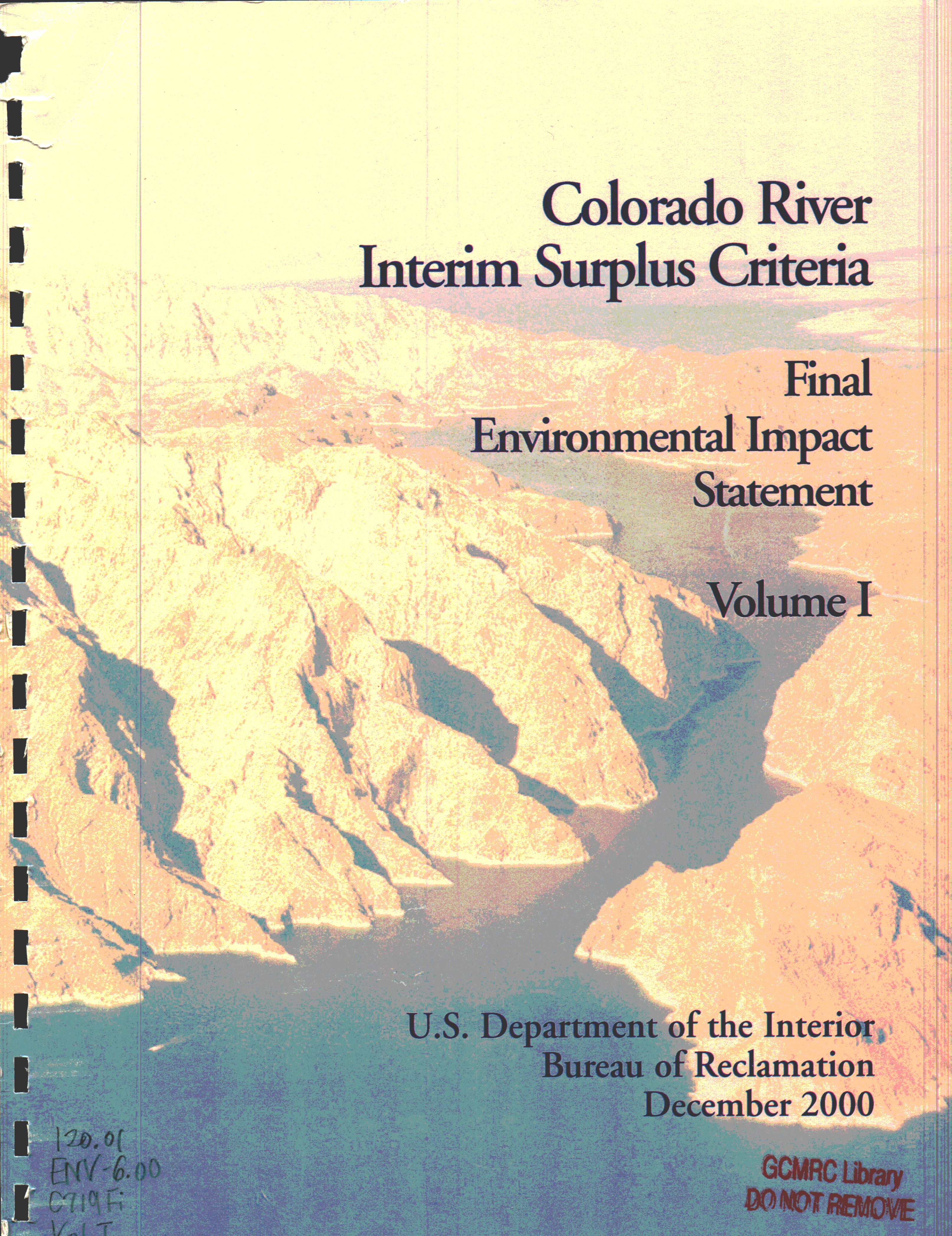

Colorado River Interim Surplus Criteria

Final Environmental Impact Statement

Volume I

U.S. Department of the Interior
Bureau of Reclamation
December 2000

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State Agencies

Tribes

Federal Agencies

Mexican Agencies/Organizations

Additional Tribe

Oral Comments

[1]This letter was submitted by the following organizations:

Defenders of Wildlife
Environmental Defense
El Centro de Derecho Ambiental e Integracion Economica del Sur, A.C.
Friends of Arizona Rivers
Glen Canyon Action Network
Glen Canyon Institute
Pacific Institute for Studies in Development, Environment and Security
Sierra Club
Fred Cagle
Jaqueline Garcia-Hernandez

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EXECUTIVE SUMMARY

ACRONYMS AND ABBREVIATIONS

4.4 Plan	California 4.4 Plan
AAC	All-American Canal
AAQS	ambient air quality standards
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
af	acre-feet
afy	acre-feet per year
AGFD	Arizona Game and Fish Department
ALP	Animas-La Plata Project
AMP	Glen Canyon Dam Adaptive Management Program
AMWG	Adaptive Management Work Group
AOP	Annual Operating Plan
APE	Area of Potential Effect
AWBA	Arizona Water Banking Authority
BA	Biological Assessment
Basin States	Colorado River Basin States
BCO	Biological and Conference Opinion
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
°C	degrees Celsius
CAP	Central Arizona Project
CA PLAN	California's Colorado River Water Use Plan
CAWCD	Central Arizona Water Conservation District
CBRFC	Colorado Basin River Forecast Center
CDFG	Colorado Department of Fish and Game
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
Clean Water Act	Federal Water Pollution Control Act
the Compact	Colorado River Compact of 1992
Corps	United States Army Corps of Engineers
Council	Advisory Council on Historic Preservation
Court	United States Supreme Court
CRBPA	Colorado River Basin Project Act of 1968
CRFWLS	Colorado River Front Work and Levee System
CRIR	Colorado River Indian Reservation
CRIT	Colorado River Indian Tribes
CRMWG	Colorado River Management Work Group
CRSP	Colorado River Storage Project

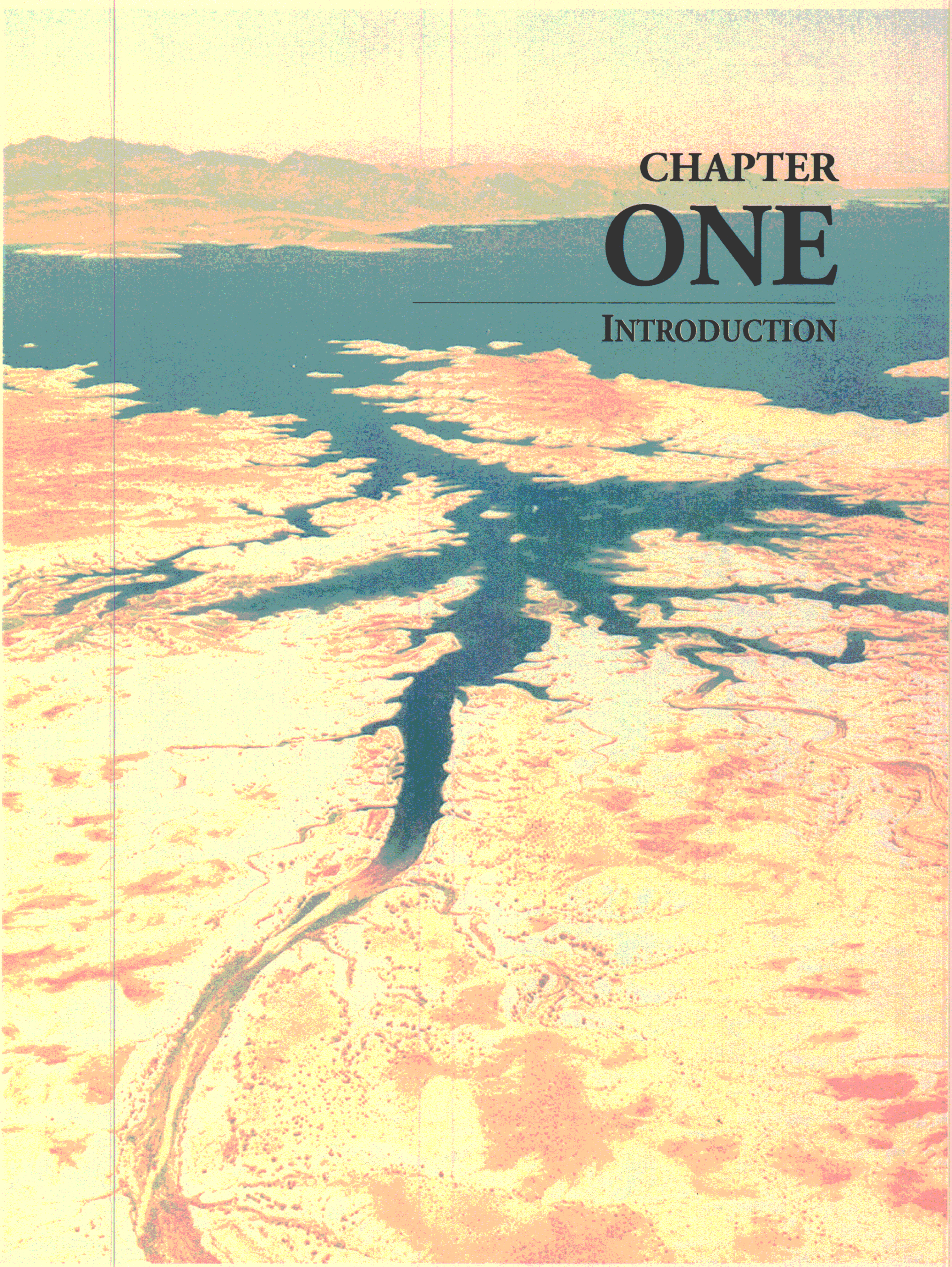
CRSPA	Colorado River Storage Project Act of 1956
CRSS	Colorado River Simulation System
CRSSez	A simplified version of CRSS
CUP	Central Utah Project
CVWD	Coachella Valley Water District
Decree	The 1964 U. S. Supreme Court Decree, *Arizona v. California*
DEIS	Draft Environmental Impact Statement
DO	dissolved oxygen
DOE	United States Department of Energy
EA	Environmental Assessment
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973, as amended
°F	degrees Fahrenheit
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
Forum	Colorado River Basin Salinity Control Forum
FWCA	Fish and Wildlife Coordination Act of 1934
GCNRA	Glen Canyon National Recreation Area
GRIC	Gila River Indian Community
Gulf	Gulf of California
GWh	gigawatt-hour
HAVFISH	Lake Havasu Fishery Improvement Project
HCP	Habitat Conservation Plan
IBWC	International Boundary and Water Commission United States and Mexico
IID	Imperial Irrigation District
Indian	American Indian
Interior	U.S. Department of the Interior
ISM	Indexed Sequential Method
ITA	Indian Trust Asset
kaf	thousand acre-feet
kV	kilovolt(s)
LCRAS	Lower Colorado River Accounting System
LCRMSCP	Lower Colorado River Multi-Species Conservation Program
LMNRA	Lake Mead National Recreation Area
LROC	Long-Range Operating Criteria
LVWCC	Las Vegas Wash Coordination Committee
LVWCAMP	Las Vegas Wash Comprehensive Adaptive Management Plan
M&I	municipal and industrial
maf	million acre-feet
mafy	million acre-feet per year
Mexico	United Mexican States
μg/g	micrograms per gram
μg/l	microgram per liter
mg/l	milligram per liter
mg/m^3	milligrams per cubic meter

MOA	Memorandum of Agreement
MOC	Memorandum of Clarification
MODE	Main Outlet Drain Extension
MOU	Memorandum of Understanding
mph	miles per hour
MSCP	Multi-Species Conservation Program for Lower Colorado River
msl	mean sea level
MW	megawatts
MWD	Metropolitan Water District of Southern California
MWh	megawatt-hours
NAAQS	National Ambient Air Quality Standards
NDEP	Nevada Division of Environmental Protection
NDOW	Nevada Division of Wildlife
NEPA	National Environmental Policy Act of 1969, as amended
NFWG	Native Fish Work Group
NHPA	National Historic Preservation Act of 1966
NHWZ	New High Water Zone
NIB	Northerly International Boundary
NIIP	Navajo Indian Irrigation Project
NMFS	National Marine Fisheries Service
NPS	National Park Service
NWR	National Wildlife Refuge
O&M	operation and maintenance
Pacific Institute	Pacific Institute for Studies in Development Environment and Security
P.L.	Public Law
PM	particulate matter
ppb	parts per billion
ppm	parts per million
PPR	present perfected rights
PVID	Palo Verde Irrigation District
Reclamation	United States Bureau of Reclamation
RM	river mile
RMP	Resource Management Plan
ROD	Record of Decision
San Carlos	San Carlos Apache Tribe
SCP	Colorado River Basin Salinity Control Program
SDCWA	San Diego County Water Authority
SDWA	Safe Drinking Water Act of 1974
Secretary	United States Secretary of the Interior
Section 7	Section 7 of the Federal Endangered Species Act
Section 10	Section 10 of the Federal Endangered Species Act
Service	United States Fish and Wildlife Service
SHPO	State Historic Preservation Officer
SIB	Southerly International Boundary
SLD	Shoreline Development Value
SNWA	Southern Nevada Water Authority

SNWS	Southern Nevada Water System
SRPMIC	Salt River Pima Maricopa Indian Community
SWP	California State Water Project
TDS	total dissolved solids
Treaty	U.S.-Mexico Water Treaty of 1944
UIIP	Uintah Indian Irrigation Project
Umho/cm^2	micromhos per centimeter squared
USGS	United States Geological Survey
USIBWC	United States Section of the International Boundary and Water Commission
Western	Western Area Power Administration
WSCC	Western States Coordinating Council

CHAPTER ONE

INTRODUCTION



1 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

The Secretary of the United States Department of the Interior (Secretary), acting through the United States Bureau of Reclamation (Reclamation), is considering the adoption of specific interim criteria under which surplus water conditions may be declared in the lower Colorado River Basin during a 15-year period that would extend through 2016.

