users Within the CAP

The DEIS states that "prior to the enactment of the AWSA, there were differing views as to how mild shortages would be distributed between CAP Indian and M&I priority users." (DEIS at 4-124).

IT-8

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 10

While there may be so-called "differing views", the Tribe's CAP Contract is very clear regarding how shortages are to be implemented as to the Tribe. Furthermore, the AWSA did nothing to clarify how such shortages are shared, because the Tribe's CAP Contract cannot be affected or modified by the AWSA. The DEIS and its underlying assumptions must be changed to reflect and analyze the true nature of the Tribe's CAP entitlement and how shortages within CAP will be implemented as to the Tribe. 37

10. The DEIS Does Not List or Discuss the Impacts to the Tribe's CAP Entitlements

The Tribe has a contractual right to CAP water under a direct contract with the United States. As reflected in the DEIS, the Tribe's CAP Contract could be used to satisfy the Tribe's *Winter's* or federal reserved water rights. Since this water could be used in this way, the DEIS should analyze the impact of the shortage criteria as an Indian Trust Asset. 38 In addition, since the Tribe has a direct contract with the United States on a co-equal basis with CAWCD, the DEIS should analyze the impact of shortage sharing upon the Tribe separately from any analysis of shortages which pertains to other CAP water users. 39

11. The DEIS Fails to Adequately Discuss or Analyze the Impacts of the Alternatives Upon the Tribe

The DEIS finds that "No vested water right of any kind, quantified or unquantified, including federally reserved Indian rights to Colorado River water, rights pursuant to the Consolidated Decree or Congressionally-approved water right settlements utilizing CAP water, will be altered as a result of any of the alternatives under consideration." DEIS at 4-123. This is incorrect. 40

The DEIS erroneously attempts to delineate between a paper water right and wet water. These are one in the same. 41 Whether or not the paper water right becomes wet water is determined by whether or not the law is followed and whether or not the Secretary undertakes actions (or fails to take actions) which diminish the reliability or injure the ability of the Tribe to receive its wet water. The

IT-8

implementation of shortage sharing criteria which would hinder the Tribe's ability to receive the water to
which it is entitled, and the selection of an alternative which would permit waters to be "conserved" and
committed to exclusive use by certain parties, alters the reliability of the Tribe's entitlement to CAP
water. The DEIS cannot distinguish between the effect of the alternative upon the legal entitlement of 42
the Tribe versus the effect upon the Tribe's receipt of the wet waters pursuant to the legal entitlement.

The DEIS proposes alternatives which will impact and diminish the reliability of the CAP water
supply and thus, injure the ability of the Tribe to receive the wet water to which it is entitled. The 43
Secretary is charged with the responsibility to implement shortage sharing criteria which protect the
Tribe's receipt of the CAP water supply which is an Indian Trust Asset. The DEIS must analyze the
impacts upon the Tribe's receipt of the water to which it is entitled, and not merely make a statement 44
that the alternatives will have "no effect" upon the Tribe's legal entitlement to the CAP water. A policy
which proclaims no impact on the Tribe's legal entitlement which results in **no wet water** to fulfill its
entitlement is deceptive and amounts to invidious discrimination. The DEIS' avoidance of discussing 45
the true impact of the alternatives upon the Tribe must be corrected.

12. The DEIS Fails to Discuss How "Voluntary" Shortages Would Be Implemented and Their Resultant Effect Upon the Tribe and Its Right to CAP Water

The DEIS mentions that certain "voluntary" shortages could be implemented. DEIS at 4-12. 46
However, the DEIS is unclear as to who would agree to such voluntary shortages. The Secretary cannot
permit the State of Arizona to decide whether or not it would enter into a voluntary shortage, where such 47
shortage would diminish the reliability of the Tribe's CAP water. This is simply unlawful. Furthermore,
the Secretary cannot allow other states to enter into "voluntary" shortages and alternative River 48
management schemes that would create conditions where the Tribes were required to bear shortages that

IT-8

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 12

would not otherwise be borne, absent such voluntary agreements or schemes. The DEIS fails to discuss this in any detail. The DEIS should be revised for clarity and to provide a meaningful analysis of the impacts of the proposed "voluntary" shortages to the Tribe's receipt of its CAP water supply. 49

13. The DEIS Fails to Discuss the Potential Impact of Any of the Alternatives on Water Quality or Quantity to Which the Republic of Mexico is Entitled Under Treaty

The DEIS fails to discuss the potential and ongoing environmental impacts of any of the alternatives on the Colorado River delta, including wet lands, and the fact that the delta is one of the primary marine nurseries supporting aquatic life, fisheries and migratory wildlife subject to international treaties, and the ultimate fish production and annual catch allocated among countries of the Pacific Rim. The alternatives proposed by the DEIS, with the increase in use of the Colorado River proposed by the alternatives, including the Basin States Alternative, will undoubtedly impact the delta. 50

Please continue to keep this Firm on your mailing list for all future communications and documents related to this matter. 51

Yours Truly,

THE SPARKS LAW FIRM, P.C.

Robyn L. Interpreter

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RLI/rli

cc: Herminia Frias, Chairwoman
Peter Yucupicio, Vice-Chairman
Council Members
Justin Ruggieri, Interim Attorney General
Pilar Thomas, Assistant to Chairwoman

I:\INDIAN\PASCUA YAQUI\CAP\ltr to sec on DEIS.wpd

IT-8

Reponses to Comment Letter IT-8

IT-8-1 and IT-8-2

Your comment is noted. No change to the Final EIS was necessary.

IT-8-3

Your comment is noted. No change to the Final EIS was necessary.

IT-8-4

See response to Comment No. IT-6-4.

IT-8-5

Your comment is noted. No change to the Final EIS was necessary..

IT-8-6

See response to Comment No. IT-6-6.

IT-8-7

See response to Comment No. IT-6-7.

IT-8-8

See response to Comment No. IT-6-6.

IT-8-9 and IT-8-10

See responses to Comment Nos. IT-6-9 and IT-6-10..

IT-8-11 through IT-8-14

See responses to Comment Nos. IT-6-11 through IT-6-14.

IT-8-15 and IT-8-16

Your comment is noted. No change to the Final EIS was necessary. Table E-1 in Appendix E lists Arizona water entitlement holders and priorities and aggregates all CAP water contracts into one entry under the heading Central Arizona Water Conservation District (CAP) for presentation purposes only. It was not intended to suggest that CAP contracts with the Secretary were subcontracts with CAWCD. Reclamation concurs that the Tribe's CAP contract is a two-party contract between the Nation and the Secretary. In the Final EIS, Appendix G was modified to more clearly explain the CAP framework (Section G.4.8). In the Final EIS, Table G-3 shows the

CAP entitlements by priority and Table G-4 shows the CAP priority 2 Indian entitlements by sub-priority. Both tables clearly show the Pascua Yaqui entitlement.

IT-8-17 and IT-8-18

Your comment is noted. No change to the Final EIS was necessary.

IT-8-19

See response to Comment No. IT-6-6.

IT-8-20

Your comment is noted. No change to the Final EIS was necessary.

IT-8-21

See response to Comment No. IT-6-21.

IT-8-22 through IT-8-24

Reclamation does not concur with these comments. See response to Comment No. IT-6-21.

IT-8-25 and IT-8-26

See responses to Comment Nos. IT-6-25 and IT-6-26.

IT-8-27

See response to Comment No. IT-6-25.

IT-8-28

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. IT-6-25.

IT-8-29

See response to Comment No. IT-6-25.

IT-8-30 through IT-8-32

See responses to Comment Nos. IT-6-30 through IT-6-32.

IT-8-33

See response to Comment No. G-6-33.

IT-8-34

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. IT-6-25.

IT-8-35 and IT-8-36

See responses to Comment Nos. IT-6-35 and IT-6-36.

IT-8-37

Your comment is noted. No change to the Final EIS was necessary. The Pasqua Yaqui Tribe is not affected by the shortage-sharing compromise in the AWSA (Section 4.4.7.1) because the compromise affects those entities within the M&I/Indian category with entitlements less firm than the Tribe's entitlement.

IT-8-38

Reclamation does not concur with this comment. See response to Comment No. IT-6-38.

IT-8-39

Your comment is noted. No change to the Final EIS was necessary. However, based on the modeling assumptions used to distribute shortages to CAP users, the shortage to the Tribe would be the same whether analyzed separately or included as part of the analysis with other CAP contractors. Appendix G (Attachment B) provides the modeled shortages to the Tribe for a range of shortages for selected years.

IT-8-40 through IT-8-42

See responses to Comment No. IT-6-40 through IT-6-42.

IT-8-43

See response to Comment No. IT-6-43.

IT-8-44 through IT-8-45

Reclamation does not concur with this comment. See response to Comment No. IT-6-6.

IT-8-46 through IT-8-49

See responses to Comment Nos. IT-6-46 through IT-6-49.

IT-8-50 and IT-8-51

See responses to Comment Nos. IT-6-50 and IT-6-51.

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4/30/07

April 27, 2007

Via U.S. Mail Certified - Return Receipt Requested
7006 0810 0000 6725 0822

BUREAU OF RECLAMATION
ATTN: BCOO-1000
P.O. Box 61470
Boulder City, Nevada 89006-1470

Re: Comments on the DRAFT Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead - SAN CARLOS APACHE TRIBE

Dear Regional Director:

This Firm serves as Special Legal Counsel to the San Carlos Apache Tribe ("Tribe") and submits the following comments on the *DRAFT Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*
("DEIS"). The Tribe previously submitted written comments to the Bureau of Reclamation
("Reclamation") on August 31, 2005, and at meetings during scoping for the preparation of the DEIS. 1
Those comments, including attachments, are incorporated here by reference.

The San Carlos Apache Tribe is located in east-central Arizona on the San Carlos Apache
Reservation ("Reservation"). The Reservation is approximately 2 million acres, is largely arid, and still
does not have an adequate water supply to serve the Reservation, though it is located along the Black 2
River, Salt River and Gila River, to name a few.

Pursuant to the San Carlos Apache Tribe Water Rights Settlement Act of 1992, 106 Stat. 4740 ("Settlement Act"), the Tribe settled a portion of its water rights claims. Under the Settlement Act, the settling parties, including the United States, entered into the San Carlos Apache Tribe Water Rights Settlement Agreement, dated March 30, 1999, as amended ("Settlement Agreement"). The Settlement

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 2

Act and Settlement Agreement confirm certain water rights for the Tribe, including, *inter alia*, rights to 64,145 acre-feet of Central Arizona Project ("CAP") water. *See* Settlement Act at 106 Stat. 4740, 4742-4747 and Settlement Agreement at Sections 9-12.

The Tribe has a Central Arizona Project Indian Water Delivery Contract Between the United States and the San Carlos Apache Tribe dated December 11, 1980 ("CAP Contract"), a copy of which was previously provided in the Tribe's letter of August 31, 2005. This CAP Contract originally allocated 12,700 acre-feet of CAP water to the Tribe. The Tribe's CAP Contract was subsequently amended to include the additional 51,445 acre-feet of CAP water allocated to the Tribe under the Settlement Act. The Tribe agreed to settle a portion of its water rights claims in valuable consideration and return for, *inter alia*, this additional allocation of CAP water and CAP construction funds to pay for the exchange and delivery systems to enable the Tribe to receive and use its CAP entitlement on the Reservation. The allocation of CAP water to the Tribe pursuant to the Settlement Act and Settlement Agreement are trust assets of the Tribe which the Secretary of Interior has a specific trust responsibility to manage and protect. *See* 512 DM 2.2 (Dec. 1995); *see also*, Secretarial Order 3215, April 28, 2000.

River management strategies or decisions which would increase the frequency of shortages or the
participation of others in the shortage pools, or reduce the long-term reliability of the Tribe's CAP water 3
by declarations of a "shortage," and other schemes which manipulate "credits", storage rights, and
exchanges must be avoided. Several of the alternatives described in the DEIS present shortage sharing
scenarios and "conservation" schemes that will substantially reduce the reliability of the Tribe's CAP 4
water supply and will materially injure the right of the Tribe to receive this water supply under the 1992
Settlement Act and Agreement.

Section 3.21 of the Tribe's CAP Contract defines a **"Time of Shortage" as "a calendar year for which the Secretary determines that a shortage exists pursuant to Section 301(b) of the Basin**

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 3

Project Act, such that there is not sufficient Project Water in that year to supply up to a limit of 309,828 acre feet of water for Indian uses, and up to a limit of 510,000 acre feet of water for non-Indian Municipal and Industrial uses." Under the Tribe's CAP Contract, deliveries of Project Water to the Tribe in Times of Shortage may be reduced or terminated in accordance with Section 4.9 of the 5
Tribe's CAP Contract.

It is paramount that the Secretary of Interior ("Secretary") reject the proposed management strategies for Lake Powell and Lake Mead that would threaten the security or breach the Tribe's CAP 6
Contract or breach the Secretary's trust responsibility to properly manage and protect the Tribe's CAP water as an Indian Trust Asset.

The Tribe has always understood the terms of the CAP Contract relating to shortage to mean that delivery of CAP water depends upon the physical situation of the Colorado River and not upon a scheme 7
of management in which some are benefitted while others are not. The Secretary owes the Tribe a trust duty to refrain from implementing management strategies which interfere with the Tribe's contractual 8
rights and expectation of delivery of CAP water and funding for construction and the payment of OM&R from the power generation revenues and Lower Colorado River Basin Development Fund under its CAP Contract and the 1992 Settlement Act and Agreement.

The following is a list of the Tribe's primary objections and concerns regarding the DEIS:

1. The DEIS Does Not Discuss How Shortages of the Natural Flow of the Colorado River Will Be Shared from Year to Year Between the Upper Basin and Lower Basin States

The DEIS provides no discussion as to how shortages in the annual natural flow of the Colorado River which is not adequate to meet the 15 m.a.f. of apportionments to the Upper and Lower Basin 9
States will be imposed as between the Upper Basin and Lower Basin. The DEIS must first discuss how 10

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 4

shortages would be borne between the Upper Basin and Lower Basin, before discussing the allocation of water that is stored in the Colorado River reservoirs. The Secretary must first look to the annual natural flow of the River to provide the water supply that is to be apportioned. 10

Thereafter, the Secretary may look to the water which is stored in the reservoirs in the Lower Basin to provide the supplemental supply to meet the apportionment entitlements of contractors in the Lower Basin States.

2. The DEIS Cannot Lawfully Place Precedence Upon the Nevada Intake at 1050' Elevation Over the Requirements that the Tribes Receive Their Entitlements from the Colorado River to Provide for Their Permanent Tribal Homelands

The DEIS should not place precedence and limit considerations regarding the mark at which shortages will be declared based upon the location of the State of Nevada's intake at the 1050' elevation 11 in Lake Mead. While Nevada may deepen its intake facilities into Lake Mead to mitigate impacts when a shortage is declared on the River, the Tribes have very few, if any, alternatives to enable them to obtain access to Colorado River water or replacement water supplies to provide for their Permanent Tribal Homelands. The DEIS should consider alternatives for shortage based upon the Secretary's obligation to protect and make available the Colorado River water supply to the Tribes, and to the long term reliability 12 of the water supply for all contractors with rights to the River. The man-made intake facilities at Lake Mead for Nevada may be readily altered to correspond with the possibility of shortage, and thus, should be of little or no concern with regard to the management of the River, as opposed to those who have no other options.

The Law of the River does not allow the Lower Basin water supply to be managed primarily to serve one State or interest over another. 13 The sole beneficiary of the Lake Mead scenario is Nevada, to the detriment of others, including the CAP Tribes. The alternatives must be adjusted to provide 14 scenarios with equal consideration of the importance of the delivery of CAP water to the Tribe.

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 5

3. The DEIS Erroneously Assumes that the Tribe is a Subcontractor of the Central Arizona Water Conservation District

The DEIS erroneously assumes and conveys that the Tribe is a subcontractor of CAP water under
the Central Arizona Water Conservation District ("CAWCD"), a political arm of the State of Arizona. 15
See Appendix E at E-1, showing the CAWCD as the entitlement holder for all CAP water. On the
contrary, the Tribe has a **direct** contract with the Secretary of Interior for the delivery of its CAP water, 16
and the United States has a **direct** obligation to deliver this water pursuant to the Tribe's contract. *See*
Tribe's CAP Contract. This misstatement should be corrected throughout the DEIS.

Since the Tribe is a direct contractor with the Secretary, it must be treated on a co-equal level
with that of CAWCD and other contractors in other states with direct contracts with the Secretary to 17
receive the waters of the Colorado River. CAWCD also has a direct contract with the Secretary for the
delivery of the non-Indian portion of CAP water and an obligation to repay the cost of the non-Indian 18
portion of the CAP project to the United States.

The Tribe's water right to CAP water is a portion of Arizona's equitable apportionment under
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Tribe. The State of Arizona should have an interest in protecting the Tribe's CAP water supply.
However, the State's conduct in this matter shows that its sole interest and effort is focused upon
committing the Tribe's CAP water supply to non-Indian use, preventing the Tribe from ever using the
"wet" water to which the Tribe has a right under its CAP Contract, as well as the 1992 Settlement Act 20
and Agreement. Its conduct also indicates that the States seeks to take and keep the financial benefits
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"converted" to use by the State and other non-Indian interests.

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 6

4. Use of Reservoirs to Store and Deliver "Conserved" Colorado River System and Non-System Water

The DEIS, at ES-2, lists one of the purposes of the proposed federal actions as to "[a]llow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions." While this purpose appears to be reasonable and foresightful, the method of implementing this purpose, as proposed in certain of the DEIS alternatives, will result in a wholesale taking of the Tribe's CAP water, and allow the Tribe's water to be committed to use by others. This is a violation of the Law of the River and of the Tribe's CAP water rights which are Indian Trust Assets that must be protected by the Secretary. 21

"The States [in the Basin States Alternative] propose that the Secretary develop a policy and accounting procedure concerning augmentation, extraordinary conservation, and system efficiency projects, including specific extraordinary conservation projects, tributary conservation projects, introduction of non-Colorado River system water, system efficiency improvements and exchange of non-Colorado River System water. The accounting and recovery process would be referred to as 'Intentionally Created Surplus' consistent with the concept that the States will take actions to augment storage of water in the Lower Colorado River Basin. The water would be distributed pursuant to Section II(B)(2) of the Decree and forbearance agreements between the States. The ICS credits may not be created or released without such forbearance agreements." (Appendix at J-11).

However, substantially all, if not all, of these "policy and accounting procedures" are based on a fiction. All of the Colorado River water, natural flow, storage, and surpluses are committed by contracts with the Secretary and the Treaty with the Republic of Mexico. There are no unallocated or uncommitted amounts of Colorado River water possible, including the fictional "Intentionally Created 22

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 7

Surplus." The fictional "Intentionally Created Surplus" is actually an attempt to convert the water that is committed to some other use to another entity. 22

Due to its position, the State of Arizona has a particular interest in "conservation" methods for the Colorado River that would preclude the Arizona Tribes from participation. Once the same Colorado River water is labeled "conserved" by a particular party, the party (such as the State of Arizona) will preclude the Tribe from participating in the benefits of the "conserved" Colorado River water. 23

The use of the "conserved" water that will be stored in the reservoirs and claimed exclusively by the State of Arizona (which thereby excludes Arizona Indian Tribe access) will reduce and manipulate the amount of water from the Colorado River and its storage that could be used by the Tribe from year to year to fulfill their CAP water orders. This manipulation of the Colorado River water source to preclude its lawful use by the Tribe is a violation of the Law of the River and a violation of the Tribe's 1992 Settlement Act and Agreement and CAP Contract. 24

Furthermore, the States cannot enter into forbearance agreements or shortage sharing agreements amongst themselves where the rights of Arizona Tribes to their share of Arizona's equitable apportionment to the Colorado River would be manipulated by the States. *See e.g.* Appendix J-10 ("Arizona and Nevada will share shortages based on a shortage sharing agreement. In the event that no agreement has been reached, Arizona and Nevada will share shortages in accordance with the 1968 Colorado River Basin Project Act, the Decree, other existing law as applicable, and the Interstate Banking Agreement between Arizona and Nevada parties."). The participation of the Arizona Tribes in the forbearance agreements or any other agreements between Arizona and other States, as co-equal water users of Arizona's equitable apportionment, is required by the Law of the River, and by the direct contracts of the Tribes with the Secretary of Interior. 25

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 8

The proposed alternatives must be revised so that any "conservation" regime used to reduce the potential conditions which may cause or enable the Secretary to make declarations of shortage on the Colorado River, or used to provide additional waters to Arizona (including Arizona Tribes), include all Arizona CAP Tribes in the mutual "wet water" and financial benefits of such schemes. Otherwise, the Tribes will be subject to significant injury as a result of the manipulation schemes in violation of the Law of the River, and the contractual and constitutional rights of the Tribes. 26

5. The DEIS Does Not Discuss the Legal Authority for Allowing Credits for Fallowed Lands, Canal Lining and Other "Conservation" Measures

The DEIS does not discuss any legal authority which would permit the States to obtain credits for "fallowing" lands, canal lining and other measures undertaken to purportedly "conserve" Colorado River water. Under the law in Arizona, other western States and Federal Reclamation Law, the waters "conserved" by the fallowing of lands and the lining of canals is committed back to the stream flow to be used by the next water user in the system. *See Phelps Dodge Corp. v. Ariz. Dep't of Water Res.*, 2005 Ariz. App. LEXIS 108 (Ariz. Ct. App. 2005) (observing that water rights in Arizona are ". . .usufructory, to ensure a maximum beneficial use of Arizona's water resources.") (citing *Clough v. Wing*, 2 Ariz. 371, 379-81, 17 P. 453, 455-56 (Terr. 1888)); *Salt River Valley Water Users' Ass'n v. Kovacovich*, 3. Ariz. App. 28, 411 P.2d 201, 203 (Ariz. Ct. App. 1966) ("any practice, whether through water-saving procedures or otherwise, whereby [a diverter] may in fact reduce the quantity of water actually taken inures to the benefit of other water users and neither creates a right to use the waters saved as a marketable commodity nor the right to apply same to adjacent property having no appurtenant water rights."); Kinney, *Treatise on the Law of Irrigation and Water Rights and the Arid Region*, (2nd Ed. 1912), §782, 783. 27

The DEIS must discuss what legal authority would permit the States to commit "conserved" water to inure to the benefit of a single party or particular beneficiary, rather than for the use and benefit 28

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 9

of **all** users in the Colorado River system under the Law of the River. Furthermore, if such a 28
"conservation" scheme could be lawfully implemented and used to benefit particular parties or 29
beneficiaries, the Tribes must be permitted to participate, and the Secretary must fully support and protect the Tribe's full and unfettered participation and receipt of benefits.

6. Use of Surplus by Basin States

The Basin States Alternative also proposes a different scheme for the distribution of surplus. For instance, the Basin States Alternative would "[d]istribute Arizona's share to surplus demands in Arizona including off stream banking and interstate banking demands." *See* Appendix at J-9. The problem is 30
that based upon historical and present practices by Arizona (which is charged with protecting the entire State's equitable apportionment from the Colorado River, including that which is used by the Tribes) the State would nevertheless use this surplus for the benefit of non-Indians, to the exclusion of the Tribes. In fact, the State of Arizona is engaging in this conduct now, through, *inter alia*, the Arizona Water Banking Authority and the interstate water banking agreement with Nevada. The Secretary's approval of 31
the Basin States Alternative would put the weight of authority of the United States behind these wrongful acts by the State of Arizona.

The Secretary should not select the Basin States Alternative or any other alternative, where it would exclude Tribes from participation in the arrangements made on the Colorado River during times 32
of surplus. In addition, the Secretary must include the Arizona Tribes and ensure that the Arizona Tribes 33
receive the mutual benefits of surplus on the Colorado River.

7. The DEIS Does Not Provide Adequate Details Regarding the Basin States Proposal for Accounting Policy and Procedure for Intentionally Created Surplus

The DEIS does not provide sufficient detail regarding the alternatives for the accounting policy 34
and procedure that the Secretary would implement for Intentionally Created Surplus or any other

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 10

"conserved" water. Without this detail, it is unclear as to how the CAP Tribes would be permitted to participate in the ICS and the impact of the uses of the ICS upon the Tribes. This should be corrected in the DEIS. 34

8. The Arizona Water Settlements Act, P.L. 108-451 Is Not Yet Enforceable

The DEIS' underlying assumption and reliance upon the AWSA as defining the characteristics of the CAP is premature. *See* DEIS at 4-81. The AWSA is not yet enforceable and may never become enforceable. 35 If so, the DEIS or Final EIS intended to be published by December 2007, will require immediate revision and further public comment. In addition, the existing DEIS should include an impact analysis which compares the impacts under the present characteristics of the CAP with the impacts under the characteristics which would exist if the AWSA were to become enforceable. 36

9. There Is No Misunderstanding As To How Shortages Are To Be Distributed Between CAP Indian and M&I Priority Users Within the CAP

The DEIS states that "prior to the enactment of the AWSA, there were differing views as to how mild shortages would be distributed between CAP Indian and M&I priority users." (DEIS at 4-124). While there may be so-called "differing views", the Tribe's CAP Contract is very clear regarding how shortages are to be implemented as to the Tribe. Furthermore, the AWSA did nothing to clarify how such shortages are shared, because the Tribe's CAP Contract cannot be affected or modified by the AWSA. The DEIS and its underlying assumptions must be changed to reflect and analyze the true nature of the Tribe's CAP entitlement and how shortages within CAP will be implemented as to the Tribe. 37

10. The DEIS States an Incorrect Amount of CAP Water That Is Allocated to the Tribe

The DEIS incorrectly states the amount of CAP water to which the Tribe is entitled at 61,645. *See e.g.* DEIS at 3-85. Pursuant to the 1992 Settlement Act and Agreement, the Tribe is entitled to 38

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 11

64,145 acre-feet of CAP water. The DEIS also shows all Indian CAP water as if it was part of the 38
CAWCD contract with the Secretary. The DEIS must be revised to correct these errors. 39

11. The DEIS Fails to Adequately Discuss or Analyze the Impacts of the Alternatives Upon the Tribe

The DEIS finds that "No vested water right of any kind, quantified or unquantified, including federally reserved Indian rights to Colorado River water, rights pursuant to the Consolidated Decree or 40 Congressionally-approved water right settlements utilizing CAP water, will be altered as a result of any of the alternatives under consideration." DEIS at 4-123. This is incorrect.