The Secretary 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 collection of documents known as the *Law of the River*, which includes a combination of federal and state statutes, interstate compacts, court decisions and decrees, an international treaty, contracts with the Secretary, operating criteria, regulations and administrative decisions (see Section 1.3.2.1 for a further discussion of the *Law of the River*).

The long-term Colorado River system management objectives are to:

- Minimize flood damages from river flows,
- Release water only in accordance with the 1964 Decree in *Arizona v. California* (Decree),
- Protect and enhance the environmental resources of the basin,
- Provide reliable delivery of water for beneficial consumptive use,
- Increase flexibility of water deliveries under a complex allocation system,
- Encourage efficient use of renewable water supplies,
- Minimize curtailment to users who depend on such supplies, and
- Consider power generation needs.

As the agency that is designated to act on the Secretary's behalf with respect to these matters, Reclamation is the Lead Federal Agency for the purposes of NEPA compliance for the development and implementation of the proposed interim surplus criteria. The National Park Service (NPS) and the United States Section of the International Boundary and Water Commission (USIBWC) are cooperating agencies for purposes of assisting with the environmental analysis.

This Final Environmental Impact Statement (FEIS) 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 [CFR] Parts 1500 through 1508). This FEIS has been prepared to address the formulation and evaluation of specific interim surplus criteria and to identify the potential environmental effects of implementing such criteria.

This FEIS addresses the environmental issues associated with, and analyzes the environmental consequences of various alternatives for specific interim surplus criteria. The alternatives addressed in this FEIS are those Reclamation has determined would meet the purpose and need for the federal action and represent a broad range of the most reasonable alternatives.

1.1.1 PROPOSED FEDERAL ACTION

The proposed federal action is the adoption of specific interim surplus criteria pursuant to Article III(3)(b) of the *Criteria for Coordinated Long-Range Operation of the Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968* (Long-Range Operating Criteria [LROC]). The interim surplus criteria would be used annually to determine the conditions under which the Secretary may declare the availability of surplus water for use within the states of Arizona, California and Nevada. The criteria must be consistent with both the Decree entered by the United States Supreme Court in 1964 in the case of *Arizona v. California* and the LROC. The interim surplus criteria would remain in effect for determinations made through calendar year 2015 regarding the availability of surplus water through calendar year 2016, subject to five-year reviews conducted concurrently with LROC reviews, and would be applied each year as part of the Annual Operating Plan (AOP).

1.1.2 BACKGROUND

Pursuant to Article II(B)2 of the Decree, if there exists sufficient water available in a single year for pumping or release from Lake Mead to satisfy annual consumptive use in the States of California, Nevada, and Arizona in excess of 7.5 million acre-feet (maf), such water may be determined by the Secretary to be available as "surplus" water. The Secretary is authorized to determine the conditions upon which such water may be made available. The Colorado River Basin Project Act of 1968 (CRBPA) directs the Secretary to adopt criteria for coordinated long-range operation of reservoirs on the Colorado River in order to comply with and carry out the provisions of the Colorado River Compact of 1922 (Compact), the Colorado River Storage Project Act of 1956 (CRSPA), the Boulder Canyon Project Act of 1928 (BCPA) and the United States-Mexico Water Treaty of 1944 (Treaty). These criteria are the LROC, described in detail later in this chapter and reproduced in Attachment A. The Secretary sponsors a formal review of the LROC every five years.

The LROC provide that the Secretary will determine the extent to which the reasonable consumptive use requirements of mainstream users in Arizona, California and Nevada (the Lower Division states) can be met. The LROC define a normal year as a year in which annual pumping and release from Lake Mead will be sufficient to satisfy 7.5 maf of consumptive use in accordance with the Decree. A surplus year is defined as a year in which water in quantities greater than normal (i.e., greater than 7.5 maf) is available for pumping or release from Lake Mead pursuant to Article II(B)2 of the Decree after consideration of relevant factors, including the factors listed in the LROC. Surplus water is available to agencies which have contracted with the Secretary for delivery of surplus water, for use when their water demand exceeds their basic entitlement, and when the excess demand cannot be met within the basic apportionment of their state. Water apportioned to, but unused by one or more Lower Division states can be used to satisfy beneficial consumptive use requests of mainstream users in other Lower Division states as provided in Article II(B)(6) of the Decree.

Pursuant to the CRBPA, the LROC are utilized by the Secretary, on an annual basis, to make determinations with respect to the projected plan of operations of the storage reservoirs in the Colorado River Basin. The AOP is prepared by Reclamation, acting on behalf of the Secretary, in consultation with representatives of the Colorado River Basin states (Basin States) and other parties, as required by federal law. The interim surplus criteria would serve to implement the provisions of Article III(3)(b) of the LROC on an annual basis in the determinations made by the Secretary as part of the AOP process.

1.1.3 PURPOSE OF AND NEED FOR ACTION

To date, the Secretary has applied factors, including but not limited to those found in Article III(3)(b)(i-iv) of the LROC, in annual determinations of the availability of surplus quantities of water for pumping or release from Lake Mead. As a result of actual operating experience and through preparation of AOPs, particularly during recent years when there has been increasing demand for surplus water, the Secretary has determined that there is a need for more specific surplus criteria, consistent with the Decree and applicable federal law, to assist in the Secretary's annual decision making during an interim period.

For many years, California has been diverting more than its normal 4.4 maf apportionment. Prior to 1996, California utilized unused apportionments of other Lower Division states that were made available by the Secretary. Since 1996, California has also utilized surplus water made available by Secretarial determination. California is in the process of developing the means to reduce its annual use of Colorado River water to 4.4 maf. Arizona is approaching full use of its apportionment and Nevada was expected to reach its apportionment in 2000.

Additionally, through adoption of specific interim surplus criteria, the Secretary will be able to afford mainstream users of Colorado River water, particularly those in California who currently utilize surplus flows, a greater degree of predictability with respect to the likely existence, or lack thereof, of surplus conditions on the river in a given year. Adoption of the interim surplus criteria is intended to recognize California's plan to reduce reliance on surplus deliveries, to assist California in moving toward its allocated share of Colorado River water, and to avoid hindering such efforts. Implementation of interim surplus criteria would take into account progress, or lack thereof, in California's efforts to achieve these objectives. The surplus criteria would be used to identify the specific amount of surplus water which may be made available in a given year, based upon factors such as the elevation of Lake Mead, during a period within which demand for surplus Colorado River water will be reduced. The increased level of predictability with respect to the prospective existence and quantity of surplus water would assist in planning and operations by all entities that receive surplus Colorado River water pursuant to contracts with the Secretary.

1.1.4 RELATIONSHIP TO THE UNITED STATES-MEXICO WATER TREATY

Under Article 10(a) of the Treaty, the United Mexican States (Mexico) is entitled to an annual amount of 1.5 maf of Colorado River water. Under Article 10(b) of the Treaty, Mexico may schedule up to an additional 0.2 maf when "there exists a surplus of waters of the Colorado River in excess of the amount necessary to satisfy uses in the United States." This is in addition to surplus determinations for the Lower Division states made pursuant to Article II(2)(b) of the Decree and Article III(3)(B) of the LROC. The proposed action is not intended to identify, or change in any manner, conditions when Mexico may schedule this additional 0.2 maf. Under current practice, surplus declarations under the Treaty for Mexico are declared when flood control releases are made. Modeling assumptions used in this EIS are based upon this practice. Reclamation is currently engaged in discussions with Mexico through the IBWC on the effects of the proposed action.

1.1.5 LEAD AND COOPERATING AGENCIES

The Secretary is 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*. 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 surplus criteria.

The NPS and the USIBWC are cooperating agencies for purposes of assisting with the environmental analysis. The NPS administers three areas of national significance along the Colorado River: Glen Canyon National Recreation Area (GCNRA), Grand Canyon National Park and Lake Mead National Recreation Area (LMNRA). The NPS administers recreation, cultural and natural resources in these areas from offices at Page and 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.

The International Boundary and Water Commission United States and Mexico (IBWC) is a bi-national organization responsible for administration of the provisions of the Treaty, including the Colorado River waters allocated to Mexico, protection of lands along the Colorado River from floods by levee and floodway projects, resolution of international boundary water sanitation and other water quality problems, and preservation of the river as the international boundary. The IBWC consists of the United States Section and the Mexico Section, which have their headquarters in the adjoining cities of El Paso, Texas and Ciudad Juarez, Chihuahua, respectively.

1.2 SUMMARY OF CONTENTS OF THIS FEIS

Following is a brief description of the topics presented in the three volumes that comprise this FEIS, including a summary of the chapters in Volume I.

Volume I of this FEIS (this volume) describes the proposed action, the alternatives considered, the analysis of potential effects of interim surplus criteria on Colorado River operation and associated resources, and environmental commitments associated with the action alternatives. The contents of the chapters in this volume are as follows:

Chapter 1, Introduction, includes the following: identification of the purpose of and need for the interim surplus criteria being considered; background information concerning the apportionment of Colorado River water and the physical facilities associated with the Colorado River system; and discussion of the institutional framework within which the river system is managed. Chapter 1 also discusses previous and ongoing actions that have a relationship to the proposed interim surplus criteria.

Chapter 2, Description of Alternatives, describes the process of formulating alternatives and presents the reservoir operation strategies of each alternative under consideration. A summary table of potential environmental consequences of action alternatives is provided at the end of Chapter 2.

Chapter 3, Affected Environment and Environmental Consequences, presents the analysis of baseline conditions along with potential impacts that could result from implementation of the interim surplus criteria alternatives under consideration. The discussion addresses both the affected environment (existing conditions within the area of potential effect) and environmental consequences (potential effects of the interim surplus criteria alternatives that could occur as compared to baseline projections). Also discussed, in Section 3.17, are environmental commitments that Reclamation would undertake if interim surplus criteria are implemented.

Chapter 4, Other NEPA Considerations, discusses cumulative impacts, the relationship between short-term use and long-term productivity, and irreversible and irretrievable commitments of resources affected by the interim surplus criteria under consideration.

Chapter 5, 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 during the preparation of this document and any permitting or approvals that may be necessary for implementation of proposed interim surplus criteria.

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 FEIS, a list of persons contributing to the preparation of the FEIS, a distribution list of agencies, organizations and persons receiving copies of the document, and an index.

Volume II contains attachments which are comprised of documents and other supporting material that provide detailed historical background and/or technical information concerning this proposed action.

Volume III contains reproductions of letters from the public resulting from the public review of the Draft Environmental Impact Statement (DEIS) and Reclamation's responses to the comments received.

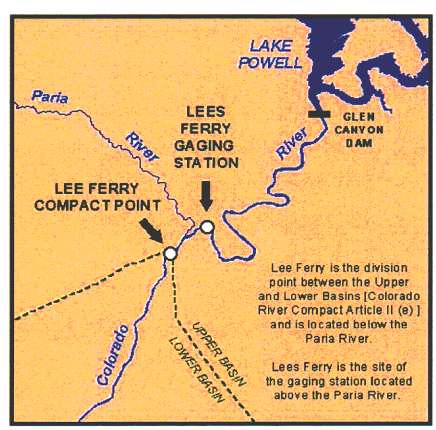
1.3 WATER SUPPLY MANAGEMENT AND ALLOCATION

This section summarizes the water supply available in the Colorado River Basin from natural runoff, its distribution under the *Law of the River*, and the reservoirs and diversion facilities through which the water supply is administered from Lake Powell to Mexico.

1.3.1 COLORADO RIVER SYSTEM WATER SUPPLY

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 benefits.