The DEIS erroneously attempts to delineate between a paper water right and wet water. These are one in the same. 41 Whether or not the paper water right becomes wet water is determined by whether or not the law is followed and whether or not the Secretary undertakes actions (or fails to take actions) which diminish the reliability or injure the ability of the Tribe to receive its wet water. The implementation of shortage sharing criteria which would hinder the Tribe's ability to receive the water to which it is entitled, and the selection of an alternative which would permit waters to be "conserved" and committed to exclusive use by certain parties, alters the reliability of the Tribe's entitlement to CAP water. The DEIS cannot distinguish between the effect of the alternative upon the legal entitlement of 42 the Tribe versus the effect upon the Tribe's receipt of the wet waters pursuant to the legal entitlement.

The DEIS proposes alternatives which will impact and diminish the reliability of the CAP water 43 supply and thus, injure the ability of the Tribe to receive the wet water to which it is entitled. The Secretary is charged with the responsibility to implement shortage sharing criteria which protect the Tribe's receipt of the CAP water supply which is an Indian Trust Asset. The DEIS must analyze the impacts upon the Tribe's receipt of the water to which it is entitled, and not merely make a statement 44 that the alternatives will have "no effect" upon the Tribe's legal entitlement to the CAP water. A policy

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 12

which proclaims no impact on the Tribe's legal entitlement which results in **no wet water** to fulfill its entitlement is deceptive and amounts to invidious discrimination. The DEIS' avoidance of discussing the true impact of the alternatives upon the Tribe must be corrected. 45

12. The DEIS Fails to Discuss How "Voluntary" Shortages Would Be Implemented and Their Resultant Effect Upon the Tribe and Its Right to CAP Water

The DEIS mentions that certain "voluntary" shortages could be implemented. DEIS at 4-12. 46
However, the DEIS is unclear as to who would agree to such voluntary shortages. The Secretary cannot permit the State of Arizona to decide whether or not it would enter into a voluntary shortage, where such shortage would diminish the reliability of the Tribe's CAP water. This is simply unlawful. 47
Furthermore, the Secretary cannot allow other states to enter into "voluntary" shortages and alternative River management schemes that would create conditions where the Tribes were required to bear shortages that would not otherwise be borne, absent such voluntary agreements or schemes. The DEIS fails to discuss this in any detail. 48
The DEIS should be revised for clarity and to provide a meaningful analysis of the impacts of the proposed "voluntary" shortages to the Tribe's receipt of its CAP water supply. 49

13. The DEIS Fails to Discuss the Potential Impact of Any of the Alternatives on Water Quality or Quantity to Which the Republic of Mexico is Entitled Under Treaty

The DEIS fails to discuss the ongoing and potential environmental impacts of any of the alternatives on the Colorado River delta, including wet lands, and the fact that the delta is one of the primary marine nurseries supporting aquatic life, fisheries and migratory wildlife subject to international treaties, and the ultimate fish production and annual catch allocated among countries of the Pacific Rim. The alternatives proposed by the DEIS, with the increase in use of the Colorado River proposed by the alternatives, including the Basin States Alternative, will undoubtedly impact the delta. 50

IT-9

THE SPARKS LAW FIRM, P. C.

April 27, 2007
Page 13

Please continue to keep this Firm on your mailing list for all future communications and documents related to this matter. 51

Yours Truly,

THE SPARKS LAW FIRM, P.C.

Robyn L. Interpreter

RLI/rli

cc: Wendsler Nosie, Sr., Chairman
David Reede, Vice-Chairman
Council Members

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IT-9

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Reponses to Comment Letter IT-9

IT-9-1 and IT-9-2

Your comment is noted. No change to the Final EIS was necessary.

IT-9-3

Your comment is noted. No change to the Final EIS was necessary.

IT-9-4

See response to Comment No. IT-6-4.

IT-9-5

Your comment is noted. No change to the Final EIS was necessary.

IT-9-6

See response to Comment No. IT-6-6.

IT-9-7

See response to Comment No. IT-6-7.

IT-9-8

See response to Comment No. IT-6-6.

IT-9-9 and IT-9-10

See responses to Comment Nos. IT-6-9 and IT-6-10.

IT-9-11 through IT-9-14

See responses to Comment Nos. IT-6-11 through IT-6-14.

IT-9-15 and IT-9-16

Your comment is noted. No change to the Final EIS was necessary. Table E-1 in Appendix E lists Arizona water entitlement holders and priorities and aggregates all CAP water contracts into one entry under the heading Central Arizona Water Conservation District (CAP) for presentation purposes only. It was not intended to suggest that CAP contracts with the Secretary were subcontracts with CAWCD. Reclamation concurs that the Tribe's CAP contract is a two-party contract between the Nation and the Secretary. In the Final EIS, Appendix G was modified to more clearly explain the CAP framework (Section G.4.8). In the Final EIS, Table G-3 shows the

CAP entitlements by priority and Table G-4 shows the CAP priority 2 Indian entitlements by sub-priority. Both tables clearly show the San Carlos Apache entitlement.

IT-9-17 and IT-9-18

Your comment is noted. No change to the Final EIS was necessary.

IT-9-19

See response to Comment No. IT-6-6.

IT-9-20

Your comment is noted. No change to the Final EIS was necessary.

IT-9-21

See response to Comment No. IT-6-21.

IT-9-22 through IT-9-24

Reclamation does not concur with these comments. See response to Comment No. IT-6-21.

IT-9-25 and IT-9-26

See responses to Comment Nos. IT-6-25 and IT-6-26.

IT-9-27

See response to Comment No. IT-6-25.

IT-9-28

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. IT-6-25.

IT-9-29

See response to Comment No. IT-6-25.

IT-9-30 through IT-9-32

See responses to Comment Nos. IT-6-30 through IT-6-32.

IT-9-33

See response to Comment No. G-6-33.

IT-9-34

Your comment is noted. No change to the Final EIS was necessary. See response to Comment No. IT-6-25.

IT-9-35 and IT-9-36

See responses to Comment Nos. IT-6-35 and IT-6-36.

IT-9-37

Your comment is noted. No change to the Final EIS was necessary. The San Carlos Apache Tribe is not affected by the shortage-sharing compromise in the AWSA (Section 4.4.7.1) because the compromise affects those entities within the M&I/Indian category with entitlements less firm than the Tribe's entitlement.

IT-9-38

Your comment is noted. No change to the Final EIS was necessary. As noted in the fifth footnote on Table 3.10-2, the modeling assumptions used in the Draft EIS and the Final EIS assume that delivery losses of six percent on the Santa Rosa Canal would be incurred for the Ak-Chin water.

IT-9-39

Your comment is noted. No change to the Final EIS was necessary. However, based on the modeling assumptions used to distribute shortages to CAP users, the shortage to the Ak-Chin Tribe would be the same whether analyzed separately or included as part of the analysis with other CAP contractors. Appendix G (Attachment B) provides the modeled shortages to the Tribe for a range of shortages for selected years.

IT-9-40 through IT-9-42

Your comment is noted. No change to the Final EIS was necessary.

IT-9-43

See response to Comment No. IT-6-43.

IT-9-44 through IT-9-45

Reclamation does not concur with this comment. See response to Comment No. IT-6-6.

IT-9-46 through IT-9-49

See responses to Comment Nos. IT-6-46 through IT-6-49.

IT-9-50 and IT-9-51

See response to Comment No. G-6-40.

GILA RIVER INDIAN COMMUNITY

Executive Office of the Governor & Lieutenant Governor

William R. Rhodes
Governor

Jennifer Allison-Ray
Lieutenant Governor

4/30/07
BCOO-1000

April 27, 2007

Regional Director, Lower Colorado Region
Bureau of Reclamation, Attention: BCOO-1000
P.O. Box 61470
Boulder City, Nevada 89006-1470

Re: Gila River Indian Community Formal Comments

Dear Sir:

The Gila River Indian Community hereby submits its formal comments for the Draft Environmental Impact Statement for the ***Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead.***

The Gila River Indian Community did not select an alternative from any of the alternatives suggested by the Draft Environmental Impact Statement. Below are the Community's comments:

<u>Comment 1:</u>
The process in which the Bureau of Reclamation is currently engaging is a potential violation of 1
NEPA by excluding from detailed consideration certain alternatives to its Preferred Alternative.
The BOR officials have drafted an Environmental Impact Statement that has five alternatives and
stated that the Preferred Alternative will be selected after the public comment period. BOR
officials also stated that the Preferred Alternative will likely be a hybrid of the five alternatives.
The models that BOR ran used only those alternatives, but BOR did not run any models on the
hybrid of the alternatives that they anticipate will be the Preferred Alternative. The public is not 2
allowed to comment on the Preferred Alternative before it becomes a Record of Decision.

Based on the five different alternatives presented, and the lack of a "Preferred Alternative" that 3
provides clear action for future guidelines, the process seems flawed. The Community would
request that the process be expanded or extended for presentation of a "Final Draft"
Environmental Impact Statement for the Colorado River Interim Guidelines for Lower Basin 4
Shortages and Coordinated Operations for Lake Powell and Lake Mead that would present the
Preferred Alternative modeled for the full period and allow a public comment period.

IT-10

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Comment 2:

The study is based upon the assumption that the Upper Basin States will release 8.23 million acre-feet per year in perpetuity. This assumption appears to be based upon the projected future use curve provided by the Upper Basin States seven years ago (Appendix C). This assumption is a fundamental assumption to the entire model. However, this assumption has two difficulties.

First, the development pattern shown in Appendix C is not realistic in light of historic data (attached as a graph). It overstates the water use in the near years and significantly understates 5
the use in the more distant years.

The second difficulty is that the Upper Basin States are not legally required to release 8.23 million acre-feet per year. The model would be useful if, instead of assuming the release of 8.23 million acre-feet per year, it used the Colorado Compact scenario as interpreted by the Upper Basin States. Specifically, in the Colorado Compact scenario, the Upper Basin States only 6
releases 75 million acre-feet every 10 years. Also, the sensitivity studies provided (Appendix N) relate solely to hydrologic assumptions, without regard to examining the assumptions relating to human activities. The assumed human actions are likely to greatly distort the answers and need to be considered.

Take for example the year 2026, the Basin States option show shortages of 400,000 plus acre-feet 35 percent of the time. If the Upper Basins' releases were cut by 750,000 acre-feet, then those shortages (instead of being 400,000 plus acre-foot shortages) would be 1,150,000 plus acre-foot shortages. By using this assumption, it has a tremendous impact on the Gila River Indian Community. The Central Arizona Project water, which constitutes a large part of the Community's Settlement for its Winters' Rights, would have the net CAP supply (after leases are met) go from the 224,300 acre-foot full supply to zero acre-feet. Further, in the years when normal conditions are projected, which is 27 percent of the time, the water supply would drop to approximately 37,500 acre-feet or roughly 15 percent of the allocation.

It appears that the shortages could be much greater and possibly longer with any of the
alternatives if the Upper Basin States do not agree with the assumption that 8.23 million acre-feet 7
will continue to be released to the Lower Basin States and Mexico. There could be significant impacts based on release of 7.5 million acre feet. Mexico's share of the shortages would be increased from 16.67% to 20%. All of the alternatives could be significantly impacted with these differences and/or Mexico or the Upper Basin States Agreement.

Comment 3:

The computer models are based upon the assumption that each of the alternatives being evaluated stops in 2027. The no-action alternative is evaluated for the rest of the period (page 4-3, lines 33-34). Thus, when statistical analyses are done, only 18[1] years represent the data concerning the alternatives being considered. The remaining 34 years are based upon a common alternative. In many cases, the data presented provide probabilities of this aggregate sample,

[1] 2008-2026= 18 years.

IT-10

making the impact of the alternative being evaluated a minor component of the aggregate data being presented.

The Community would recommend that all of the alternatives be modeled through the full period rather than the 2026 period. The irrigation delivery system that will deliver Colorado River water via the Central Arizona Project on the Community is scheduled for completion in 2029. By the time the system is completed, allowing for full delivery and benefit of the Arizona Water Settlements Act of 2004, there are only three years left on the guidelines and the modeling does not address what might then be the Preferred Alternative for the balance of the modeling period.

This type of modeling is highly misleading. Either data showing the impacts through 2026
should be provided or the various alternatives should be continued for the duration of the model. 8
The Community requests that the data be provided or that alternatives continued for the duration
of the model.

Comment 4:
The terms of the Mexican Treaty only provide that there will be sharing of shortages. It is
inconsistent and probably impracticable to assume that Mexico takes its share of the shortages
based solely on the Lower Basin supplies while, at the same time, assuming that the Upper Basin
States are expected to share in the shortage. A more likely assumption is that Mexico accepts its 9
pro-rata share of all waters in the Colorado River, which would increase the portion of the supply
shorted to Nevada and the Central Arizona Project. As commented with regard to the Upper
Basin assumptions, there has been no sensitivity study made concerning the human/legal 10
impacts. The model merely assumes that Mexico shares in the shortages on the Colorado River.

Comment 5:
In Appendix P, it is indicated that various data will be presented, specifically including a section
on the water delivery sections. However, the table of contents does not show any such section 11
and, in scrolling through the Appendix P, does not show any such section.

Comment 6:
At paragraph 4.15.8, the EIS concludes that there is no significant impact on Indian Trust assets.
However, the EIS does not adequately address the impacts on CAP supplies to the Central 12
Arizona Tribes, specifically including the Gila River Indian Reservation.

Comment 7:
Many Central Arizona Project contracts exist with Tribes for delivery of water. The EIS does
not address those contracts. The EIS does not adequately address those contracts with a 13
discussion of BOR's fiduciary duty to protect Tribal water rights.