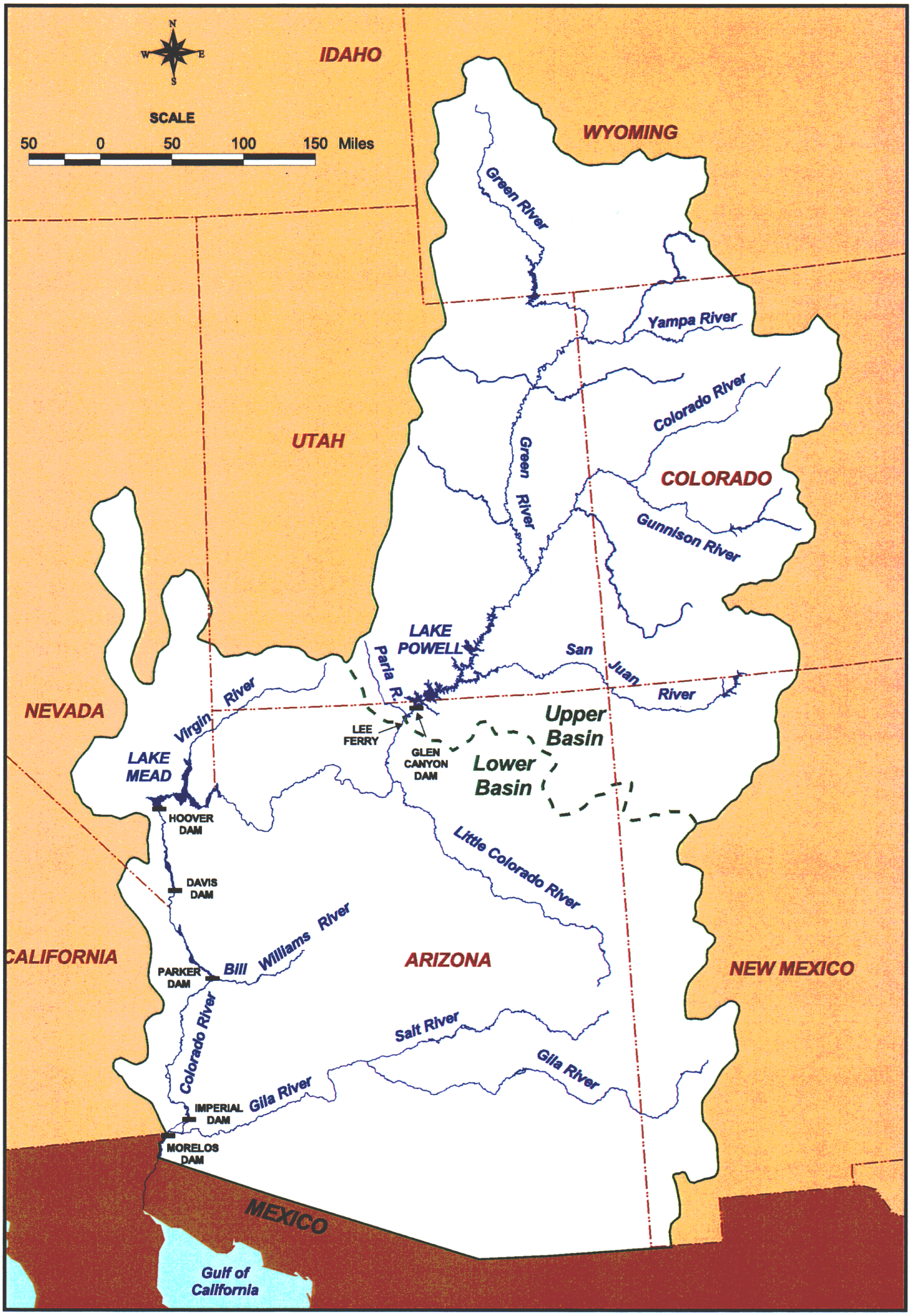
Figure 1-1
Locations of Lee Ferry and Lees Ferry



The Colorado River Basin is located in the southwestern United States, as shown on Map 1-1, and occupies a total area of approximately 250,000 square miles. The Colorado River is approximately 1400 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 Basin is comprised of desert

Map 1-1 Colorado River Drainage Basin



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 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, San Juan, Yampa, Gunnison and Gila Rivers.

The annual flow of the Colorado River varies considerably from year to year. The natural flow at the Lees Ferry gaging station (see Figure 1-1), located 17 river miles (RMs) below Glen Canyon Dam, has varied annually, from 5 maf to 23 maf. Natural flow represents an estimate of flows that would exist without reservoir regulation, depletion, or transbasin diversion by man.

Most of the lower Colorado River's water, or about 88 percent of the annual natural supply, flows into the Lower Basin from the Upper Basin and is accounted for at Lee Ferry, Arizona. The remaining 12 percent of the lower Colorado River's water is attributed to sidewash inflows due to rainstorms and tributary rivers in the Lower Basin. The Lower Colorado River Basin's mean annual tributary inflow is about 1.38 maf, excluding the intermittent Gila River inflow. Actual tributary inflows are highly variable from year to year.

1.3.2 APPORTIONMENT OF WATER SUPPLY

This section summarizes the Colorado River apportionments of the Basin States and Mexico stemming from the *Law of the River*, past and current river diversions and consumptive use and projected future depletions. The apportionments of the Basin States are stipulated in terms of consumptive use, which consists of diversions minus return flows to the river system.

1.3.2.1 THE *LAW OF THE RIVER*

As stated previously, the Secretary is vested with the responsibility to manage the mainstream waters of the lower Colorado River 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* encompasses 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 among the Upper and Lower Basins; The Boulder Canyon Project Act of 1928 (BCPA), which authorized construction of Hoover Dam and the All-American Canal (AAC), also authorized the Lower Division states to enter into an agreement apportioning the water, 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;

2) The California Seven Party Water Agreement of 1931, which established the relative priorities of rights among major users of Colorado River water in California who claimed rights at that time;

3) The United States-Mexico Water Treaty of 1944 and subsequent specific applications through minutes of the IBWC related to the quantity and quality of Colorado River water delivered to Mexico;

4) The Upper Colorado River Basin Compact of 1948), which apportioned the Upper Basin water supply;

5) 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;

6) The 1964 United States Supreme Court Decree, *Arizona v. California* (Decree), which confirmed 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 mainstem apportionments of 4.4 maf for use in California, 2.8 maf for use in Arizona and 0.3 maf for use in Nevada; addressed the reservation of water for American Indian (Indian) reservations and other federal reservations in California, Arizona and Nevada; and confirmed the significant role of the Secretary in managing the mainstream of the Colorado River within the Lower Basin;

7) The Colorado River Basin Project Act of 1968,which authorized construction of a number of water development projects including the Central Arizona Project (CAP) and required the Secretary to develop the LROC;

8) 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

9) The Grand Canyon Protection Act of 1992, which addressed the protection of resources in Grand Canyon National Park and Glen Canyon National Recreation Area.

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

1.3.2.2 APPORTIONMENT PROVISIONS

The initial apportionment of water from the Colorado River was determined as part of the 1922 Colorado River Compact. The Compact divided the Colorado River into two sub-basins, the Upper Basin and the Lower Basin (see Map 1-2). 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 (Arizona). The Compact also divided the seven Basin States into the Upper Division and the Lower Division (see Map 1-3). The Upper Division consists of the states of Wyoming, Utah, Colorado and New Mexico. The Lower Division consists of the states of Arizona, California and Nevada.

Map 1-2
Upper and Lower Basins of the Colorado River

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

The River and Harbor Act, 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

United States-Mexico Water Treaty 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

United States Supreme Court Decree, *Arizona v. California*, March 9, 1964

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

Supplemental Irrigation Facilities, Yuma Division Act of September 25, 1970

Minutes 218, March 22, 1965; 241, July 14, 1972, (replaced 218); and 242, August 30, 1973, (replaced 241) of the International Boundary and Water Commission, pursuant to the United States-Mexico Water Treaty of 1944

The Colorado River Basin Salinity Control Act of June 24, 1974

United States Supreme Court Supplemental Decrees, *Arizona v. California*, January 9, 1979 and April 16, 1984

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

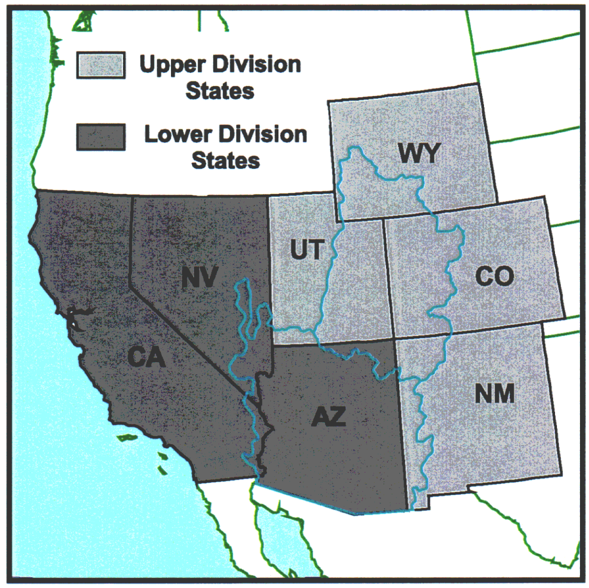
Grand Canyon Protection Act of October 30, 1992

43 CFR 414 Offstream Storage of Colorado River Water in the Lower Division States

43 CFR 417 Lower Basin Water Conservation Measures

The Compact apportioned to each Basin, in perpetuity, the exclusive beneficial consumptive use of 7.5 maf of water per year. In addition to this apportionment, Article III(b) gives the Lower Basin the right to increase its beneficial consumptive use by 1.0 maf per annum. The Compact also stipulates in Article III(d) that the states of the Upper Division will not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75 maf for any period of 10 consecutive years.

Map 1-3
Upper and Lower Division States of the Colorado River



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 tribes to Colorado River water were subsequently adjudicated, some Tribal rights remain unadjudicated.

1.3.2.2.1 Upper Division State Apportionments

The Compact apportioned 7.5 maf of water in perpetuity to the Upper Basin. The Upper Basin Compact apportioned among the four Upper Division states the following percentages of the total quantity of consumptive use apportioned to and available for use each year by the Upper Basin under the Upper Colorado River Basin Compact and remaining after deduction of the use, not to exceed 50,000 acre-feet (af) per annum, made in the State of Arizona:

- Wyoming 14.00 percent
- Utah 23.00 percent
- Colorado 51.75 percent
- New Mexico 11.25 percent

In 1988, a determination of Upper Basin water supply was made in *Hydrologic Determination: Water Availability from Navajo Reservoir and the Upper Colorado River Basin for Use in New Mexico* (Interior, 1989). In consideration of Article 3(d) of the Compact and accounting for the decrease in the average natural flow of the Colorado River since the signing of the Compact in 1922, the Determination concluded that Upper Basin annual water depletion can reasonably be expected to reach six maf.

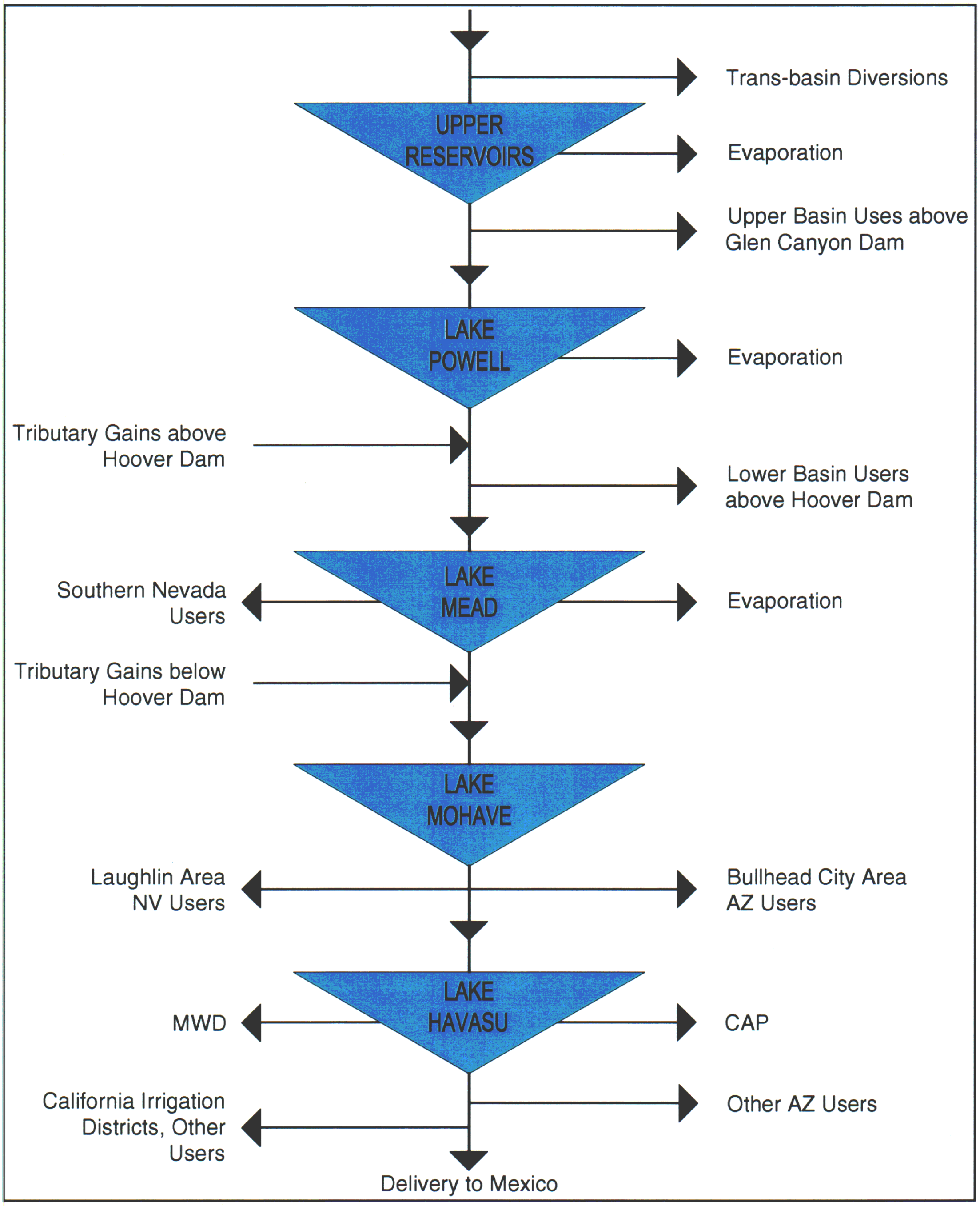
1.3.2.2.2 Lower Division State Apportionments

If sufficient mainstream water is available for release, as determined by the Secretary, to satisfy 7.5 maf of consumptive use in the Lower Division states, then the amount of Colorado River water apportioned for consumptive use in each Lower Division state is expressed in terms of a fixed amount in each state, subject to varying provisions at times of surpluses or shortages. These apportionments are: California, 4.4 maf; Arizona, 2.8 maf; and Nevada, 0.3 maf, totaling 7.5 maf. Figure 1-2 presents a schematic of the operation of the Colorado River, primarily in the Lower Basin. The apportionments to the Lower Division states were established by the BCPA and confirmed by the Decree. 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 offstream for future use by that state or another state.

All mainstream Colorado River waters apportioned to the Lower Basin, except for a few thousand af apportioned for use in the State of 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 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.

The highest priority Colorado River water rights are present perfected rights (PPRs), which the Decree defines as those perfected rights existing on June 25, 1929, the effective date of the BCPA. The Decree also recognizes Federal Indian reserved rights for the quantity of water necessary to irrigate all the practicably irrigable acreage on five Indian reservations along the lower Colorado River. The 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.

Figure 1-2
Schematic of Colorado River Releases and Diversions



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 to water users within that state after consultation with the state as required by the BCPA.

1.3.2.2.3 Mexico Apportionment

Mexico has an annual apportionment of 1.5 maf of Colorado River water, based on the provisions of the Treaty. Mexico may also receive additional water under two conditions. First, when surplus water exists in excess of the amount that can be beneficially used by the Basin States, Mexico is apportioned up to an additional 200,000 af of water which Mexico is allowed to schedule throughout the year in accordance with Article 15 of the Treaty. Second, when high runoff and flooding occur on the Colorado or Gila Rivers that is substantially more than can be put to beneficial use by the Lower Division states, such runoff flows into Mexico.

Deliveries to Mexico are subject to reduction under extraordinary drought conditions or serious accident to the irrigation system in the United States. In such cases, deliveries to Mexico, as provided for under the Treaty, could be reduced in proportion to the reduction faced by users in the United States.

As part of this NEPA documentation, international impacts are addressed in Section 3.16 pursuant to Executive Order 12114-Environmental Effects Abroad of Major Federal Actions, January 4, 1997, and the July 1, 1997 CEQ Guidelines on NEPA Analyses for Transboundary Impacts. (See Attachment B for copies of these documents.)

1.3.3 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 (see Attachment A), control the operation of the Colorado River reservoirs in compliance with requirements set forth in the Compact, the CRSPA, the BCPA, the Treaty and other applicable federal laws. Under the LROC, the Secretary makes annual determinations in the AOP (discussed in the following section) regarding the availability of Colorado River water for deliveries to the Lower Division states (Arizona, California and Nevada). A requirement to equalize the active 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. A more complete discussion of this concept is presented in Section 1.4.2 of this document.

Section 602 of the CRBPA, as amended, provides that the LROC can only be modified after correspondence with the governors of the seven Basin States and appropriate consultation with such state representatives as each governor may designate. The LROC call 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 Glen Canyon Dam. Past reviews have not resulted in any changes to the criteria.

1.3.4 ANNUAL OPERATING PLAN

The CRBPA requires preparation of an AOP for the Colorado River reservoirs that guides the operation of the system for the water year. The AOP describes how Reclamation will manage the reservoirs over a 12-month period, consistent with the LROC and the Decree. The AOP is prepared annually by Reclamation in cooperation with the Basin States, other 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 makes annual determinations regarding the availability of Colorado River water for deliveries to the Lower Division states as described below.

1.3.4.1 NORMAL, SURPLUS AND SHORTAGE DETERMINATIONS

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.

Normal conditions exist 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 covered under a contract with the consuming entity.

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 California, Arizona and Nevada in allocations of 50, 46 and four percent, respectively. As stated above, 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 covered under a contract with the consuming entity. Surplus water under the Decree, for use in the Lower Division states, was made available by the Secretary in calendar years 1996, 1997, 1998, 1999 and 2000.

Deliveries of surplus water to Mexico in accordance with the Treaty were made in calendar years 1983-1988, 1997, 1998, 1999 and 2000.

Shortage conditions exist when the Secretary determines that insufficient mainstream water is available to satisfy 7.5 maf of annual consumptive use in the Lower Division states. When making a shortage determination, the Secretary must consult with various parties as set forth in the Decree and consider all relevant factors as specified in the LROC (described above), including Treaty obligations, the priorities set forth in the Decree, and the reasonable consumptive use requirements of mainstream water users in the Lower Division. The Secretary is required to first provide for the satisfaction of the PPRs in the order of their priority, then to users who held contracts on September 30, 1968 (up to 4.4 maf in California), and finally to users who had contracted on September 30, 1968, when the CAP was authorized. To date, a shortage has never been determined.

1.3.5 SYSTEM RESERVOIRS AND DIVERSION FACILITIES

The Colorado River system contains numerous reservoirs that provide an aggregate of approximately 60 maf of active storage. Lake Powell and Lake Mead provide approximately 85 percent of this storage.

Upper Basin reservoirs provide approximately 31.2 maf of active storage, of which Lake Powell provides 24.3 maf. The other major storage reservoirs in the Upper Basin include Flaming Gorge Reservoir on the Green River, Navajo Reservoir on the San Juan River, and Blue Mesa Reservoir on the Gunnison River.

The Lower Basin dams and reservoirs include Hoover, Davis and Parker dams, shown on Map 1-4. Hoover Dam created Lake Mead and can store up to 26.2 maf of active storage. 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 creates Lake Mohave and provides 1.8 maf of active storage. Parker Dam forms Lake Havasu 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' (Corps) 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, listed in Table 1-2, 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.

Map 1-4
Lower Colorado River Dams

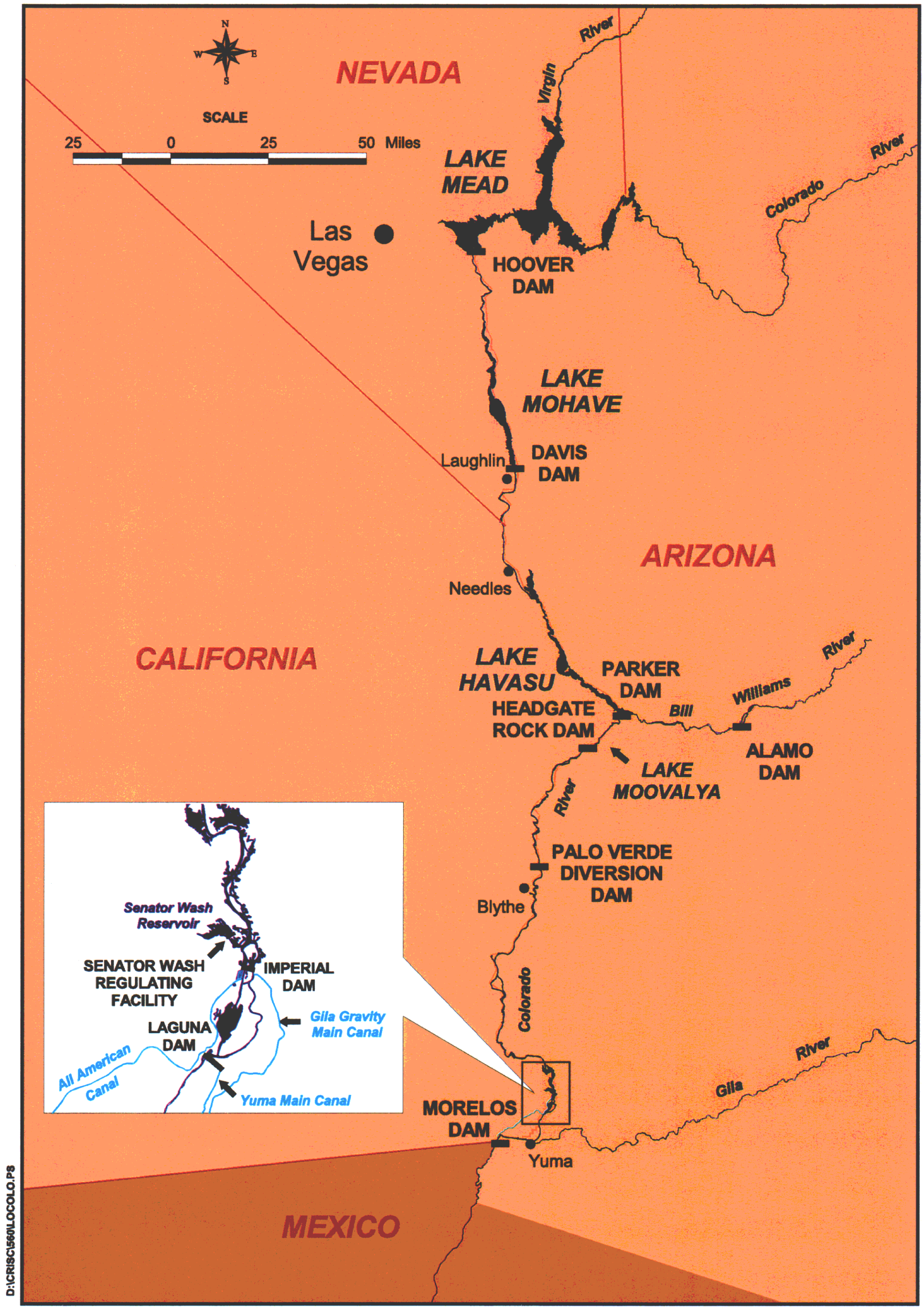


Table 1-2 summarizes the Colorado River storage facilities (i.e., dams and reservoirs) and major diversion dams from Lake Powell downstream to Morelos Dam. Attachment C, Dams and Reservoirs Along the Lower Colorado River, describes the reservoirs and the role that each plays in the operation of the Colorado River system.

Table 1-2
Colorado River Storage Facilities and Major Diversion Dams from Lake Powell to Morelos Dam

Facility	Reservoir	Location	Storage Capacity (af)
Glen Canyon Dam	Lake Powell	Upstream of Lee Ferry, Utah, Arizona	24,322,000 Live
Hoover Dam	Lake Mead	Nevada and Arizona near Las Vegas, 270 miles downstream of Glen Canyon Dam	27,400,000 Live
Davis Dam	Lake Mohave	70 miles downstream of Hoover Dam	1,818,000
Parker Dam	Lake Havasu[1]	150 miles downstream of Hoover Dam	648,000
Headgate Rock Dam	Lake Moovalya	164 miles downstream of Hoover Dam	N.A.[3]
Palo Verde Diversion Dam	Unnamed impoundment	209 miles downstream of Hoover Dam	N.A.[3]
Senator Wash regulating facility	Senator Wash Reservoir[2]	290 miles downstream of Hoover Dam near Imperial Dam	13,800
Imperial Dam	Unnamed impoundment	290 miles downstream of Hoover Dam	1000
Laguna Dam	Unnamed impoundment	300 miles downstream of Hoover Dam	700
Morelos Dam	Unnamed impoundment	320 miles downstream of Hoover Dam	N.A.[3]

1 Lake Havasu provides a relatively constant water level for pumped diversions by MWD and CAP.
2 Senator Wash Reservoir is an offstream reservoir with a pumping/generating plant.
3 Run-of-river diversion structure.

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 below Davis Dam in the Laughlin area.

There are several points of diversion in Arizona. Up to 50,000 af of water is diverted above Lee Ferry. The intake for the CAP is the pumping plant on Lake Havasu below the confluence of the Bill Williams River. Irrigation water for the Fort Mojave Indian Reservation, near Needles, California, is pumped 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 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 and Drainage District's diversion at the Palo Verde Diversion Dam near Blythe, California; and the AAC diversion at Imperial Dam.

1.3.6 FLOOD CONTROL OPERATION

Under the BCPA, flood control was 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 Corps) will prescribe regulations for flood control for projects authorized wholly or partially for such purposes.

The Los Angeles District of the Corps published the current flood control regulations in the *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 Corps 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 Corps and Reclamation; however, the Corps 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. Any deviation from the flood control operating criteria must be authorized by the Corps.

Flood control operation of Lake Mead was established to deal with two distinct types of flooding—snowmelt and rain. Snowmelt constitutes about 70 percent of the annual runoff in the Upper Basin. Lake Mead's uppermost 1.5 maf of storage capacity, between elevations 1219.61 feet above msl and 1229.0 feet msl, are allocated exclusively to control floods from rain events.

The flood control regulations set forth two primary criteria to deal with snowmelt:

- Preparatory reservoir space requirements, applicable from August 1 through December 31; and
- Application of runoff forecasts to determine releases, applicable from January 1 through July 31.