Comment 8:
Specific comment on the Conservation Alternative: While the Community does not object to the
concept of conservation, if the water is going to be maintained in the Lower Colorado River 14
Dams, then the release of that water should be restricted to times of normal or surplus supply.
The Community understands that the modeling is based upon this assumption. This assumption
is critical to the operation of the conservation before storage method and must be considered in

IT-10

an integral matter with that alternative. If diversions are permitted to occur at the desire of the beneficiary, *i.e.*, environmental interests, then it is highly likely that additional releases will occur at exactly the same time and will exacerbate any shortages that occur to the users. This will create a much more erratic supply than would otherwise exist.

<u>Comment 9:</u>

Specific comment on the Water Supply Alternative: While it provides short-term supplies, it fails to recognize or prepare for the time when shortages will start to occur; such that, by 2026, 15
shortages could occur of a substantial magnitude. It is highly beneficial to users and environmental activities to provide a relatively constant and dependable supply for natural and human use.

The Gila River Indian Community currently receives a highly erratic supply from the Gila River. Even with substantial conservation capacity in Coolidge Dam, there is dramatic variability from year to year in the water supply. The Community has learned from bitter experience how this variability can dramatically impact the ability of its members to farm and maintain their farmland. This can lead to great hardship for the members and government of the Gila River Indian Community.

<u>Comment 10:</u>

Specific comment on the Reservoir Storage Alternative: While the Community believes in the concept of preserving the water to create as stable a supply as possible, it appears from Tables 4.4-5, 6, and 7, that this option reaches too far towards that goal. Severe shortages over 600,000 16
acre-feet become highly prevalent very early, yet it appears that no such restrictions are needed for the future.

<u>Comment 11:</u>

Specific comment on the Basin States Alternative: In the worst case scenario, the magnitude of 17
the shortages here are less severe than in the Reservoir Shortage Alternative. The water supply alternative, as presented, clearly indicates this is simply borrowing against the future--since 18
dramatic shortages are probable beginning in 2027, when the criteria are revised. Long-term sustainability is probably one of the most critical interests to the Community.

The Community requests that the Bureau of Reclamation provide the Community with modeling of the 75 million in any consecutive 10-year period to allow the Community to evaluate its risks 19
vis a vis the highly contentious issue of the required releases by the Upper Basin States.

<u>Comment 12:</u>

The Gila River Indian Community will be significantly impacted, as will all of the Central Arizona Tribes that receive their allocations through the Central Arizona Project. All of the alternatives, other than the No-Action Alternative, will extend a modified ISG through 2026. This provision allows other entities to utilize "surplus" Colorado River water while all of the Central Arizona Tribes and the five Colorado River Tribes are tied to consumptive use or take or 20
lose deliveries.

IT-10

If there are any questions regarding this letter, please contact Ann Marie Chischilly at the Office of Water Rights at 520-796-1344x3.

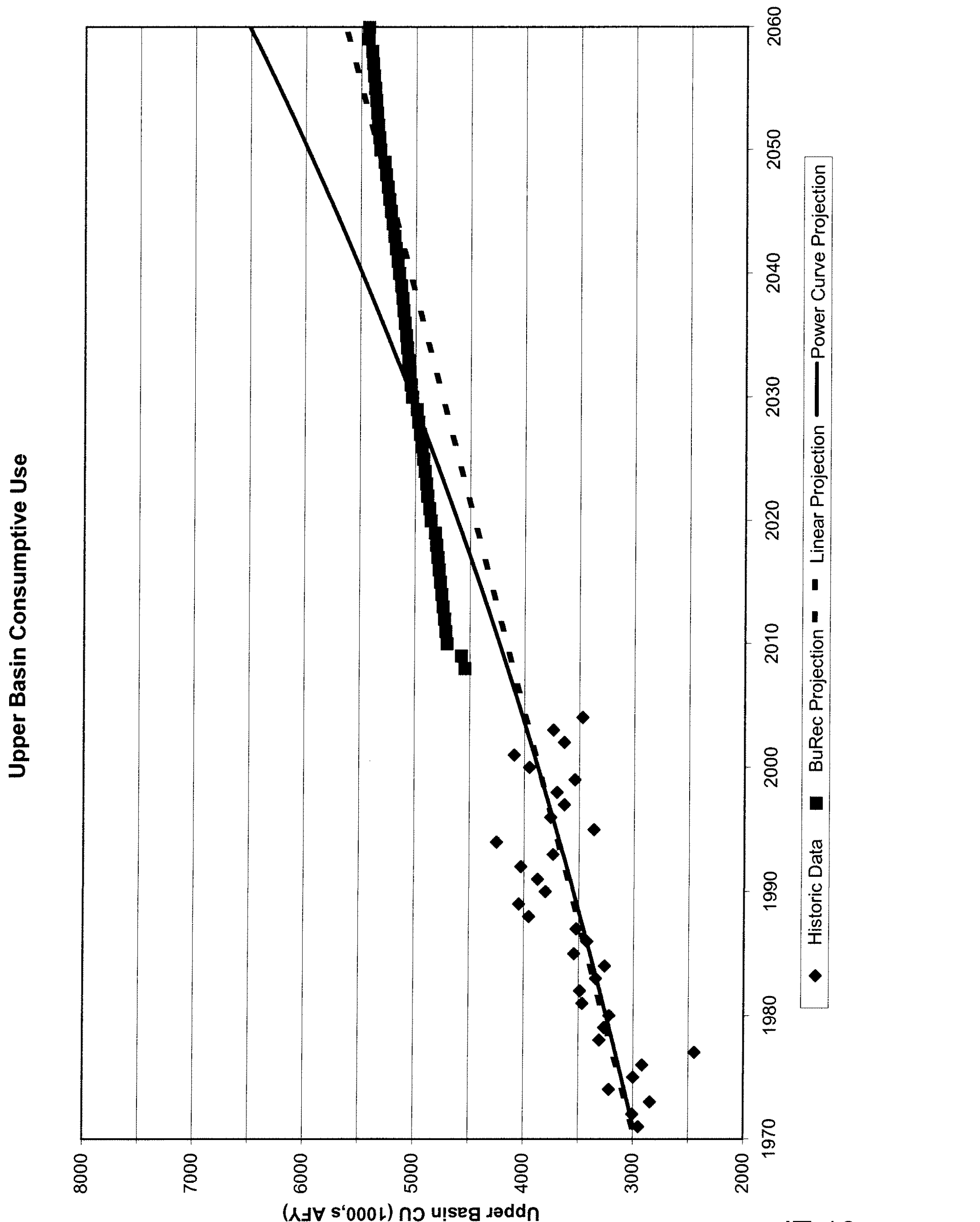
Sincerely,

Jennifer Allison-Ray

William R. Rhodes, Governor
Gila River Indian Community

cc: Jennifer Giff, GRIC General Counsel
Margaret Cook, GRIC Department of Environmental Quality Director

IT-10


Upper Basin Consumptive Use
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2060
Historic Data
BuRec Projection
Linear Projection
Power Curve Projection

IT-10

Reponses to Comment Letter IT-10

IT-10-1 through IT-10-4

Reclamation does not concur with these comments. The Council on Environmental Quality (CEQ) regulations for implementing NEPA do not require identification of a Preferred Alternative in the Draft EIS. Reclamation considered all public comments on the Draft EIS in identifying the Preferred Alternative. Pursuant to the CEQ regulations, a 30-day review period will commence after the publication of the Final EIS.

IT-10-5

Reclamation does not concur with this comment. As discussed in Section 3.4.1 of the Final EIS, the depletion schedules for the Upper Basin states used in the EIS were developed by each Upper Basin state and are the best data currently available regarding future Upper Basin depletions. Reclamation will continue to work with the Upper Colorado River Commission and the Basin States and other stakeholders to update these depletion schedules as appropriate.

IT-10-6 and IT-10-7

Your comment is noted. No change to the Final EIS was necessary. As described in Section 2.2, the No Action Alternative provides a reasonable representation of future conditions under no action, including with regard to Lake Powell operations. Pursuant to the LROC, the minimum objective release from Lake Powell is 8.23 mafy and the No Action Alternative assumes that operation. The other alternatives assume different Lake Powell operations as summarized in Table 2.8-2. Section 4.3.3.2 provides an analysis of the Glen Canyon Dam 10-year running total of annual releases for each alternative. Section 4.4.4.1 provides an analysis of shortages for each alternative. Section 4.4.6 provides an analysis of water deliveries to Mexico for each alternative.

IT-10-8

Reclamation disagrees with this comment. As noted in Section 1.1, the Secretary proposes that the guidelines be interim in duration and extend through 2026. As noted in Section 4.2.2, the period of analysis was through 2060 in order to disclose potential resource impacts beyond the 19-year interim period. Since the operational rules are unknown after 2026, all action alternatives were assumed to revert back to the modeling assumptions used for the No Action Alternative beginning in 2027. Throughout the EIS, the graphs, tables, and statistics clearly display the results of the entire modeling period.

IT-10-9 and IT-10-10

See response to Comment No. F-5-2. A sensitivity analysis regarding the modeling assumptions regarding water delivery reductions to Mexico has been added in the Final EIS (Appendix Q).

IT-10-11

Your comment is noted. Additional graphs have been added in Appendix P regarding water deliveries.

IT-10-12 and IT-10-13

Reclamation does not concur with these comments. As discussed in Section 4.10 of the Draft EIS and of the Final EIS, no vested water right of any kind, quantified or unquantified, including federally reserved Indian rights to Colorado River water, rights pursuant to the Consolidated Decree or Congressionally-approved water right settlements utilizing CAP water, will be altered as a result of any of the alternatives under consideration. Furthermore, as noted in Section 4.4.3 of the Draft EIS and of the Final EIS, the proposed federal action will not affect the entitlements to water users within the Lower Division states. However, water deliveries to users within each state may be affected and were analyzed in the EIS.

Section 4.4.7.1 and Appendix G provides an analysis of shortages to all contractors within the CAP including tribes.

IT-10-14

Your comment is noted. No change to the Final EIS was necessary.

IT-10-15

Your comment is noted. No change to the Final EIS was necessary.

IT-10-16

Your comment is noted. No change to the Final EIS was necessary.

IT-10-17 and IT-10-18

Your comment is noted. No change to the Final EIS was necessary.

IT-10-19

Section 4.3.3.2 of the Draft EIS and in the Final EIS evaluates each of the alternatives regarding the 10-year running total of Glen Canyon Dam releases. Appendix N also evaluates the 10-year running total of Glen Canyon releases for alternative methodologies for projecting future hydrologic inflows.

IT-10-20

See response to Comment No. IT-6-33.

NAVAJO NATION DEPARTMENT OF JUSTICE
OFFICE OF THE ATTORNEY GENERAL

LOUIS DENETSOSIE
ATTORNEY GENERAL

HARRISON TSOSIE
DEPUTY ATTORNEY GENERAL

April 29, 2007
via regular mail & email

Terrance J. Fulp, Ph.D., Area Manager
Boulder Canyon Operations
Bureau of Reclamation
Lower Colorado River Region
Attention: BCOO-1000
P.O. Box 61470
Boulder City, NV 89006-1470

tfulp@lc.usbr.gov & strategies@lc.usbr.gov

Re: Comments of the Navajo Nation on Draft Environmental Impact Statement on the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead ("DEIS")

Dear Dr. Fulp:

Please consider this letter as comments submitted on behalf of the Navajo Nation
concerning the above-referenced DEIS. The Navajo Nation believes that the Secretary of the
Interior has an affirmative obligation to take all necessary action to quantify the Navajo Nation's 1
water rights and needs from the Colorado River. President Shirley's letter of August 31, 2005 to
then Regional Director Johnson, requested the Department of the Interior to account for the water 2
needs of the Navajo Nation as part of these Interim Guidelines. The DEIS fails to adequately 3
account for or address the needs of the Navajo Nation.

Reclamation asserts one purpose of the proposed federal action is to "provide mainsteam
United States users of Colorado River water, particularly those in the Lower Division states, a
greater degree of predictability with respect to the amount of annual water deliveries in future
years, particularly under drought and low reservoir conditions." DEIS at 1-3. The DEIS is
deficient in that it does not fully account for how the Navajo claims would increase the risk of 4
curtailment of water deliveries, particularly to users in the Lower Division states. As a general
matter, the DEIS treats the Navajo claims in Arizona as part of that state's water allocations; 5
however, since these claims are not described in the water balance reporting nor were the impacts
analyzed, the DEIS understates the impact of such claims on other water users within the State.
Moreover, were the Navajo Nation successful in developing its water rights pursuant to these
claims, such development upstream of Lake Mead would displace junior water users below Lake 6
Mead. It appears that the DEIS does not fully examine the impact of exercising these Indian
Trust Assets; therefore, the DEIS fails far short of its goal of providing a greater degree of 7
predictability to the water users.

IT-11

P.O. Drawer 2010 ● Window Rock, Navajo Nation (AZ) 86515 ● (928) 871-6192 ● Fax (928) 871-7570

Terrance J. Fulp, Ph.D., LC, BOR
Re: Comments of the Navajo Nation on DEIS
April 29, 2007
Page 2

Turning to the specific sections of the DEIS, the Navajo Nation offers the following comments:

ES-2.9 Executive Summary, Indian Trust Assets

The conclusion that "Tribal trust resources identified in the study area would not be adversely affected by any of the anticipated environmental impacts stemming from the proposed federal actions" is unwarranted. The DEIS does not include an analysis of the projected water needs of the Navajo Nation or identify any water sources to satisfy those needs. By letter of August 21, 2006, the Navajo Nation identified a reasonable breakdown of its anticipated demands. None of those demands are reflected in the DEIS analyses, nor are they reflected in Appendices C or D. If the water rights of the Navajo Nation, an Indian Trust Asset, are unknown and unquantified, no conclusion can be reached with respect to impacts on those assets. Moreover, even where Indian Trust Assets are known, such as the Navajo Nation's dependency on Lake Powell as a source of water for development and for recreational values, the DEIS identifies very clear adverse impacts on water levels in Lake Powell resulting from various alternatives. Alternatives that increase the risk of lower water levels in Lake Powell have adverse impacts on the Navajo Nation because of increased pumping costs for water development or lost economic development opportunities at Navajo marinas.