In preparation for each year's seasonal snow accumulation and associated runoff, the first criterion provides for progressive expansion of the total Colorado River system reservoir space during the latter months of each year. Required system space increases from 1.5 maf on August 1 to 5.35 maf on January 1. Required flood storage space up to 3.85 maf can be located within Lake Powell and in specified Upper Basin reservoirs.

Space-building releases from Lake Mead are made when needed to meet the required August 1 to January 1 flood control space. Space-building releases beyond the minimum requirements of the Corps' Water Control Manual (often described as anticipatory flood control releases) may be considered by the Secretary. The Secretary takes into consideration the following: 1) the channel capacity of the river below Davis Dam; 2) the channel capacity and channel maintenance of the river below the Southerly International Boundary (SIB) (through the IBWC); and 3) power plant maintenance requirements at Hoover, Davis and Parker dams.

Between January 1 and July 31, flood control releases, based on the maximum forecasted inflow into Lake Mead, may be required to prevent filling of Lake Mead beyond its 1.5 maf minimum flood control space. Each month, runoff forecasts are developed by the National Weather Service's Colorado Basin River Forecast Center. The required monthly releases from Hoover Dam are determined based on available space in Lake Mead and upstream reservoirs and the maximum forecasts of inflow into Lake Mead. Average monthly releases are determined each month and apply only to the current month. Release rates, developed pursuant to the Colorado River Floodway Protection Act of 1986, are discussed in Section 3.6.4.1.

1.3.7 HYDROPOWER GENERATION

Reclamation is authorized by legislation to produce electric power at each of the major Colorado River system dams, except Navajo Dam. Power generation at the Glen Canyon Dam Powerplant requires the water surface elevation of Lake Powell to be above 3490 feet msl. Water is released from Glen Canyon Dam Powerplant into the Colorado River through a combination of the eight main generating units. The minimum water surface elevation of Lake Mead necessary for power generation at Hoover Powerplant is approximately 1083 feet msl. Water is released from Hoover Powerplant to Lake Mohave through a combination of the 17 main generating units. Water is then released at Davis Dam Powerplant into the river through a combination of the five generators. Parker Dam is the last major regulating and reservoir facility on the Lower Colorado River. All releases scheduled from Parker Dam are in response to downstream water orders and reservoir regulation requirements and pass through a combination of its four generators.

Although Reclamation is the federal agency authorized to produce power at the major Colorado River system dams, Western Area Power Administration (Western) is the federal agency authorized to market 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. The released water generates power, but water is not to be released from any Colorado River facility for the sole purpose of generating power.

Under operating agreements with Western, Reclamation is subject to downstream water requirements to meet the power generation schedules of Hoover, Parker and Davis dams. Western produces these schedules in accordance with existing electric service contracts, recognizing Reclamation's release requirements on the lower Colorado River (i.e., based on downstream delivery requirements) from the respective reservoirs.

1.4 RELATED AND ONGOING ACTIONS

A number of ongoing and new actions proposed by Reclamation and other entities are related to the development of interim surplus criteria and the analysis contained in this document. This section describes these actions and their relationship to the development of interim surplus criteria. The following actions have been described in environmental documents, consultation packages under Section 7 of the ESA, or as project planning documents. Where appropriate, this FEIS incorporates by reference information contained in these documents. The documents described below are available for public inspection upon request at Reclamation offices in Boulder City, Nevada; Salt Lake City, Utah; and Phoenix and Yuma, Arizona.

1.4.1 CALIFORNIA'S COLORADO RIVER WATER USE PLAN

California's Colorado River Water Use Plan (CA Plan), which was formerly known as the California 4.4 Plan or the 4.4 Plan, calls for conservation measures to be put in place that will reduce California's dependency on surplus Colorado River water. Surplus water is required to meet California's current needs until implementation of the conservation measures can take place. During the period ending in 2016, the State of California has indicated that it intends to reduce its reliance on Colorado River water to meet its water needs above and beyond its 4.4-maf apportionment. It is important for the long-term administration of the system to bring the Lower Basin uses into accordance with the Lower Basin normal apportionment. In order to achieve its goals, California has expressed a need to continue to rely in some measure on the existence of surplus Colorado River water through 2016. These interim surplus criteria could aid California and its primary Colorado River water users as California reduces its consumptive use to 4.4 maf while ensuring that the other Basin States will not be placed at undue risk of future shortages.

The CA Plan contains numerous water conservation projects, intrastate water exchanges, and groundwater storage facilities. The CA Plan is related to the implementation of the interim surplus criteria in the ways discussed below.

First, implementation of the CA Plan is necessary to ensure the Colorado River system can meet the normal year deliveries in the Lower Basin over the long term. Failure of California to comply with the CA Plan places at risk the objective of providing reliable delivery of water for beneficial consumptive use to Lower Basin users. Therefore, the Secretary may condition the continuation of interim surplus criteria for the entire period through 2016 on a showing of satisfactory progress in implementing the CA Plan. Regardless of which alternative is ultimately selected, failure of California to carry out the CA Plan may result in termination or suspended application of the proposed interim surplus criteria. In that event, the Secretary would fashion appropriate surplus criteria for the remaining period through 2016. For example, the Basin States Alternative presented in Chapter 2 anticipates that the 70R strategy would be used in the event of such a reversion.

Second, from the perspective of the State of California, because of the linkage between various elements of the CA Plan and the quantities of water involved, a reliable supply of interim surplus water from the Colorado River is an indispensable pre-condition to successful implementation of the CA Plan.

From the standpoint of environmental documentation and compliance, the CA Plan and its various elements have been, or will be, addressed under separate federal and/or state environmental reporting procedures.

1.4.1.1 IMPERIAL IRRIGATION DISTRICT/SAN DIEGO COUNTY WATER AUTHORITY WATER TRANSFER

The Imperial Irrigation District (IID)/San Diego County Water Authority (SDCWA) water transfer is one of the intrastate exchanges that is a part of the CA Plan. SDCWA has negotiated an agreement for the long-term transfer of conserved water from the IID. Under the proposed contract, IID customers would undertake water conservation efforts to reduce their use of Colorado River water. Water conserved through these efforts would be transferred to SDCWA. The agreement sets the transfer quantity at a maximum of 200 kaf/year. After at least 10 years of primary transfers, an additional discretionary component not to exceed 100 kaf/year may be transferred to SDCWA, MWD of Southern California, or Coachella Valley Water District in connection with the settlement of water rights disputes between IID and these agencies. The initial transfer target date is 2002, or whenever the conditions necessary for the agreement to be finalized are satisfied or waived, whichever is later. This transfer is being addressed in an ongoing EIS/EIR and involves the change in point of delivery of up to 300 kaf/year from Imperial Dam to Parker Dam.

1.4.1.2 ALL-AMERICAN AND COACHELLA CANAL LINING PROJECTS

Two other components of the CA Plan having effects on the river are the All-American and Coachella Canal Lining Projects (the Coachella Canal is a branch of the AAC). These two similar actions involve the concrete lining of unlined portions of the canals to conserve water presently being lost as seepage from the earthen reaches. Together the projects involve a change in point of delivery from Imperial Dam to Parker Dam that totals 93.7 kaf/year, 67.7 kaf/year for the AAC and 26 kaf/year for the

Coachella Canal. The effects of this change in point of delivery are being addressed in the Secretarial Implementation Agreement EA and BA (described in Section 1.4.5). The Record of Decision (ROD) for the All-American Canal Lining Project was approved on July 29, 1994. Construction is expected to begin in 2001. A draft EIS/EIR for the Coachella Canal Lining Project was released on September 22, 2000 for public review.

1.4.2 GLEN CANYON DAM OPERATIONS

Glen Canyon Dam is operated consistent with the CRSPA and the LROC, which were promulgated in compliance with Section 602 of the CRBPA. Glen Canyon Dam is also operated consistent with the 1996 ROD on the Operation of Glen Canyon Dam (Attachment C) developed as directed under the Grand Canyon Protection Act of 1992.

The minimum release from Lake Powell, as specified in the LROC, is 8.23 maf per year. In years with very low inflow, or in years when Lake Powell is significantly drawn down, annual releases of 8.23 maf from Lake Powell are made. The LROC also require that, when Upper Basin storage is greater than the storage required under Section 602(a) of the CRBPA, releases from Lake Powell will periodically be governed by the objective to maintain, as nearly as practicable, active storage in Lake Mead equal to the active storage in Lake Powell. Because of this equalization provision in the LROC, changes in operations at Lake Mead will, in some years, result in changes in annual release volumes from Lake Powell. It is through this mechanism that delivery of surplus water from Lake Mead can influence the operation of Glen Canyon Dam. Equalization is not required when there exists insufficient storage in the Upper Basin, per Section 602(a) of the CRBPA.

In acknowledgement that the operation of Glen Canyon Dam, as authorized, to maximize power production was having a negative impact on downstream resources, 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 (Service) under the ESA and incorporated the Service's recommendations into the ROD.

The ROD describes criteria and plans 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, beach/habitat-building flows (BHBFs), beach/habitat-maintenance flows, and further study of temperature control.

The ROD is based on the EIS, which contains descriptions and analyses of aquatic and riparian habitats below Glen Canyon Dam, effects of Glen Canyon Dam release patterns on the local ecology, cultural resources, sedimentation processes associated with the maintenance of backwaters and sediment deposits along the river, Native American interests, and relationships between release patterns and the value of hydroelectric energy produced. Analyses of effects on other resources within the affected area are also included. Additional information concerning the operation of Glen Canyon Dam is contained in Section 3.3.

1.4.2.1 ADAPTIVE MANAGEMENT PROGRAM

The Adaptive Management Program (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.

1.4.2.2 BEACH/HABITAT-BUILDING FLOWS AND BEACH/HABITAT-MAINTENANCE FLOWS

BHBF 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 as described in Section 3.6.2. 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.

Beach/habitat-maintenance flow 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. Beach/habitat-maintenance flow releases can be made in years when no BHBF releases are made.

Both beach/habitat-building and beach/habitat-maintenance flows, along with the testing and evaluation of other types of releases under the AMP, were recommended by the Service to verify a program of flows that would improve habitat conditions for endangered fish. The proposed interim surplus criteria 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. The magnitude of this reduction in flexibility has been evaluated for each interim surplus alternative. The results are presented in Section 3.6, *Riverflow Issues*.

1.4.2.3 TEMPERATURE CONTROL AT GLEN CANYON DAM

In 1994, the Service issued a *Biological Opinion on the Operation of Glen Canyon Dam*. 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 issued a draft planning report and environmental assessment (EA) entitled *Glen Canyon Dam Modifications to Controls and Downstream Temperatures* (Reclamation, 1999). Based on comments to this draft EA, Reclamation is currently in the process of preparing a new draft EA on temperature control at Glen Canyon Dam.

Interim surplus criteria could result in new information related to temperature control at Glen Canyon Dam. Data and information made available from analysis related to interim surplus criteria will be utilized in the revised EA on temperature control at Glen Canyon Dam. Such information would also be considered in the development of an appropriate design for a temperature control device.

1.4.3 ACTIONS RELATED TO THE BIOLOGICAL AND CONFERENCE OPINION ON LOWER COLORADO RIVER OPERATIONS AND MAINTENANCE

Reclamation prepared a Biological Assessment (BA) in accordance with Section 7 of the ESA, addressing effects of ongoing and projected routine lower Colorado River operations and maintenance (Reclamation, 1996). After formal consultation, a Biological and Conference Opinion (BCO) was prepared by the Service (Service, 1997). Both documents are described in Section 1.4.5, Documents Incorporated by Reference. Pursuant to the reasonable and prudent alternative and 17 specific provisions provided in the BCO, Reclamation is taking various actions that benefit the riparian region of the lower Colorado River and associated species. In particular, these actions include: 1) acquisition, restoration, and protection of potential and occupied Southwestern willow flycatcher habitat; 2) extensive life history studies for Southwestern willow flycatcher along 400 miles of the lower Colorado River and other areas; and 3) protection and enhancement of endangered fish species through risk assessments, assisted rearing, and development of protected habitats along the lower Colorado River. This five-year BCO provides ESA compliance for Reclamation actions on the lower Colorado River until 2002.

The BA and BCO contain life histories/status of lower Colorado River species, descriptions of ongoing and projected routine operation and maintenance activities, the

Secretary's discretionary management activities, operation and maintenance (O&M) procedures, endangered species conservation program, environmental baseline, effects of ongoing operations, reasonable and prudent alternatives, and supporting documentation useful in this FEIS. The 1996 BA and the 1997 BCO did not anticipate or address the effects of specific interim surplus criteria on the species considered. A separate Section 7 ESA consultation is in progress for the proposed action addressed by this FEIS.

1.4.4 LOWER COLORADO RIVER MULTI-SPECIES CONSERVATION PROGRAM

Following the designation of critical habitat for three endangered fish species on nearly all of the lower Colorado River in April of 1994, the three Lower Basin States of Arizona, California and Nevada, Reclamation and the Service initiated the Lower Colorado River Multi-Species Conservation Program (LCRMSCP), which was one of the reasonable and prudent provisions of the five-year BCO received in 1997. The purpose of the LCRMSCP is to obtain long-term (50-year) ESA compliance for both federal and non-federal water and power interests. The LCRMSCP is a partnership of Federal, State, Tribal, and other public and private stakeholders with an interest in managing the water and related resources of the lower Colorado River Basin. In August 1995, the Department of the Interior and Arizona, California and Nevada entered into a Memorandum of Agreement (MOA) and later a Memorandum of Clarification (MOC) for development of the LCRMSCP. The purpose of the MOA/MOC was to initiate development of an LCRMSCP that would accomplish the following objectives:

- Conserve habitat and work toward the recovery of threatened and endangered species and reduce the likelihood of additional species listing under the ESA; and
- Accommodate current water diversions and power production and optimize opportunities for future water and power development.

The LCRMSCP is currently under development, and it is anticipated that the final EIS-environmental impact report (EIR) will be finalized in 2001. Once the LCRMSCP is accepted by the Service, Reclamation and other federal agencies, as well as the participating non-federal partners, will have achieved ESA compliance for ongoing and future actions.

Since the interim surplus criteria determination is scheduled to be completed prior to the completion of the LCRMSCP, a separate Section 7 consultation has been conducted with the Service on the anticipated effects of implementing the interim surplus criteria.

1.4.5 SECRETARIAL IMPLEMENTATION AGREEMENT RELATED TO CALIFORNIA'S COLORADO RIVER WATER USE PLAN

Within California, the allocation of Colorado River water is stipulated by various existing agreements among the seven parties with diversion rights. Recently, these parties have negotiated a *Quantification Settlement Agreement* which further defines the priorities for use of Colorado River water in California. This agreement provides a basis for various water conservation and transfer measures described in the CA Plan (California, 2000). The water transfers would require changes in the points at which the Secretary would deliver transferred water to various California entities, as compared with provisions in existing water delivery contracts. The operational changes caused by the water transfers are being addressed in separate NEPA and ESA documentation.

1.4.6 OFFSTREAM STORAGE OF COLORADO RIVER WATER AND DEVELOPMENT AND RELEASE OF INTENTIONALLY CREATED UNUSED APPORTIONMENT IN THE LOWER DIVISION STATES

The above titled rule establishes a procedural framework for the Secretary to follow in considering, participating in, and administering Storage and Interstate Release Agreements among the States of Arizona, California, and Nevada (Lower Division states). The Storage and Interstate Release Agreements would permit State-authorized entities to store Colorado River water offstream, develop intentionally created unused apportionment (ICUA), and make ICUA available to the Secretary for release for use in another Lower Division state. This rule provides a framework only and does not authorize any specific activities. The rule does not affect any Colorado River water entitlement holder's right to use its full water entitlement, and does not deal with intrastate storage and distribution of water. The rule only facilitates voluntary interstate water transactions that can help satisfy regional water demands by increasing the efficiency, flexibility, and certainty in Colorado River management. A Finding of No Significant Impact (FONSI) was approved on October 1, 1999.

1.5 DOCUMENTS INCORPORATED BY REFERENCE

During recent decades, a considerable amount of environmental information has been obtained and environmental analyses conducted concerning the operation of the Colorado River water supply system. Much of this information is contained in various documents prepared under NEPA and the ESA. These documents have been previously distributed to interested agencies and private parties. In the interest of avoiding duplication and undue paperwork, this FEIS incorporates by reference parts or all of several documents. The documents described below are available for public inspection upon request at Reclamation offices in Boulder City, Nevada; Salt Lake City, Utah; Phoenix and Yuma, Arizona.

- *Biological Assessment for Proposed Interim Surplus Criteria, Secretarial Implementation Agreements for California Water Plan Components and Conservation Measures,* August 30, 2000.

  This BA was prepared by Reclamation in Boulder City, Nevada, to address the potential effects on threatened or endangered species and designated critical habitat along the lower Colorado River attributable to the water transfers proposed by California as part of its CA Plan and to the implementation of the proposed interim surplus criteria. The BA was prepared to facilitate formal Section 7 consultation with the Service, which resulted in the BO cited below addressing these proposed actions. The pertinent parts of this BA are the ecology of aquatic and riparian habitat systems from Lake Mead to the SIB and the potential effects of these proposed actions on listed species and critical habitat. With regard to any potential effects of the proposed adoption of interim surplus criteria on ESA listed species in the Republic of Mexico or the Gulf of California, Reclamation has prepared additional information to supplement this assessment.

- *Biological Opinion on Proposed Interim Surplus Criteria, Secretarial Implementation Agreements for California Water Plan Components and Conservation Measures, December,* 2000.

  This Biological Opinion (BO), issued by the Service in Phoenix, Arizona, through formal consultation with Reclamation in Boulder City, Nevada, addresses the potential effects on threatened or endangered species and designated critical habitat along the lower Colorado River attributable to the water transfer agreements proposed by California as part of its CA Plan and to the implementation of interim surplus criteria. The BO identifies reasonable and prudent measures for the avoidance of adverse effects of these proposed actions. The pertinent parts of the BO are the life histories of various species, their habitat descriptions, and relationships with river operations.

- *Biological Assessment on Transboundary Effects for Proposed Interim Surplus Criteria, December,* 2000.

  This BA was prepared by Reclamation in Boulder City, Nevada, to address the potential effects on threatened or endangered species in the Colorado River Delta of Mexico attributable to the implementation of proposed interim surplus criteria. The BA was prepared to facilitate informal consultation with the Service and the National Marine Fisheries Service, which is in progress. The pertinent parts of the BA are the ecology of aquatic and riparian habitat systems from the SIB to the estuary at the mouth of the Colorado River in the Sea of Cortez and the potential effects of the proposed action on United States-listed species and critical habitat.

- *Description and Assessment of Operations, Maintenance, and Sensitive Species of the Lower Colorado River (Biological Assessment)*, August 1996.

  This BA was prepared by Reclamation in Boulder City, Nevada, to develop an inventory of aquatic and marsh habitat along the lower Colorado River and to analyze the relationships between river operation and maintenance of threatened and endangered species and critical habitat. The BA was prepared to facilitate the formal Section 7 consultation with the Service, which resulted in the April 1997 BCO cited below. The pertinent parts of the BA are the ecology of aquatic and riparian habitat systems from Lake Mead to the SIB and the potential effects of ongoing operation and maintenance on listed species and critical habitat.

- *Biological and Conference Opinion on Lower Colorado River Operations and Maintenance*, April 1997.

  This BCO, prepared by the Service in Phoenix, Arizona, through formal consultation with Reclamation in Boulder City, Nevada, addresses the critical habitat for endangered species along the lower Colorado River that is related to the operation of the river for delivery of water to the Lower Division states and Mexico. The report identifies a reasonable and prudent alternative for the avoidance of adverse effects of river operation. The pertinent parts of the conference and opinion are the life histories of various species, their habitat descriptions, and relationships with river operations.

- *Operation of Glen Canyon Dam Final Environmental Impact Statement,* March 1995, and *Record of Decision*, October 8, 1996.

  The FEIS was prepared by Reclamation in Salt Lake City, Utah, to evaluate alternative plans for the water releases at Glen Canyon Dam and Powerplant and the ecological effects on the Colorado River corridor downstream to Separation Rapid. The FEIS was based on an extraordinary depth of analysis, involving numerous work groups with specialists in various disciplines from other agencies and private practice. The pertinent parts of the FEIS are the aquatic and riparian habitats below Glen Canyon Dam, the relationships between Glen Canyon Dam and Powerplant release patterns, effects on downstream ecology, and the sedimentation processes associated with the maintenance of backwaters and beaches along the river. The relationships between release patterns and the value of hydroelectric energy produced were also pertinent.

  The ROD adds commitments in the following areas: establishment of an AMP, monitoring and protecting cultural resources, flood frequency reduction measures, BHBF releases, efforts to establish a new population of the humpback chub, further study of selective withdrawals from Lake Powell, and emergency exception criteria to respond to various emergency situations.

- *Glen Canyon Dam Modification to Control Downstream Temperatures Plan and Environmental Assessment*, January 1999 Draft.

  This draft planning report and EA was prepared by Reclamation in Salt Lake City, Utah, to consider alternatives for modifying the intakes to the penstocks to permit the selective withdrawal of water from Lake Powell at various temperatures. The pertinent parts of the report are the sensitivity of downstream fish species, particularly endangered species, to temperatures of Colorado River water downstream from the dam and the degree of temperature control that could be achieved by the modifications. Based on comments on the draft EA, Reclamation is in the process of preparing a new draft EA on temperature control at Glen Canyon Dam.

- *Final Biological Opinion, Operation of Glen Canyon Dam as the Modified Low Fluctuating Flow Alternative*, December 1994.

  This Biological Opinion was prepared by the Service in Phoenix, Arizona, through consultation with Reclamation in Salt Lake City, Utah. The document addresses Glen Canyon Dam operations and the critical habitat for endangered species in the Colorado River from Glen Canyon Dam to Lake Mead and identifies a reasonable and prudent alternative for the avoidance of jeopardy. The document also provides environmental baseline and status of species in the action area related to the preferred alternative.

- *Glen Canyon Adaptive Management Work Group Charter*, December 8, 1998.

  This charter outlines the membership and duties of the AMWG. The duties are to establish AMWG operating procedures, advise the Secretary in meeting environmental and cultural commitments of the Glen Canyon Dam FEIS and ROD, recommend a framework for AMP policy, goals and direction; develop recommendations for modifying dam operations and operating criteria; define and recommend resource management objectives for a long-term monitoring plan; review and provide input to the Secretary on required reports; facilitate input and coordination of information from stakeholders to the Secretary; and monitor and report on compliance of all program activities with applicable laws, permitting requirements, and the Grand Canyon Protection Act.

- *Quality of Water, Colorado River Basin, Progress Report No. 19*, January 1999.

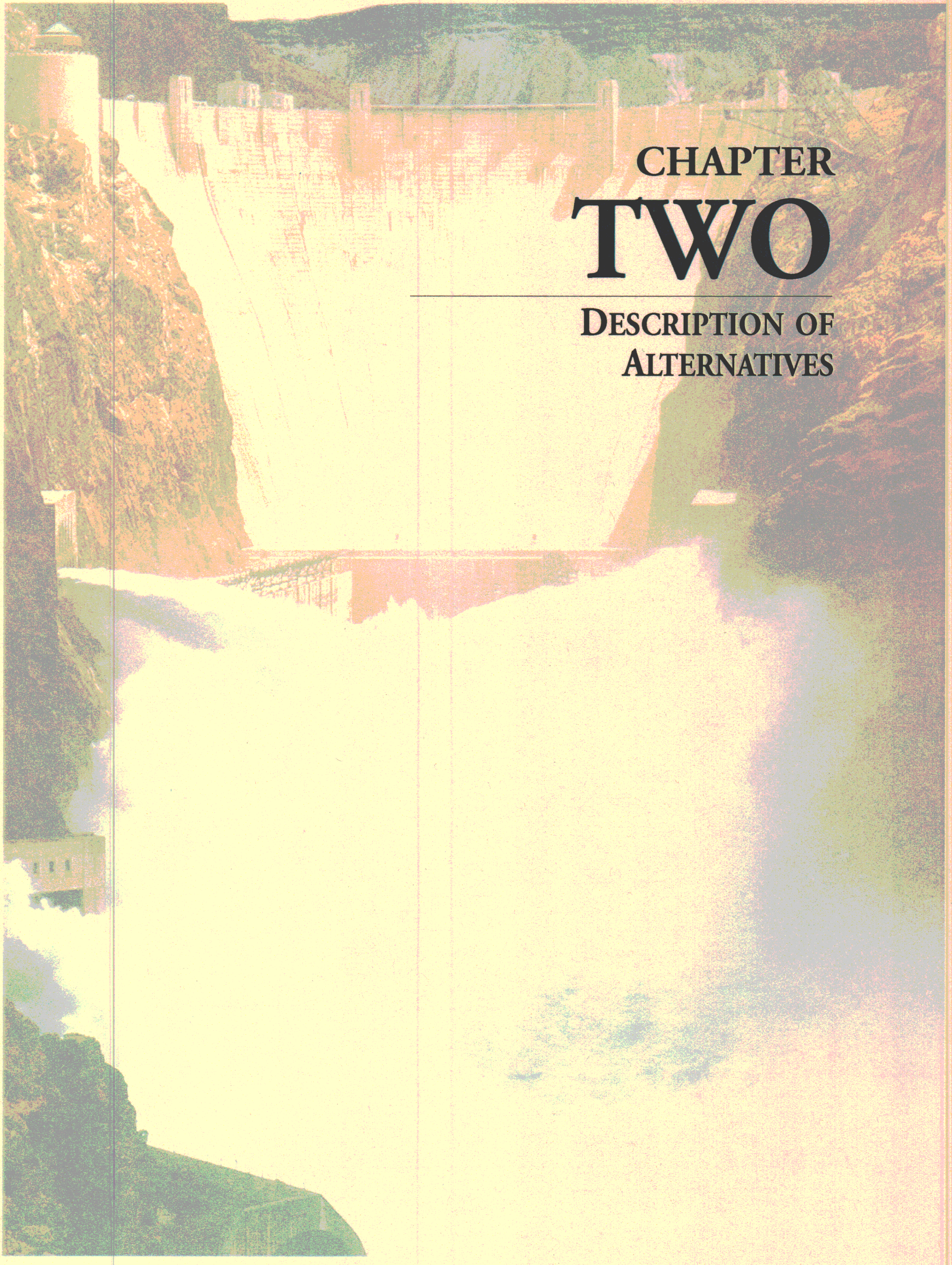
  This report is the latest of a series of biennial reports to Congress, prepared by Reclamation in Salt Lake City, Utah, that summarize progress of the Colorado River Water Quality Improvement Program in controlling Colorado River salinity. The pertinent parts of the report are those which discuss the mechanisms that contribute dissolved salts to the river system, the relationships between dissolved salt concentrations and abundance of basin water supply, and the effects of dissolved minerals on uses of Colorado River water.