8 9 10

3.2.1.1 Affected Environment, Lake Powell and Glen Canyon Dam

The DEIS does not analyze potential diversions by the Navajo Nation out of Lake Powell. Moreover, the DEIS does not even recognize current water uses from Lake Powell by the Navajo Nation. The Navajo Nation entered into contract on September 14, 1969, with the Department of the Interior for water from Lake Powell. This allows the City of Page to divert water from Lake Powell for use by the Navajo community of LeChee. An Environmental Assessment is underway for a new intake, and the Navajo Nation is negotiating a new Secretarial contract for an increased water supply for the LeChee area. The DEIS neglects to describe the current and ongoing economic development at Antelope Canyon and marina at Antelope Point. In addition, the Navajo Generating Station obtains its cooling water from Lake Powell. The Navajo Generating Station is located on the Navajo Reservation, employs hundreds of Navajos and burns coal produced from the Navajo Nation. Any adverse impact visited upon the Navajo Generating Station by any federal action should be viewed to have an adverse impact on the Navajo Nation.

11 12 13

These comments are equally applicable to the provisions at 3.3.2 Affected Environment, Lake Powell and Glen Canyon Dam.

3.4.1 Affected Environment, Apportionment to the Upper Division States

Reclamation relies on depletion schedules for the Upper Division states developed by the Upper Colorado River Commission and submitted to Reclamation in December 1999. Revised depletions schedules were provided in 2006. 14

IT-11

3.10.6.1 Affected Environment, Navajo Indian Reservation

The DEIS asserts that the "Navajo Nation economy is historically based on livestock herding and dry farming." This statement is a gross over simplification of the Navajo economy. 15 Royalty and tax revenues from mineral production on the Navajo Nation account for at least 90% of the non-federal portion of the Navajo Nation's operating budget. With respect to agricultural production, the Navajo Nation has significant resources in addition to the Navajo Indian Irrigation Project. In 1986 the USDA Soil Conservation Service conducted a partial inventory of irrigation projects on the Navajo Reservation. The 1986 SCS inventory identified more than 80 16 irrigation projects that included more than 40,000 acres. In 1994 in the *Report of Amended Water Claims by the Untied State of America for the Indian Lands in the Little Colorado River Basin*, the U.S. Justice Department reports more than 69,000 acres irrigated with surface water on the Navajo Reservation just within the Little Colorado River Basin.

By letter of August 21, 2006, referenced in this section, the Navajo Nation estimated that it would need at least 76,732 acre-feet per year from the mainstream of the Colorado River in 17 Arizona. That budget does not appear to be included within the depletion schedules at Appendices C or D. In addition to this demand from the mainstream, the Navajo Nation also projected a demand of 63, 000 acre-feet per year from the Little Colorado River, a tributary of the Colorado River. The DEIS does not appear to account for the 139,732 acre-feet of potential 18 Navajo uses from the Colorado River system in Arizona. The DEIS does not attempt to evaluate the impact of the exercise of these water demands as part of any of the alternatives. It is misleading to conclude that this water would simply be deducted from Arizona's allocation without impact on the overall water balance. The diversion and use of water by the Navajo Nation upstream of Lake Mead and/or Lee Ferry would be to the detriment of junior users 19 downstream of Lake Mead. Since such diversions would be at points different than the junior rights displaced, there could be differential impacts visited upon the various alternatives.

Impacts on the ability of the Navajo Nation to meet the needs of its people are not just related to hydrologic variables such as lower median water levels in Lake Powell, "occasionally" reduced flows below Lake Powell, and altered water quality. These impacts may also involve any number of administrative or operational variables for instance, securing Secretarial water 20 contracts, establishing points of diversion above or below Lee Ferry, and protecting endangered species in the future. The DEIS fails to conduct a thoughtful analysis of all of the variables that need to be considered. Without this analysis it is impossible for the DEIS to unequivocally conclude in this document that there are no impacts on Indian Trust Assets.

3.11.7.2, Affected Environment, City of Page Water Supply Intake

This description is flawed for the reasons stated above concerning section 3.2.1.1. The DEIS does not address Navajo municipal uses from Lake Powell or future impacts on the Navajo 21 Nation's ability to use the lake as a forebay for additional water projects, including projects

IT-11

Terrance J. Fulp, Ph.D., LC, BOR
Re: Comments of the Navajo Nation on DEIS
April 29, 2007
Page 4

recently evaluated by Reclamation in the *North Central Arizona Water Supply Study Report*, December 2006.

The Navajo Nation's recreational interests at Lake Powell include but are not limited to
the Quality Inn Lake Powell, Antelope Canyon, Antelope Point Marina, Navajo Bridge, and
Castle Rock. Reservoir elevations that could potentially impact Navajo Nation tourism include
Castle Rock Cut, which is closed at 3,620 feet mean storage level, and the Antelope Point Public
Launch Ramp, which is closed at 3,588 feet mean storage level. Each of the alternatives predict
some impact on the mean storage level, but the DEIS provides no analysis of the impacts on 22
Navajo tourism revenues, including tourist accommodations, park entrance fees, tour guides, etc.

3.15.1 Minority, Low-income Populations, and Indian Tribes

The DEIS relies on county level statistics to describe Minority, Low-income Populations,
and Indian Tribes. This recitation of county level statistics obfuscates the desperate
socioeconomic conditions of those living on the Navajo Reservation. The U.S. Census Bureau
produced ample data that far better reflect these on-reservation conditions than the county level 23
data. The document needs to more accurately address this issue so that the readers will better
understand that the high rates of poverty and unemployment, the high number of homes that do
not have direct access to safe drinking water, and the need for improved infrastructure are very
closely related.

4.10.1 Environmental Consequences, Water Rights and Trust Lands

The DEIS states that to the extent that "additional Tribal water rights are developed,
established or quantified, during the interim period of the proposed federal action, the United
States will manage Colorado River facilities to deliver water consistent with such additional
water rights, if any, pursuant to federal law." This commitment merely to follow federal law,
rather than affirmatively manage the Colorado River consistent with the Navajo Nation's trust
assets, ensures that other interests will continue to rely on water supplies claimed by, reserved
for, and potentially belonging to the Navajo Nation. Reclamation has an affirmative obligation
to operate federal water projects, such as Glen Canyon Dam and Hoover Dam, consistent with
"vested, fairly implied senior Indian water rights." *Joint Board of Control of Flathead, Mission and* 24
Jocko Irrigation Districts, 832 F.2d 1127 (9th Cir. 1987). It is logical to expect that the current
water users will have even more incentive to resist the development of Colorado River water by
the Navajo Nation in order to minimize their risk of shortage.

Moreover, the DEIS fails to provide any analysis of the impacts on the vested, but 25
unquantified water rights of the Navajo Nation. The U.S. Supreme Court has repeatedly
recognized that tribes possess reserved water rights that vest no later than the date their
reservations were established. *See: Winters v. United States*, 207 U.S. 564 (1908); *Arizona v.
California*, 373 U.S. 546 (1963). It is not sufficient for the DEIS to evaluate only those water rights
presently "developed, established or quantified." As part of the adjudication of its water rights,

IT-11

the Navajo Nation will have to prove that the water necessary for its permanent homeland can be diverted and used in a practicable manner. The recent decision of the Arizona Supreme Court suggests that tribes must demonstrate the practicability of diversion for beneficial use for all water claimed. *See: In Re: The General Adjudication of All Rights to Use Water in the Gila River System and Source,* 35 P.3d 68, 80 (Ariz. 2001)("[P]roposed projects should be scrutinized to insure that they are practical and economical.") The Navajo Nation's ability to divert water from Lake Powell in a feasible manner will depend to a large degree on the cost of the energy needed to lift the water. To the extent that any alternative will result in lower water levels at Lake Powell, the costs of diverting water necessarily increase as noted at 3.11.7.2 of the DEIS. ("[D]rops in the elevation of Lake Powell could cause an increase in the cost of power for the City of Page's
intake pump station.") While the DEIS considered drops in lake elevation to be an environmental
consequence that must be evaluated for the City of Page and the Navajo Generating Station, the
DEIS completely ignores the potential impact that such changes in elevation would have, not 26
only on the ability of the Navajo Nation to divert water from Lake Powell, but to demonstrate the
practicability of such diversions in any future water rights adjudications.

In short, the DEIS fails to provide any meaningful evaluation of impacts on Navajo water 27
rights.

4.15.8 Environmental Consequences, Indian Trusts Assets

The Department of the Interior has made no effort to quantify the Navajo Nation's water
rights. It is unclear how the DEIS can conclude that there are no significant impacts on Indian 28
Trust Assets when the extent of those trust assets are unknown. Even though the water rights of
the Navajo Nation are unquantified, the DEIS failed to give meaningful consideration to the 29
water budget proposed in the Navajo Nation's letter of August 21, 2006 or to account for any
impacts on the unquantified water rights for reasons discussed above.

Similarly, the statement at 5.1.29.7 concerning the absence of cumulative effects on 30
Indian Trust Assets is also fundamentally wrong.

* * *

As President Shirley previously advised in his letter of August 31, 2005, the Secretary must account for the needs of the Navajo Nation as he undertakes the difficult task of developing guidelines to deal with Lake Powell and Lake Mead in times of shortage. Moreover, absent forceful action by the Secretary to secure an adequate water supply for the Navajo Nation, the stated objective of providing certainty about the quantities of water available to other users cannot be achieved because those supplies will always be at risk from the outstanding and un-quantified Navajo claims.

IT-11

Terrance J. Fulp, Ph.D., LC, BOR
Re: Comments of the Navajo Nation on DEIS
April 29, 2007
Page 6

Please do not hesitate to contact me if you have any questions concerning the information provided here. Thank you for your anticipated cooperation.

Sincerely,

NAVAJO NATION DEPARTMENT OF JUSTICE

signed on original

Stanley M. Pollack
Assistant Attorney General

IT-11

Reponses to Comment Letter IT-11

IT-11-1

Your comment is noted. No change to the Final EIS was necessary.

IT-11-2 through IT-11-8

Your comment is noted. To the extent that additional Tribal water rights are developed, established or quantified during the interim period of the proposed federal action, the United States will manage Colorado River facilities to deliver water consistent with such additional water rights, if any, pursuant to federal law. Thus, modifications to system operation, in accordance with pertinent legal requirements, will be considered as Tribal water rights and will be exercised in accordance with applicable law.

IT-11-9 and IT-11-10

Your comment is noted. No change to the Final EIS was necessary.

IT-11-11

Your comment is noted. Some confusion may exist with respect to the modeled Upper Basin Arizona uses. As shown in Table C-1 of Appendix C, the Upper Basin states depletion schedules include Arizona use of 45 kafy for 2008 and 2009, and 50 kafy from 2010 through 2060. In the hydrologic model, this node includes the use of the Navajo Generating Station, the City of Page, and the Gallup-Navajo project.

IT-11-12

Your comment is noted. Section 4.12 has been updated to include a discussion of the effects of the alternatives on operations to the marina at Antelope Point. The assessment, conducted in a similar fashion to the other recreation resources at Lake Powell evaluated in the EIS, is based on the probabilities that the surface elevation of Lake Powell would fall below the level at which the marina can operate.

IT-11-13

Your comment is noted. Reclamation estimated the annual changes in pumping costs to supply water to the Navajo Generating Station and the City of Page (Section 4.11). In addition, Section 4.3.2 presents the analysis of the probabilities of Lake Powell falling below key elevations, including 3490 feet msl.

IT-11-14

See response to Comment No. S-1-21.

IT-11-15

Your comment is noted. The referenced sentence in Section 3.10.6.1 has been revised to include mining.

IT-11-16

Your comment is noted. No change to the Final EIS was necessary.

IT-11-17 through IT-11-19

See response to Comment No. IT-11-2.

IT-11-20

Your comment is noted. No change to the Final EIS was necessary.

IT-11-21

See response to Comment No. IT-11-13.

IT-11-22

Section 4.12 discloses the effects of the no-action and action alternatives on recreation occurring at Lake Powell. This analysis concluded that lake levels would be similar among all the alternatives, with the exception of the Reservoir Storage Alternative, which would result in higher lake levels when compared to conditions occurring under the No Action Alternative. The socioeconomic assessment concluded that there would be no substantial difference in recreation-related economic activity among the alternatives because the lake levels and resulting recreation opportunities would be similar.

IT-11-23

As noted in Section 3.15.1, the Census data included Indian tribes.

IT-11-24 and IT-11-25

See response to IT-1-1.

IT-11-26

See response to Comment No. IT-11-13.

IT-11-27

See response to Comment No. IT-11-1.

IT-11-28 through IT-11-29

See response to Comment No. IT-1-1 and IT-11-2.

IT-11-30

Reclamation does not concur with this comment.