- *Southern Nevada Water Authority Treatment and Transmission Facility Final Environmental Impact Statement*, September 1996, and *Record of Decision*, November 1996.

  This EIS and ROD contain pertinent information concerning the influence of Las Vegas Valley drainage on the water quality in Lake Mead's Boulder Basin and the resulting quality of water pumped from the reservoir by the SNWA's intake facilities. Critical intake elevations are identified in the documents.

- *Final Programmatic Environmental Assessment for Rulemaking for Offstream Storage of Colorado River Water and Development and Release of Intentionally Created Unused Apportionment in the Lower Division States*, October 1999.

  This document, which includes a BA, analyzes the environmental effects of potential changes in reservoir and river operations that could occur if a Lower Division state diverts and stores water for the benefit of another Lower Division state for future use (interstate offstream storage). The BA contains aquatic and marsh habitat descriptions and the relationships between changes in diversions from Lake Mead and Lake Havasu and downstream aquatic and marsh habitat maintenance. The relationships between release patterns from Hoover Dam and the value of hydroelectric energy are also useful for this analysis.



CHAPTER TWO

DESCRIPTION OF ALTERNATIVES

2 DESCRIPTION OF ALTERNATIVES

2.1 INTRODUCTION

This chapter discusses the process used to define the No Action Alternative and develop a range of reasonable interim surplus criteria alternatives, and summarizes various alternatives that were considered but eliminated from further analysis. It then describes the alternatives analyzed in this FEIS. Modeling procedures and assumptions used to analyze the alternatives are discussed in Section 3.3. The end of this chapter presents a table of effects of all alternatives.

2.2 DEVELOPMENT OF ALTERNATIVES

This FEIS considers five interim surplus criteria alternatives as well as a No Action Alternative/baseline that was developed for comparison of potential effects. The five action alternatives considered include the Basin States Alternative (preferred alternative), the Flood Control Alternative, the Six States Alternative, the California Alternative, and the Shortage Protection Alternative (as described in Section 2.3). Section 2.2.1 discusses the strategies and origins of the action alternatives and describes alternatives that were considered but eliminated from further analysis.

2.2.1 OPERATING STRATEGIES FOR SURPLUS DETERMINATION

2.2.1.1 THE R STRATEGY

In 1986, Reclamation developed an operating strategy for distributing surplus water and avoiding spills (Reclamation, 1986). That analysis established the Spill Avoidance or "R" strategy. The development of this strategy was an outcome of sustained flood control releases at Lake Mead from 1983 through 1986. The R strategy assumes a particular percentile historical runoff, along with normal 7.5 maf delivery to Lower Division states, for the next year. Applying these values to current reservoir storage, the projected reservoir storage at the end of the next year is calculated. If the calculated space available at the end of the next year is less than the space required by flood control criteria, then a surplus condition is determined to exist.

Two alternatives considered in this FEIS use variations of the R strategy. The 70R strategy uses an annual runoff of 17.4 maf whereas the 75R strategy uses 18.1 maf. The 70R strategy was used to represent the baseline as described in Section 2.3.1.

2.2.1.2 THE A STRATEGY

In the early and mid-1990s, Reclamation continued discussing surplus criteria strategies with the Colorado River Management Work Group (CRMWG), which formed a technical committee was formed to investigate additional surplus criteria strategies.

One of the strategies developed through the CRMWG analysis was the Flood Control avoidance or "A" strategy. This strategy determines when there is insufficient storage space in Lake Mead and upstream reservoirs, in order to avoid flood control releases from Lake Mead with a particular percent assurance.

The most common usage became the 70 percent assurance level (70A strategy). This alternative was eliminated because the modeling results were so similar to the Flood Control Alternative and the No Action/baseline (70R strategy) that it was not necessary to analyze it.

2.2.1.3 THE P STRATEGY

Another strategy is the Shortage Protection or "P" strategy. This strategy is based on making surplus water available while maintaining storage sufficient to meet a 7.5 maf Lake Mead release requirement, while avoiding the likelihood of a future shortage determination at a specified assurance level. Through a separate modeling study, Reclamation determined the Lake Mead storage needed in each future year to meet Lower Basin and Mexico demands, with a specified percent assurance that Lake Mead would not drop below a specified elevation. Water stored in Lake Mead in excess of that storage requirement is deemed surplus to be made available to the Lower Basin states. The Shortage Protection Alternative used in this FEIS, commonly referred to as the 80P strategy, is described in more detail in Section 2.3.6.

2.2.1.4 FLOOD CONTROL STRATEGY

Under a flood control strategy, surplus conditions are determined only when flood control releases from Lake Mead are occurring or projected to occur in the subsequent year. In the 1998, 1999 and 2000 Annual Operating Plans (AOPs), Reclamation used the projection of flood control releases as the basis for making surplus water available to the Lower Division States. The Flood Control Alternative in this FEIS uses this strategy and is described in Section 2.3.3.

2.2.2 ORIGINS OF THE CALIFORNIA, SIX STATES, AND BASIN STATES ALTERNATIVES

On December 17, 1997, California presented to the other Basin States its draft 4.4 Plan (CRBC, 1997), a plan to achieve a reduction in its dependence on surplus water from the Colorado River, through various conservation measures, water exchanges and conjunctive use programs. One of the elements of the draft 4.4 Plan was the expectation that the Secretary would continue to determine surplus conditions on the Colorado River until 2015. California proposed criteria on which the Secretary would base his determinations of surplus conditions during the interim period.

In 1998, in response to California's 1997 proposal of interim surplus criteria, the other six states within the Colorado River Basin (Six States) submitted a proposal with surplus criteria that were similar in structure to those in California's proposal. Under the proposal from the Six States, use of surplus water supplies would be limited depending on the occurrence of various specified Lake Mead surface elevations. The interim surplus criteria proposed by the Six States, presented in Attachment E, were used to formulate the "Six States Alternative" presented in Section 2.3.4.

California subsequently proposed specific interim surplus criteria which were attached to the October 15, 1999 *Key Terms for Quantification Settlement Among the State of California, Imperial Irrigation District, Coachella Valley Water District, and Metropolitan Water District of Southern California* (See Attachment F). California also updated, renamed and re-released its 4.4 Plan in May 2000. The revised plan is now known as the California Colorado River Water Use Plan (CA Plan). The interim surplus criteria proposal stemming from the CA Plan and Quantification Settlement was used to formulate the "California Alternative" detailed in Section 2.3.5.

In July 2000, during the public comment period on the DEIS, Reclamation received a draft proposal for interim surplus criteria from the seven Colorado River Basin States (Seven States). After a preliminary review of that proposal, Reclamation published it in the August 8, 2000 *Federal Register* for review and consideration by the public during the public review period for the DEIS. Reclamation published minor corrections to the proposal in a *Federal Register* notice of September 22, 2000. Copies of the *Federal Register* notices are in Chapter 5. Reclamation derived the Basin States Alternative in this FEIS from the draft Seven States Proposal.

2.2.3 PACIFIC INSTITUTE PROPOSAL

On February 15, 2000, a consortium of environmental organizations led by the Pacific Institute for Studies in Development, Environment and Security (Pacific Institute) presented an interim surplus criteria proposal for consideration by the Secretary. Their proposal (as clarified by the Pacific Institute's September 8, 2000 letter of comment on the DEIS), contains interim surplus criteria that are similar to the criteria in the Six States Alternative with respect to Lower Basin surplus determinations. The proposal and excerpts from the September 8 letter are included as Attachment G to this FEIS. The Pacific Institute Proposal also suggested that, during years when Lake Mead's surface elevation exceeds 1120.4 feet mean sea level (msl), at least 32,000 af of additional water (i.e. water in excess of Mexico's treaty deliveries) be delivered to Mexico for the purpose of restoring and/or maintaining habitat in the upper reaches of the Colorado River delta. The proposal also included 260,000 af of additional water to be delivered to the Colorado River delta for ecological restoration purposes when reservoir elevations are high.

This proposal is beyond the purpose and need for the proposed action because it would expand the proposed action by prescribing releases of Colorado River water stored in Lake Mead to Mexico. The proposed adoption of surplus criteria for use in Arizona, California and Nevada does not, by definition, apply to determinations of surplus to the

United Mexican States (Mexico). Water delivery to Mexico is governed by the United States-Mexico Water Treaty of 1944. Releases of water to Mexico are not addressed by Section III(3) of the LROC or Article II(B)(2) of the Decree and are therefore not part of the proposed action analyzed in this EIS. From its initiation of this proposed action on May 18, 1999, Reclamation has clearly stated that its undertaking was intended to "identify those circumstances under which the Secretary of the Interior ("Secretary") may make Colorado River water available for delivery to the States of Arizona, California, and Nevada ...." (64 *Federal Register* 27008, May 18, 1999). The proposed action only involves determinations of domestic surplus conditions pursuant to Article III(3) of the LROC (64 *Federal Register* 27009). Section 1.1.4 of the DEIS (page 1-4) states that "This proposed action is not intended to identify conditions when Mexico may schedule [its] 0.2 maf [surplus under Article 10(b) of the Treaty]." The United States, in its consultation with Mexico conducted through the Department of State, has consistently informed Mexico that the proposed action does not address determinations of surplus conditions to Mexico under the 1944 Treaty, and is limited to declarations of surplus conditions for the Lower Division states.

In addition to changing and expanding the proposed action in a manner inconsistent with the purpose and need for the action, the Pacific Institute's proposed alternative would also require that Reclamation make releases of water from Lake Mead to Mexico in a manner that is inconsistent with the mandatory injunction issued to the Secretary by the United States Supreme Court in Article II of the Arizona v. California Decree (1964). Pacific Institute's proposal calls for releases of water from Lake Mead in excess of the amount of water that would be released to Mexico "in satisfaction of [the United States] obligations to the United States of Mexico under the treaty dated February 3, 1944 ...." Reclamation does not believe that the range of reasonable alternatives includes alternatives that would violate the United States Supreme Court's Decree and injunction. For the foregoing reasons, Reclamation concluded that the proposed alternative was not a reasonable alternative and it accordingly was not analyzed in this EIS.

Because the Lower Basin surplus determinations of the Pacific Institute's proposed interim surplus criteria are similar to, and within the range of, those contained in the alternatives already being analyzed, and because the proposed delivery of additional water to Mexico is beyond the purpose and need for interim surplus criteria, the Pacific Institute's proposal is not analyzed in this FEIS.

2.2.4 FORMULATION OF ALTERNATIVES

In response to the CA Plan and the Six States proposal, and the dialogue among Reclamation and the seven Basin States, Reclamation initiated a NEPA process to provide structure to evaluating potential interim surplus criteria alternatives and to determine and disclose the potential effects of these interim surplus criteria. At the initiation of the NEPA process, Reclamation began a public scoping process. Under that process, Reclamation conducted a series of public meetings in 1999 to inform interested parties of the consideration being given to the development of interim surplus criteria, to show options and proposals developed up to that time, and to solicit public and agency comments and suggestions regarding the formulation and evaluation of alternatives for the criteria.

The alternatives below were presented at the public meetings:

Flood Control Alternative
Spill Avoidance Alternative (70R)
Flood Control Avoidance Alternative (70A)
Multi-tier Alternative (based on the Six States Plan)
Shortage Protection Alternative (80P)

The scoping process and issues identified, including those associated with alternatives development, are discussed in Chapter 5 of this FEIS. Following the scoping meetings, and in consideration of comments received, Reclamation included the interim surplus criteria proposals of the Six States and California for evaluation in the DEIS. It should be noted that while the California and Six States alternatives analyzed in the DEIS and in this FEIS were based on criteria proposed by California and the Six States, the respective alternatives presented in this FEIS do not contain all the specific elements of those plans.

The draft Seven States proposal was discussed informally with the public during the public review period for the DEIS, and was the subject of comment in various letters received by Reclamation in response to the DEIS and the *Federal Register* notice of the proposal. Based on these discussions and comments, Reclamation formulated an alternative based on the Seven States proposal and identified it as the preferred alternative (the Basin States Alternative herein). It should be noted that the Basin States Alternative presented in this FEIS does not contain all the specific elements of the draft Seven States proposal.

2.2.5 UTILIZATION OF PROPOSALS FROM THE BASIN STATES

As discussed in Section 2.2.2, various proposals submitted by individual Colorado River Basin states or groups of states were used by Reclamation to formulate interim surplus criteria alternatives. In recognition of the need to limit the delivery of surplus water at lower Lake Mead water levels, these proposals specified allowable uses of surplus water at various triggering levels.

The Secretary will continue to apportion surplus consistent with the applicable provisions of the Decree, under which surplus water is divided 50 percent to California, 46 percent to Arizona, and 4 percent to Nevada. The Secretary also intends to appropriately report the accumulated volume of water delivered to MWD under surplus conditions. The Secretary also intends to honor any forbearance arrangements made by various parties for the delivery of surplus water or reparations for future shortage conditions.