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Part 2
Public Hearing Transcripts

Reclamation conducted three hearings to invite public input on the Draft EIS on April 3, 4, and 5, 2007. The hearings took place in Henderson, Nevada; Phoenix, Arizona; and Salt Lake City, Utah, respectively. Transcripts were prepared for each public hearing to provide a written record of the meeting and oral comments. A copy of the transcript from each of the three public hearings is included in this section.

Public Hearing – April 3, 2007
Henderson Convention Center, Henderson, Nevada

PUBLIC MEETING

US DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

Draft Environmental Impact Statement

Overview and Opportunity for Public Comment

Held at the Henderson Convention Center
200 South Water Street
Henderson, Nevada

On Tuesday, April 3, 2007
6:15 p.m.

Reported by: Lori M. Judd, CCR #233, RMR

Lori M. Judd, CCR #233, RMR
702-260-9678

APPEARANCES:

Terrance J. Fulp, Ph.D
Area Manager, Boulder Operations Office

Nan Yoder
Amber Cunningham
Boulder Canyon Operations Office

Public Attendees as indicated on
Sign-in sheet

* * * * *

HENDERSON, NEVADA, APRIL 3, 2007, 6:15 p.m.

* * * * *

(Introduction and overview by Nan Yoder.)

(Project presentation by Terry Fulp.)

QUESTION BY MR. DANOS: Have you had any requests to extend the comment period yet?

MR. FULP: No, we have not. We are hopeful to stay on schedule, by the way. We will certainly listen to such requests.

(Continuation of presentation by Mr. Fulp.)

(Question and answer session as follows:)

MR. FULP: Are there any other questions that we could take and answer?

QUESTION BY MR. DANOS: What was the basis of the assumption that the YDP would not be operated for any of the alternatives?

MR. FULP: That's a good question.

Well, we had a couple things in mind. The primary one was we wanted to look at kind of the worst case impact, particularly to Lake Mead. And so those bypass flows coming from the Wellton-Mohawk return flows, we assumed those would happen every year. And that in some sense gives us a worst case, at least with regard to that decision at Lake Mead. That's water leaving the system, which would lower the lake and continue those types of impacts. So that was primarily a worst case.

Now a couple of alternatives assume some other things can happen to replace those bypass flows, primarily due to conservation, conservation mechanisms, but none of them assumed that the YDP would operate. Again, in order to get to that maximum impact of water leaving the system.

Any other questions?

QUESTION BY MR. BARON: Alex Baron, UNLV. Which models are used to predict the inflows?

MR. FULP: It's actually a pretty simple technique that we have used on the system for quite awhile. We take the 100 year historical record, and we just sample out of that record and so we do not create any future inflow sequences that have not been seen in 100 year records and we also don't create any magnitudes that we have not seen in the 100 year historical record.

With that technique, what we did do in this EIS, this draft is we did a sensitivity analysis and it's in an appendix, so if you are interested in that, we did look at three other alternative techniques of looking at future inflows that do, in fact, generate sequences we have not seen in the past and magnitudes we have not seen in the past and we did that again as a sensitivity analysis on the hydrologic resource. We did not continue that all the way through all the resource analyses.

Does that help a little bit? So one of the key pieces of information that the three scenarios used, the real key one was we looked at tree ring construction data and used it in a couple of ways to generate that.

Any others?

QUESTION BY LESLIE JAMES: Leslie James, from CREDA. I have a pretty small question.

I'm interested in why the reference in a couple of places to the beach/habitat building flows -- BHBF -- because I don't believe the analysis assumed any specific BHBF, and given the controversy and the current state of discussion -- I just came from an all-day meeting on that today -- I was interested in why reference was included on that.

MR. FULP: Well, let me clear up something and make sure that I explain what we really did do and then perhaps we didn't disclose that in a reasonable or understandable way.

MS. JAMES: I didn't understand it.

MR. FULP: What we have assumed is in

Lake Powell operation for all the alternatives, that BHBF would be made under those triggering, I'll call them criteria that were put in place in about 1997. So it's at those high reservoir levels of Lake Powell, that's that criteria that's been built into here and boy, Leslie, if you ask me to remember the details of that, I would probably not.

MS. JAMES: Not the sentiment triggering criteria, but the lake level triggering criteria?

MR. FULP: Yes, the lake level, high level. It's essentially near spill avoidance, if Powell is near spill avoidance, it's triggered.

Now there's a bunch of rules on forecast, and you understand that. I don't remember all the details, but it's at that spill avoidance level.

MS. JAMES: We'll probably make some comment to clarify that, because we just heard yesterday, in fact, that there is not yet a science plan that's been put in place to even be able to do another one of those and there's been a lot of discussions about utilizing other triggering criteria besides just sediment triggers, like economic criteria and other criteria. So it's still very controversial.

MR. FULP: I understand that. And I'll only make one other clarification, I think you know this, but for everyone else's benefit, those two, if that happened would not be modeled with those triggering criteria that are in place in the model. Those were not done at the high level spill avoidance level. They were more experimental, I guess is maybe the proper term.

MS. JAMES: That helps clarify for me because I didn't understand that the triggering criteria you were talking about were the high levels, not the sediment triggering criteria that the 1996 and 2004. Okay, thank you.

MR. FULP: Correct, we did not do that. That should be detailed, and it's probably buried in Appendix A, but I can direct you to Appendix A and don't worry about all the other flub, but hone in on the BHBS and it will explain those exactly.

Any other questions?

Okay. Then I think we get to sit down and let you, if you would like to make a public comment to us, we'll capture it, record it, and essentially listen to you all.

(No public comments.)

MR. FULP: Well, okay, we've got plenty of time. Don't feel pressured.

MS. YODER: If you didn't want to speak right now, you can express whatever comments you have to us in writing. And again, you can fax those comments to us, e-mail them to us, or if you want to use the good old postal mail, you can do those as well. And again, the close of the comment period is April 30th, so we're hoping to hear from everyone.

We put a lot of effort into the document and putting it out there for your consideration and we're sure that you will have a lot of things to share with us as a result. And that is the end of our presentation tonight.

So we thank you all for being here and if there is any other questions, we will be staying here through 9:00, should anyone show up late after having done their civic duty and voted, okay. Thank you very much.

(The floor remained open for public comment until 9:00 p.m., whereupon the proceedings concluded.)

REPORTER'S CERTIFICATE

STATE OF NEVADA)
) ss.
COUNTY OF CLARK)

I, Lori M. Judd, a duly commissioned Notary Public, Clark County, State of Nevada, do hereby certify:

That I reported the foregoing proceedings on Tuesday, April 3, 2007, commencing at the hour of 6:30 p.m.

That I thereafter transcribed my said shorthand notes into typewriting and that the typewritten transcript of said proceedings are a complete, true and accurate transcription of my said shorthand notes taken down at said time.

I further certify that I am not a relative or employee of an attorney or counsel involved in said action, nor a person financially interested in said action.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal in my office in the County of Clark, State of Nevada, this 30th day of April, 2007.

LORI M. JUDD
CCR #233, RMR

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Public Hearing – April 4, 2007
Phoenix Airport Marriott, Phoenix, Arizona

COLORADO RIVER INTERIM GUIDELINES FOR LOWER BASIN SHORTAGES

AND COORDINATED OPERATIONS FOR LAKE POWELL AND LAKE MEAD

\- - - - -

KEY ASPECTS OF DRAFT ENVIRONMENTAL IMPACT STATEMENT

PUBLIC MEETING

Q&A SESSION

Phoenix, Arizona
April 4, 2007
6:17 p.m.

REPORTED BY:
RABIN´ MONROE, RMR, CR
CERTIFIED REPORTER
CR #50653

PREPARED FOR:
BUREAU OF RECLAMATION

(COPY)

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PUBLIC MEETING

BE IT REMEMBERED that the Public Meeting was taken before RABIN´ MONROE, RMR, CRR, Certified Reporter #50653, in and for the County of Maricopa, State of Arizona, on Wednesday, April 4, 2007, commencing at 6:17 p.m., at the PHOENIX AIRPORT MARRIOTT, 1101 North 44th Street, Buckhorn Room, Phoenix, Arizona.

A P P E A R A N C E S

BUREAU OF RECLAMATION:

TERRY FULP
NAN YODER
ROBERT ZOBIA
GREGG ROY
JAYNE HARKINS
CAROL ERWIN
AMBER CUNNINGHAM

P R O C E E D I N G S

(Presentation by Terry Fulp.)

TERRY FULP: If there's any other questions, we'd be glad to answer them, and if not, we're gonna turn it over to see if you have any formal comments.

Yes, sir.

PLACIDO DOS SANTOS: Saw that there was consultation with Mexico.

TERRY FULP: Yeah.

PLACIDO DOS SANTOS: And I was wondering if the results of that consultation -- consultation are public. Can we learn what they said?

TERRY FULP: They -- certainly we can provide the materials we presented. In terms of their comments, they also have been asked to submit formal comments. Those will obviously be published and everyone can see those. But at this point we've not planned to make these meetings, what's been discussed, exactly available. We can make our materials available to you, sir.

NAN YODER: Can you --

TERRY FULP: I'm sorry. Could we have your name?

PLACIDO DOS SANTOS: I'm sorry. I'm Placido dos Santos with the Arizona Water Institute.

TERRY FULP: Yeah, that's a very good question.

Might -- if you don't mind, I might just try to explain something there, make sure it's very clear to us.

This is a U.S.-only action. The Secretary of the Interior is only adopting these -- this proposed action would only adopt it for U.S. users. It would not extend to Mexico.

Now, in the draft EIS we made some modeling assumptions with regard to how Mexico might share in shortages, but that's essentially what they are, is assumptions, modeling assumptions. We've certainly in our consultations with Mexico explained that to them, explained what we've assumed, you know, and explained all the stuff we've talked to you about -- about tonight.

But the point I really want to make sure is clear is there's a separate, parallel process through the State Department and the International Boundary of Water Commission that is dealing with how Mexico might in fact incur water reductions under the treaty. It's not -- would not be done in this process.

Does that make -- if that makes sense.

Any other questions?

ROBERT S. LYNCH: There are, however, assumptions in the Seven Basin States Alternative with regard to shortage-sharing by Mexico.

TERRY FULP: That's correct. And we, by the way, adopted those assumptions for this model.

Now, the key I want to make sure and state there is those assumptions are consistent through all the alternatives. We aren't changing between alternatives these assumptions on how shortages will be shared.

So we -- again, because we're not doing that analysis in this process, but ...

NAN YODER: And your name?

ROBERT S. LYNCH: I'm Bob Lynch. I'm an attorney here in Phoenix, and among others I represent the Irrigation and Electrical District Association of Arizona.

TERRY FULP: Great.

ROBERT S. LYNCH: I had a follow-up.

I've only had a chance to go through the executive summary so far, but somewhere in the document do you explain the differentiation among surpluses? There are four surpluses on the river.

TERRY FULP: Yes.

ROBERT S. LYNCH: There's gonna be California, Interim Surplus, RofA, and Treaty. And they use the same word, but they use them in different contexts.

TERRY FULP: Yes, they do.

ROBERT S. LYNCH: And it can be very confusing. I'm just wondering if -- if that sorting-out process is in chapter two.

TERRY FULP: It's not in two. It's sorted -- I mean, there's some preliminary materials in one, chapter one, introduction that addresses some of that, albeit maybe not exactly to the detail you -- you propose there.

But in chapter four in the Water Delivery section, we do look at the different types of surpluses, the probability of them occurring, and try to make that distinction particularly with regard to the idea of surplus for the Treaty.

But again, we'd certainly accept any comment if -- if you thought that ought to be even made more clear. But we've attempted to.

ROBERT S. LYNCH: Are there in these Al -- in the substantive alternatives are there off-ramps?

TERRY FULP: Off-ramps meaning if it didn't work out there's --

ROBERT S. LYNCH: Well, you start -- the nice thing about the annual operating plan is every year you're taking another look at where you are and -- with updated data.

You lock into some assumptions in 2008 for a 19-year period, you get four or five years down the road this isn't working, what's the mechanism -- do you have to go back through the same process? Is there an off-ramp? Is there a t- -- is there a default position like going back to the AOP and -- and bagging this whole thing?

TERRY FULP: Yeah ...

ROBERT S. LYNCH: Is that -- is that cranked into any of these alternatives?

TERRY FULP: It's not at this point.

A couple things to say there. I think the answer to one of your questions, what would we have to do. Yes, if we wanted to implement other guidelines, we'd have to go back through a similar type of process.

I believe we're -- when that'll come out would really be in the development of the guidelines. That would be where that discussion would happen.

I'll look at any of my project team to -- to chime in there if you think it's somewhat different.

But when we develop those guidelines, that's where we would discuss that; are there off-ramps. If so, what are they, how they work.

That allows me to stand on the thing that I've probably forgotten, and that is we plan to publish some draft guidelines in the final EIS so at least you can see what -- what we're thinking before we go -- get all the way to the record of decision.

Did that answer that?

NAN YODER: We actually --

TERRY FULP: I think he had his hand up first.

Sam?

SAM SPILLER: Sam Spiller, U.S. Fish and Wildlife Service, Phoenix.

Could you discuss further, Terry, in regard to just -- just what the parameters are regarding how Mexico would share? That was mentioned earlier that they -- to use the Basin States Alternative in regard to how they recommend it?

TERRY FULP: Yes.

SAM SPILLER: Can you define more --

TERRY FULP: What it is? You bet.

These assumptions, again, are consistent between all the five alternatives. What it basically does is come up with a fixed percentage for each of the entities that would share in the shortages. Now, that's essentially the concept.

The way we came up with the numbers, or that this proposal came up with the numbers, is a ratio of the entities' apportioned value to the total delivery apportioned value.

Give you an example. Mexico, 1.5 million acre-feet is their allotment, and the total in the Lower Basin States plus Mexico is nine million acre-feet. So in the numerator is 1.5, the denominator is 9, and that equals 16.7 percent.

If you substitute Nevada in the numerator, that's a 300,000 over 9 million, that ends up being 3.3 percent. And finally in -- Arizona is assumed to take the rest.

It's the -- that's essentially what you were asking, Sam; is that right?

SAM SPILLER: (Inaudible response.)

TERRY FULP: Yeah. So the Mexico percentage doesn't change no matter how big the shortage gets. It turns out Nevada's percentage doesn't change no matter how large the shortage gets.

But Arizona's is a little different, and it's a little complicated, but the idea really is it -- the break point is once all of Arizona's fourth priority has been reduced to zero, there's a shift of the percentages, because California now would come in under these assumptions and start to share somewhat in the shortages.

So I know that's a little complicated. It's listed in Appendix G. Is that right? Appendix G if you're interested, in the front part of it, we explain those shortage-sharing assumptions that have been made in more detail. But I hope I addressed your question.

NAN YODER: You'll also find it in Chapter 4.3.

TERRY FULP: Yeah, probably is there, too, isn't it? Okay.

VAL DANOS: Val Danos with AMWUA.

I'm -- I'm a little confused. You spoke -- you answered one of Bob's questions at the end you were talking draft guidelines in the final EIS. I may be a little slow, but wasn't the purpose of this EIS process to evaluate guidelines for operation of the river under low-flow conditions and the operation of the reservoirs so --

TERRY FULP: Yeah --

VAL DANOS: -- so what new guidelines -- I mean, are we talking about different guidelines here or --

TERRY FULP: No. I didn't make it very clear. Let me try again with you.

The -- this draft makes these key -- as I mentioned, these key elements, and we're looking at the differences of what the impacts would be if you determine Lake Powell release, for instance, in a certain way. Right? Similarly if you declare shortages in a certain way. That's what we mean, and that's what this is evaluating.

Now, when we talk about the actual guidelines, what I meant to say there were things, like Bob mentioned, about off-ramps. Well, the modeling doesn't know anything about that. This draft doesn't go as far as to say, "Hey, what if by 2010 you wanted to do something different?"

That would be done when you implement actually the record of decision and say:

"Here's how the guidelines will work. Here's exactly how this prescribed element that we just -- have just mentioned on Powell's release and how that gets determined. Here's how it would exactly work in practice."

So it's the same concept; it's just you gotta get it down finally to say, "Here's exactly how it works."

Let me give you an example. Maybe that helps that again. I know this is not very straightforward.

Lake Mead's operated on a calendar-year basis. And similar if we had dropped it something similar to the way the surplus guidelines works, you're doing your annual operating plan in the fall of the year, ready to go at the start of January.

Well, you don't want to wait till January to see where Mead is, because your users need to know what their water deliveries are going to be; right?

So you could say in the guidelines, "In August we'll run our midterm operational model, project where Mead will be on January 1st, and that come -- gets compared to those trigger elevations." That's the guidelines.

The how it actually works is what we're talking about, those nitty-gritty details that this level of analysis doesn't need to know about and would only make it even more cumbersome. But that's what we mean by the guidelines.

Did that help any, sir?

VAL DANOS: Yes.

TERRY FULP: Yeah, sorry, it's ... I -- I know that's a bit confusing.

Bob.

ROBERT S. LYNCH: When you get to the details, are these the kinds of things that are gonna be sorted out in the AOP process? Are we -- I mean, once you've established the shortage criteria, we have surplus criteria, we have interim surplus criteria, all of that affects what we discuss at the end of the operating plan.

Should we assume, then, that once this process is set and these criteria are in place that a lot of that dialogue will be occurring in that same fashion?

TERRY FULP: Yeah, I think that dialogue will still occur, to -- to answer your straightforward question, but if we -- and again, we haven't written these guidelines yet, so --

ROBERT S. LYNCH: Yeah.

TERRY FULP: I'm just supposing what they might look like.

But much as our domestic surpluses are determined now by this projected January 1st elevation, that's how -- what we run and show you in August, and we say, "If Lake Powell is above 1125 or below 1125, it's a normal condition."

Well, a similar type of guideline could be put in place here that said, "Hey, if Lake Mead on January 1st at or below 1075, there will be a shortage of X thousand acre-feet."

We'd still have the dialogue, of course, because it's an interactive process, but it would be more prescriptive of applying the methodology that the guidelines might outline.

Did that help?

ROBERT S. LYNCH: Yeah. I -- yeah, we've got stops --

TERRY FULP: Yeah.

ROBERT S. LYNCH: -- and we talk about 'em, but the stops would be automatic.

TERRY FULP: Yeah. Yeah. Yeah.

Yes.

GARY PARKER: Gary Parker with the Gila River Indian Irrigation and Drainage District.

When you identified the different alternatives and that you're going to after this comment period possibly select parts of any or all of them, are you then going to publish as part of the final EIS the model with those modifications and all of those scenarios that go with that final?

TERRY FULP: Certainly.

GARY PARKER: And that's going to be open for public comment?

TERRY FULP: It would be open for comment, but most likely we wouldn't have a set-aside comment period. Point is we've got a pretty rapid turnaround there to get a record of decision, and we certainly will take comments all along the way, but particularly during that period of time.

NAN YODER: If I could just clarify. Certainly when we notice availability of the final EIS there will be a 30-day comment period on that final document as is prescribed for all of the NEPA documents. So that will be available.

TERRY FULP: Thank you, Nan.

GARY PARKER: Could I ask a follow-up to that?

TERRY FULP: You bet. Sure.

GARY PARKER: If you have -- if you have that final alternative, the preferred alternative, and you go through that, are you also going to have the policy that goes with it at that time? Because --

TERRY FULP: Like the guidelines we were just talking about?

GARY PARKER: Right.

TERRY FULP: Yes. That's the goal --

GARY PARKER: They will be done?

TERRY FULP: -- is we will have draft guidelines published in that final Environmental Impact Statement, yes.

GARY PARKER: Okay.

TERRY FULP: Very good question. Thank you.

Thanks, Nan.

Yes.

ROBERT S. LYNCH: Yeah, to clarify a little more, you're gonna come out with the final EIS that'll have the criteria -- and those are, shall we say, automatic stops, elevation, certain things happen -- and draft guidelines.

How -- what process do you then envision using to finalize the guidelines related to the criteria?

TERRY FULP: Well, again, based on the comments we receive and the things we've heard, we would go through the Department and we would finalize those guidelines in anticipation to publish the record of decision, and I think our goal would be we publish the final guidelines in the decision. And the record of decision would essentially be guidelines plus the other associated information that should be disclosed at that time. And again, that's targeted for December.

Okay. Any other questions? They were all very good questions.

Well, with that, I think we'll --

VIKKI DEE BRADSHAW: I have one question. I'm sorry.

TERRY FULP: No, not a problem.

VIKKI DEE BRADSHAW: Dee Bradshaw, Imperial Irrigation District.

In the context of the Conservation Before Shortage Alternative, since it is willing conservation, I assume that there will be other areas that would be impacted other than just, you know, Metropolitan Service Area and Southern Nevada Water Authority Service Area.

How would you handle with that -- I mean, if that is -- some element of that is part of the preferred alternative, that would mean that the impacts would clearly be addressed for maybe air quality or socioeconomics or something of that nature.

TERRY FULP: That's a very good question. Because we don't know who may want to participate in such a voluntary program, it's very difficult to analyze impacts today, and so we have I hope made it fairly clear in the draft that we weren't able to do that. What we were looking at are the impacts to the river corridor of this kind of -- of mechanism.

And what we'd anticipate is whenever in the future willing sellers or leasers of water come forward and say, "Hey, I want to conserve water and put it in Lake Mead," then whatever analyses we need to do at that time would get done at that time.

And could be a State process more, as you are very familiar with, and it could be very straightforward depending on what the activity is. So we just can't predict them, and so we -- we chose to -- to not try to analyze what we couldn't forecast or even somewhat anticipate.

ROBERT S. LYNCH: Is part of the answer to her question that to the extent that you create for short-end purposes a market mechanism is then executed by nonfederal entities, there is no federal action to analyze?

TERRY FULP: That's -- could certainly be the case. Again, our goal here is to achieve our environmental compliance for allowing the water to move around in the system, to be put in Mead, taken out of Mead, and corresponding reductions and increases in river flows and any associated impacts of that.

And that really is our part in this action, is to allow that to happen. And as Bob said, whatever's appropriately needs to be done with at the time of the activity is proposed, that's what we would have to happen. Could very well be not the feds doing it.

Anything to add back there? Okay.

I have to look to the environmental compliance folks here to be sure --

MITCH HAWS: Terry, Mitch Haws with the Bureau of

Reclamation in the Phoenix area office.

I was asked by one of our local partners here: Are you planning to give one of these meetings in California? Or is there a reason why California's not on the fact sheet?

TERRY FULP: We are not -- yeah, we are not planning to. We didn't just over -- omit it by mistake. The idea really was that from the perspective of these critical elements and what we know about them -- and again, saying that we don't know much about what a mechanism might -- how it might want to be used, particularly with regard to shortage -- the risk of California of sharing in shortages is fairly -- is fairly low. Pretty low.

And again, due to the '68 Basin Project Act that deemed essentially the fourth priority post-1968 water rights in Arizona to be subservient to California 4.4 million acre-feet.

So given that, we felt that we could touch most everyone that needs to through either this outreach and/or through other meetings. And I think we're gonna be successful doing that. At least we feel like -- for instance, I'll be honest, some of the California agencies have asked us to come out this month, and we -- IID's one, in fact. And so we'll go there and deal with it that way.

Great. Any other -- any other questions?

Yes.

VAL DANOS: What's the nature of these meetings in California? Are they hearings or --

TERRY FULP: No, not at all. It's a request from an agency for information, so -- and so we'll -- we'll do that. We try to meet all the requests we get, so ...

They are not public hearings. They're just requests for either additional information or some dialogue in terms of explaining what the analysis is.

Okay. If that's the case, then we'll turn it back over to you, and ask you if anyone would like to make a public comment, please -- please do so.

NAN YODER: Okay. I have one.

Was anyone else going to be brave?

Okay. Well, then the spotlight is for John Weisheit. And if you would like to get up and give us your comment, we'd appreciate it.

JOHN WEISHEIT: My name is John Weisheit. I am the conservation director of Living Rivers. Our base is in Moab, Utah. I'm also a Colorado River Keeper, which has an affiliation of an international organization called the Water Keeper Alliance. As background, we submitted comments as an organization during scoping called the One Dam Solution, and it is a dam-decommissioning alternative to decommission Glen Canyon Dam.

The reason is to save water through the loss of evaporation because of its existence, to also reduce salinity in the Colorado River, and also to take care of the environmental problems that are being -- that are occurring in Grand Canyon National Park as the result of the operations of Glen Canyon Dam.

This alternative was not -- was rejected in this EIS. There is a -- a ban, congressional rider, against federal funds being used to study -- to decommissioning of Glen Canyon Dam, and that is why it was not considered as an alternative.

I did bring some copies of our document. It's outside the door on a chair on the right as you're leaving if you care to look at it. I have extra copies in my backpack, too, in case we run out.

These are my comments.

Models are only as valuable as the inputs they receive. While the sophistication and effort put into these projections are unprecedented and well-appreciated, the models' inputs, however, fail to provide the public the results necessary from which to make an informed decision as to merits of any of the proposed alternatives.

Garbage in, garbage out, as they say, but this garbage is so well masked that the people of the Colorado River Basin are being asked to put the rubber stamp on a

Katrina in the making. Those levees in New Orleans did not hold, nor will the assumptions painted on what otherwise is probably a very valuable model.

Scientists have been in agreement for decades that the Colorado River flows through the past century were among the wettest in 1200 years. Scientists are also in agreement that the Colorado River Basin in modern times has warmed upwards to two degrees during this period, and the trend is expected to continue, compromising streamflows upwards of 20 percent in the next 50 years.

We're now in the longest drought in recorded history. Things are changing all over the Basin, but not at the Bureau of Reclamation.

The results produced by their inflated inputs are based on historical streamflows that, while useful, in and of themselves must not alone be used to gauge future runoff.

Failing to account for a more long-term historical view of streamflow coupled with the climate change we are already experiencing is tremendously misleading to the public when developing shortage strategies.

Even under Reclamation's inflated scenario, this system is headed for an imbalance of water use, namely an oversupply of 400,000 acre-feet annually in the next 50 years. Corrected for a more accurate presentation -- representation of historical streamflow, this increases to

1.1 million-acre-feet.

But most importantly, we must begin to accept the reality of climate change. Anyone can notice how the reservoirs are dropping. A ten percent reduction on long-term flow estimates show an annual deficit right now of 1.1 million acre-feet rising to 2.8 million acre-feet by 2060.

Adjust this to 20 percent, as an increasing number of scientists are recommending, and we're looking at a 2.6 million -- million acre-feet deficit now, and nearly 4 million acre-feet in 50 years.

We're at ground zero tonight. Phoenix, Chandler, Tucson are not going to be protected by token changes in reservoir operations or even its ground-water banking Arizona is first in line for cuts, and there is no plan or how -- for how the state will survive if the rosy inputs put into this model evaporate away as Lakes Powell and Mead drop lower and lower.

The public is quite fortunate that the National Research Council has completed its recent Colorado River Report at this time. It reiterates the warnings that have yet found their way into the assumptions used by this model. We certainly hope these changes in the final EIS will present a more realistic view of what the future may hold.

And the public would also benefit from a more comprehensive presentation of what the real benefits are to these minimal dam operational changes it is being asked to support.

Chart 4.3, dash, 26 and 27 illustrate that a significant amount of water savings, at least in terms of increased levels for Lake Mead, occur not because of new operating plans that are the focus of these documents, but the results of anticipated but as yet mostly undetermined water-conservation activities.

It's already clear in looking at the plotted data represented from the 50th percentile the net volume of stored water in Lake Powell and Mead is greater under the No Action Alternative than what the Basin States -- States hope to implement.

Reclamation must present a comparable analysis of strictly the reservoir-operation component of the Basin States Alternative, not volumes of studies and charts based on undefined activities that may be exaggerating these limited benefits.

There is no question that the objective of this DEIS is critical or that valuable work has not gone into developing the model, but the public is anxiously awaiting some assurances that the water managers they rely on will develop a real strategy to guide us through what looks to be a very parched future ahead.

Unfortunately, Reclamation is still hoping history repeats itself and high flows will bail us out as demand continues to grow and temperatures continue to rise. But we're already at the end of what the river has historically provided.

There's no water left, and climate change is taking what their -- what's there back. It's time for Reclamation to admit this and get on with the real task ahead: Developing a solution for managing the system headed for failure.

Thank you.

NAN YODER: John, thank you for your comment.

Is there anyone else? No?

Okay. All right. So we'll remind you one more time that we're in our public-comment period. It closes April 30th. And we are more than welcome to hear from you tonight or also from here forward to fax or e-mail. And again, your input is valuable to our process. Thank you very much.

(Whereupon the presentation was concluded at 7:30 p.m.)

(Whereupon the public-comment session at this public meeting was concluded at 9:00 p.m.)

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

BE IT KNOWN that the foregoing Public Meeting was taken before me, RABIN´ MONROE, RMR, CRR, a Certified Reporter, No. 50653, in and for the County of Maricopa, State of Arizona; that the proceedings were taken down by me in machine shorthand and thereafter transcribed by computer-aided transcription under my supervision and direction; that the foregoing pages, numbered from 1 to 24, inclusive, constitute a true and accurate excerpt of all the proceedings had upon the taking of said public meeting, all done to the best of my skill and ability.

I FURTHER CERTIFY that I am in no way related to any of the parties hereto, nor am I in any way interested in the outcome hereof.

DATED in Phoenix, Arizona, this 20th day of April, 2007.

RABIN´ MONROE, RMR, CRR
CR #50653

RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Speaker Request Form

Please write clearly so that we do not misspell any personal details. Give the completed card to a project representative prior to the meeting's comment session.

4/4/07
Date

JOHN WEISHEIT (WHY-SIGHT)
Name*

PO BOX 466 MOAB UT 84532
Address* ☐ ***Please check this box if you'd like your address withheld from publication***

LIVING RIVERS
Organization

435-259-1063
Telephone

***Mandatory Information**

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Public Hearing – April 5, 2007
Hilton Hotel, Salt Lake City, Utah

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

IN RE:

PUBLIC HEARING ON THE DRAFT EIS,)
COLORADO RIVER INTERIM)
GUIDELINES FOR LOWER BASIN SHORTAGES)
AND COORDINATED OPERATIONS FOR)
LAKE POWELL AND LAKE MEAD.)
)

Held at the Hilton Hotel
Salt Lake City, Utah
April 5, 2007, 6:00 PM

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APPEARANCES:

BUREAU OF RECLAMATION STAFF PARTICIPATING:

AMBER CUNNINGHAM
NAN YODER
TERRANCE FULP

Comments and Questions by:

David Kanzer, Colorado River Water Conservation District
Tony Willardson, Western States Water Council
V.C. Danos, AMWUA
Janice Houston, University of Utah

0002

SALT LAKE CITY, UTAH, APRIL 5, 2007, 6:00 PM
(Opening comments by Nan Yoder and Presentation of Project by Terrance Fulp.)
MR. KANZER: This might be too specific, but the Drop 2 reservoir, is that an ICS conservation measure? You guys are assuming that it gets built?
MR. FULP: That's a good question and it is fairly detailed, I don't mind at all you asking it.
MR. KANZER: I'm sorry, my name is David Kanzer, Colorado River Water Conservation District.
MR. FULP: Great. All five alternatives, including no action, assume the Drop 2 reservoir is constructed, okay? And so, under no action or other alternatives that have no mechanism, that water that's conserved is just treated as system water. Okay? It just goes into Lake Mead and stays and is available for future delivery as any system water is. Okay? Does that make sense?
And then under -- for this particular proposal, the proposal was Nevada would pay for that reservoir and get an equivalent amount of water back and we've modeled that in this mechanism essentially. So, up until, oh, remind me, 250,000 acre feet? 300,000 acre feet was assumed, based on some assumption of the price of the reservoir, would be assumed that Nevada could draw on of

0003

the conserved water due to Drop 2. And it's spread out through, I don't know, 10, 12 years, is that about right?

MR. KANZER: And that's only in one alternative?

MR. FULP: It's actually in three alternatives and we'll get to that. There's three other alternatives that have this mechanism. They all assumed that same participation by Nevada, okay? Did that answer it, Dave?

MR. KANZER: Yes.

0004

(Presentation continues.)

MR. KANZER: Dave Kanzer, Colorado River Water Conservation District. The CSD service area has got that break in it. Is that the Salt River -- what's the link there?

MR. FULP: Well, this is back here, these are some reservations out here. I will not remember who all is sitting here, but we can find out for you.

MR. KANZER: Do they get tap water through the Indian settlement?

MR. FULP: Right.

MR. WILLARDSON: Tony Willardson with Western States Water Council. Can you say if there had been any discussions on the definition of the ICS water, and how that would be monitored? What actions would create ICS water?

MR. FULP: Oh, sure, there's been discussions. Absolutely. The states themselves, in their proposal in February that they sent to us that we published in our scoping, proposed some things that they thought were reasonable in terms of creating conserved water. Certainly internally, Interior and Reclamation, we are having discussions as we move forward in the process to figure out how the guidelines might end up being written and what they say with regard to that.

0005

MR. WILLARDSON: My understanding is extraordinary conservation methods have to be verifiable.
MR. FULP: Verifiability is an important part in our opinion. We usually use the term it needs to be wet water. It needs to really create a benefit and be water that's truly stored and ends up in Mead, you know. But there's certainly -- it's not been settled on completely by any means.
MR. KANZER: But the Drop 2 is one?
MR. FULP: The Drop 2 system efficiency, the state's termed that, but yes, Drop 2 certainly would be one, too.
MR. KANZER: Most obvious and the biggest, right?
MR. FULP: Yes. Okay, any other questions?
MR. LIND: Gordan Lind, Sierra Club. Which is the environmentally preferred alternative?
MR. FULP: We have not identified that either.
MR. LIND: In the draft, you will identify one in the final?
MR. FULP: We will. Yes, we will. I looked at my NEPA person and she said yes, she absolutely will. Thank you Nan.
MR. DANOS: Val Danos of AMWUA. I have one question. What happens between September of 2007 and December of 2007? I mean, it would seem to me that the

0006

Record of Decision presumably would be consistent with the final alternative in the final EIS.
MR. FULP: That's a good question. We will have the public comment period, as I mentioned, of 30 days. We've built -- this is a little bit of our float that's left, a little bit, not much. There's a little. But then also we'd have to develop the Record of Decision, write it and work through all the details of how the guidelines would work so that we can include those in the Record of Decision. So, we won't, I'm sure, be twiddling our thumbs during that period.
MR. DANOS: It's not like you're gonna spend three weeks with spell check.
MR. FULP: Not at all. Dave?
MR. KANZER: Dave Kanzer, Colorado River District. It's more of a comment. I mean, the way that we're -- we do the, what do you call it, the management group, we're always looking one year ahead, right? Now, this year we're doing 2008. So, in fact, we wouldn't implement these guidelines until 2009, correct? And so, are we incorporating any of this stuff into this year's process and do you need to change one of your slides to talk about the guidelines that really start in 2009?
MR. FULP: That's a really good question and I think we don't have a firm answer. It's not been

0007

obviously decided. But one approach might be that obviously we would develop our 2008 operating plan based on the guidance we have today, and that is not a decision yet. So we know what the guidance is, we have no storage criteria, we know what Powell's release, how it would be determined, right? There would be no storage and delivery mechanism, etcetera, right? One possibility might be, if we're successful and we implement a Record of Decision, as you well know Dave, you've been through this many times, there is a mid year review option in the AOP and we might, in fact if we have guidelines, sit down with the work group and say hey, we think it's appropriate to do review and see if we really need to change this operation based on the current knowledge.

And so that might be a possible way to go about it. So I guess to answer your question, no, we weren't willing to put 2009 down on the slide yet. We want to go ahead and see the process through and let us see. If we got into '08 and we have these guidelines in place and it looks like they ought to be applied, it seems to us we ought to apply them. That's one way we could do that.

MR. KANZER: So there may be discussion in this year's process which starts next month?

0008

MR. FULP: June actually. I can almost guarantee there will be discussion. Yes.

MS. HOUSTON: Janice Houston, University of Utah. Just a quick question about water delivery. I see that on the slide. Was there any consideration taken into the modeling of water delivery with the potential project that the State of Utah is kicking around about building of the pipeline from Lake Powell to St. George?

MR. FULP: There was not any assumption made with regard to that. Now, what we would point out that we did take the, you know, essentially the depletion schedules that are in the model, and I think you're probably familiar with that, that the Upper Colorado River Commission has supplied. Those are constant through the alternatives and no additional assumptions were made.

Anyone else?

(BEGINNING OF COMMENT PORTION)

MR. WECHSLER: I'm Jim Wechsler, I'm with the Sierra Club Southwest Waters Committee, which is a Regional committee, and we were one of the environmental groups that submitted the conservation before shortage proposal which was originally submitted as a conservation before shortage and then later adapted to the basin states. And I haven't read the DEIS yet. I

0009

have been practicing with the Manhattan telephone book, but I haven't read it yet. And so these comments are all taken from somebody else who glanced at Volume I and this managed to arrive in my E-mail this morning and I think it needs some clarification.

It's about how the conservation before shortage is represented in this DEIS. One thing that he noticed, and other people have said, is that the term voluntary shortage is quite common. We actually think that -- we didn't think anybody needs practice, and so we think voluntary conservation would probably be a better way to say it. Or as it said in one place, voluntary compensated reductions in water use. As Terry pointed out, compensation is a major feature. And another comment is that the ICS intentionally created surplus under the conservation before shortage proposal, can be assigned to other entities, and they aren't specified. And the other entities that we would -- was in our mind and we thought in our proposal were U.S. agencies, non governmental organizations, Mexican agencies and water users. So for unassigned, read that.

And I'm not sure this is correct. But he said that the way he read it was that the federal funding for ICS appeared to be limited to flows that were bypassed to the wetlands of Mexico to the Senega to Santa Clara.

0010

If it gives that impression, it's wrong, and I think everybody agrees that would be wrong.

And finally, that the ICS has talked about, relative to evaluation before shortage, suggests that all of it is assigned to Mexico. One of the things that the conservation before shortage proposal does is it's saying why not add Mexico to the mix, not just the basin states can create these, through extraordinary conservation events, a intentionally created surplus, but Mexico could as well. The reason for doing that is one, it adds flexibility and two, it does go directly to something we're interested in, which is the Delta area New Mexico. And to give an example of how you could add Mexico into that mix is, for example, southern Nevada is looking for more water. Southern Nevada could fund a project in Mexico that would conserve water. Some of that water would presumably go to Mexico, and Mexico, we've certainly had talks with them about the possibility of using some of their, what amounts to additional water. I mean, this could be lots of things. But for example, taking the most, perhaps most significant asset would be for southern Nevada to say construct a desalinization plant for agricultural runoff in Mexico, give some portion of that water back to Mexico.

0011

We would only be happy if we could convince Mexico in putting some of that to environmental uses in Mexico. The other portion would be stored in Lake Mead for southern Nevada's use. So, that that's a way for southern Nevada to gain more water out of the total system. That's one concept there, and that's why we added or suggested adding Mexico to the mix.

And those are just things I wanted to point out when you're reading this. Thanks.

MS. YODER: Thanks Jim.

MR. KANZER: I noticed on the list of areas where hard copies are available, none in western Colorado? I'm wondering whether the western area office could receive a copy?

MR. FULP: Absolutely.

MR. KANZER: Is this the full list, or what do you have to do to -- or maybe --

MR. FULP: We'll make sure they have it, we'll make sure they get a hard copy right away, that's an oversight.

(End of questions and comment session.)

0012

STATE OF UTAH)

COUNTY OF SALT LAKE)

I, Linda J. Smurthwaite, Certified Shorthand Reporter, Registered Professional Reporter, and notary public within and for the county of Salt Lake, State of Utah do hereby certify:

That the foregoing proceedings were taken by me at the time and place set forth herein, and was taken down by me in shorthand and thereafter transcribed into typewriting under my direction and supervision.

That the foregoing pages contain a true and correct transcription of my said shorthand notes so taken.

In Witness Whereof, I have subscribed my name this 7th day of April, 2007.

LINDA J. SMURTHWAITE
CERTIFIED SHORTHAND REPORTER

0013

RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

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