2.2.6 NO ACTION ALTERNATIVE AND BASELINE CONDITION

As required by NEPA, a No Action alternative must be considered during the environmental review process. Under the No Action Alternative, determinations of surplus would continue to be made on an annual basis, in the AOP, pursuant to the LROC and the Decree as discussed in Chapter 1. The No Action Alternative represents the future AOP process without interim surplus criteria. Surplus determinations consider such factors as end-of-year system storage, potential runoff conditions, projected water demands of the Basin States and the Secretary's discretion in addressing year-to-year issues. However, the year-to-year variation in the conditions considered by the Secretary in making surplus water determinations makes projections of surplus water availability highly uncertain.

The approach used in this FEIS for analyzing the hydrologic aspects of the interim surplus criteria alternatives was to use a computer model that simulates specific operating parameters and constraints. In order to follow CEQ guidelines calling for a No Action alternative for use as a "baseline" against which to compare project alternatives, Reclamation selected a specific operating strategy for use as a baseline condition, which could be described mathematically in the model.

The baseline is based on a 70R spill avoidance strategy. Reclamation has utilized a 70R strategy for both planning purposes and studies of surplus determinations in past years. When Reclamation reviewed previous surplus determinations as part of the DEIS effort, the data indicated that the 1997 surplus determination did not precisely fit the 70R strategy. As a result, Reclamation selected the 75R strategy as representative of recent operational decisions, for use as the baseline condition in the DEIS. However, based on further review and analysis, public comment, and discussion with representatives of the states during the DEIS review period, Reclamation is using the 70R strategy for the baseline condition in this FEIS. While the 70R strategy is used to represent baseline conditions, it does not represent a decision by Reclamation to utilize the 70R strategy for determination of future surplus conditions in the absence of interim surplus criteria. It should be noted that the 70R strategy and 75R strategy yield very similar results for the purpose of determining impacts associated with the action alternatives analyzed in this FEIS. Figure 2-1 illustrates the close relationship between the 70R and 75R trigger lines (see Section 2.3.1.2).

2.3 DESCRIPTION OF ALTERNATIVES

This section describes the five interim surplus criteria alternatives analyzed in this FEIS, and No Action, which is represented by the baseline condition for comparison purposes. The Secretary would base his annual determination of surplus conditions on the criteria selected, if any, as part of the AOP process unless extraordinary circumstances arise. Such circumstances could include operations necessary for safety of dams or other emergency situations, the failure of California to meet its commitment to reduce dependence on Colorado River water, or other activities arising from actual operating experiences. The interim surplus criteria would remain in effect for surplus determinations made through calendar year 2015, subject to five-year reviews concurrent with the LROC reviews. As noted in Section 1.4.1, implementation of interim surplus criteria would take into account the progress, or lack thereof, in the implementation of the CA Plan.

As noted above, the 70R operating strategy is not presented as an alternative for adoption. If an interim surplus criteria alternative is not implemented, the Secretary would determine surplus conditions using the same dynamic considerations currently used in the AOP.

Subsequent to the surplus determination for 2016, the interim surplus criteria would terminate and, in the absence of subsequently-specified surplus criteria, surplus determinations would be made by future Secretaries based on factors such as those that are considered in the AOP, as discussed in Chapter 1.

Because the selected baseline and the interim surplus criteria alternatives deal with operations, rather than construction or other physical Colorado River system changes, the alternatives are described below in terms of their operating rules. The Department and Reclamation intend to deliver water in accordance with Article II(B)2 of the Decree. The estimated volumes of surplus water projected to be available each year under baseline conditions and each alternative are tabulated to demonstrate the operation under the respective conditions. The projected volumes of surplus water vary over the interim period in response to various factors including the implementation of various components of the CA Plan.

A common element of all alternatives is that in years in which the *Field Working Agreement between the Bureau of Reclamation and the Army Corps of Engineers for Flood Control Operation of Hoover Dam and Lake Mead* requires releases greater than the downstream beneficial consumptive use demands, the Secretary shall determine a "flood control surplus" will be declared in that year. In such years, releases will be made to satisfy all beneficial uses within the United States (see the estimated amounts under Flood Control for each alternative), and up to an additional 200,000 af will be made available to Mexico under the Treaty.

2.3.1 NO ACTION ALTERNATIVE AND BASELINE CONDITION

2.3.1.1 APPROACH TO SURPLUS WATER DETERMINATION

As discussed above in Section 2.2.6, the 70R operating strategy is being used as a baseline to show possible future operating conditions in the absence of interim surplus criteria. The primary effect of simulating operation with the 70R operating strategy would be that surplus conditions would only be determined when Lake Mead is nearly full.

2.3.1.2 70R Baseline Surplus Triggers

The 70R baseline strategy involves assuming a 70-percentile inflow into the system subtracting out the consumptive uses and system losses and checking the results to see if all of the water could be stored or if flood control releases would be required. If flood control releases would be required, additional water is made available to the Lower Basin states beyond 7.5 maf. The notation 70R refers to the specific inflow where 70 percent of the historical natural runoff is less than this value (17.4 maf) for the Colorado River basin at Lee Ferry.

The 70R strategy is illustrated on Figure 2-1, which shows the average trigger elevation of Lake Mead's water surface above which a surplus would be determined. In practice, the 70R surplus determination would not be based on the trigger line shown, but would be made during the fall of the preceding year using projected available system space.

The 70R trigger line rises from approximately 1199 feet msl in 2002 to 1205 feet msl in 2050. The gradual rise of the 70R trigger line shown in Figure 2-1 is the result of increasing water use in the Upper Basin. Under baseline conditions, when a surplus condition is determined to occur, surplus water would be made available to fill all water orders by holders of surplus water contracts in the Lower Division states in estimated amounts on Table 2-1.

Figure 2-1
Baseline Surplus Trigger Elevations

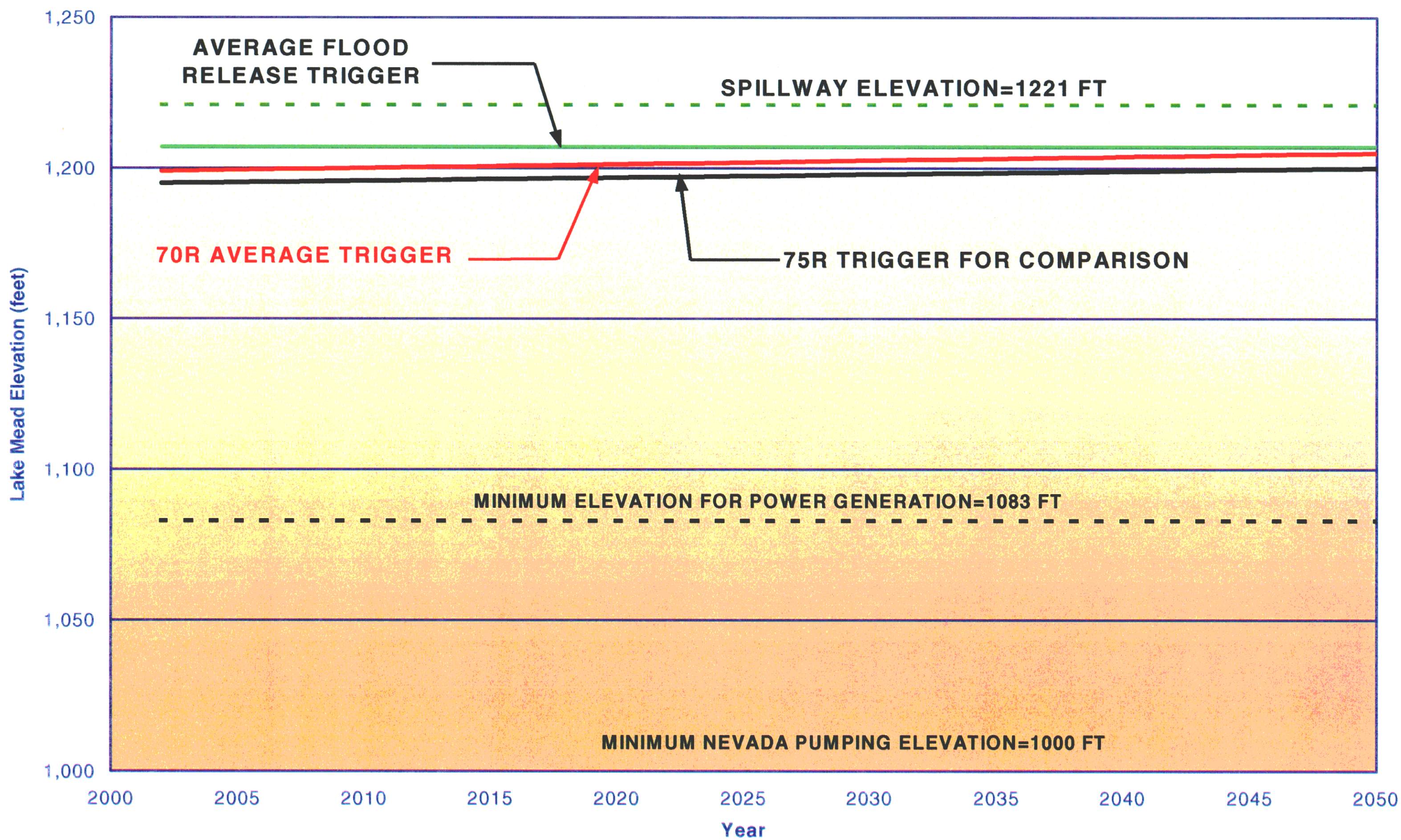


Table 2-1
Baseline Potential Surplus Water Supply
Unit : thousand acre-feet (kaf)

Year	Flood Control	70R Trigger
2002	1350	1350
2003	1350	1350
2004	1350	1350
2005	1350	1350
2006	1400	1400
2007	1450	1450
2008	1500	1500
2009	1550	1550
2010	1600	1600
2011	1600	1600
2012	1650	1650
2013	1650	1650
2014	1650	1650
2015	1700	1700
2016	1700	1700

2.3.2 BASIN STATES ALTERNATIVE (PREFERRED ALTERNATIVE)

Reclamation has identified the Basin States Alternative as the preferred alternative in this FEIS. The Basin States Alternatives is similar to, and based upon, information submitted to the Secretary by representatives of the governors of the states of Colorado, Wyoming, Utah, New Mexico, Arizona, Nevada and California. After receipt of this information (during the public comment period), Reclamation shared the submission with the public (through the *Federal Register* and Reclamation's surplus criteria web sites) for consideration and comment. Reclamation then analyzed the states' submission and crafted this additional alternative for inclusion in the FEIS. Some of the information submitted for the Department's review was outside of the scope of the proposed action for adoption of interim surplus criteria and was therefore not included as part of the Basin States Alternative (i.e., adoption of shortage criteria and adoption of surplus criteria beyond the 15-year period) as presented in this FEIS. With respect to the information within the scope of the proposed action, Reclamation found the Basin States Alternative to be a reasonable alternative and fully analyzed all environmental effects of this alternative in this FEIS. The identified environmental effects of the Basin States Alternative are well within the range of anticipated effects of the alternatives presented in the DEIS and do not affect the environment in a manner not already considered in the DEIS.

Reclamation selected the Basin States Alternative as its preferred alternative based on Reclamation's determination that it best meets all aspects of the purpose and need for the action, including the needs to remain in place for the entire period of the interim criteria, to garner support among the Basin States that will enhance the Secretary's ability to manage the Colorado River reservoirs in a manner that balances all existing needs for these precious water supplies, and to assist in the Secretary's efforts to insure that California water users reduce their over reliance on surplus Colorado River water.

Reclamation notes the important role of the Basin States in the statutory framework for administration of Colorado River Basin entitlements and the significance that a seven-state consensus represents on this issue. Thus, based on all available information, this alternative appears to be the most reasonable and feasible alternative.

2.3.2.1 APPROACH TO SURPLUS WATER DETERMINATION

The Basin States Alternative specifies ranges of Lake Mead water surface elevations to be used through 2015 for determining the availability of surplus water through 2016. The elevation ranges are coupled with specific uses of surplus water in such a way that, if Lake Mead's surface elevation were to decline, the amount of surplus water would be reduced. The interim criteria would be reviewed at five-year intervals with the LROC (and additionally as needed) and revised as needed based upon actual operational experience.

2.3.2.2 BASIN STATES ALTERNATIVE SURPLUS TRIGGERS

The surplus determination elevations under the preferred alternative consist of the tiered Lake Mead water surface elevations listed below, each of which is associated with certain stipulations on the purposes for which surplus water could be used. The elevation tiers (also referred to as levels) are shown on Figure 2-2. They are as follows, proceeding from higher to lower water levels:

Tier 1 - 70R Line (approximately 1199 to 1201 feet msl)
Tier 2 - 1145 feet msl
Tier 3 - 1125 feet msl

Table 2-2 lists the estimated maximum annual amounts of surplus water that would be available to contractors for surplus water in the Lower Division states under the Basin States Alternative, when Lake Mead is at or above each trigger. The table also lists the estimated amounts of surplus water that would be available to the Lower Division states when flood control releases are required.

Figure 2-2
Basin States Alternative Surplus Trigger Elevations

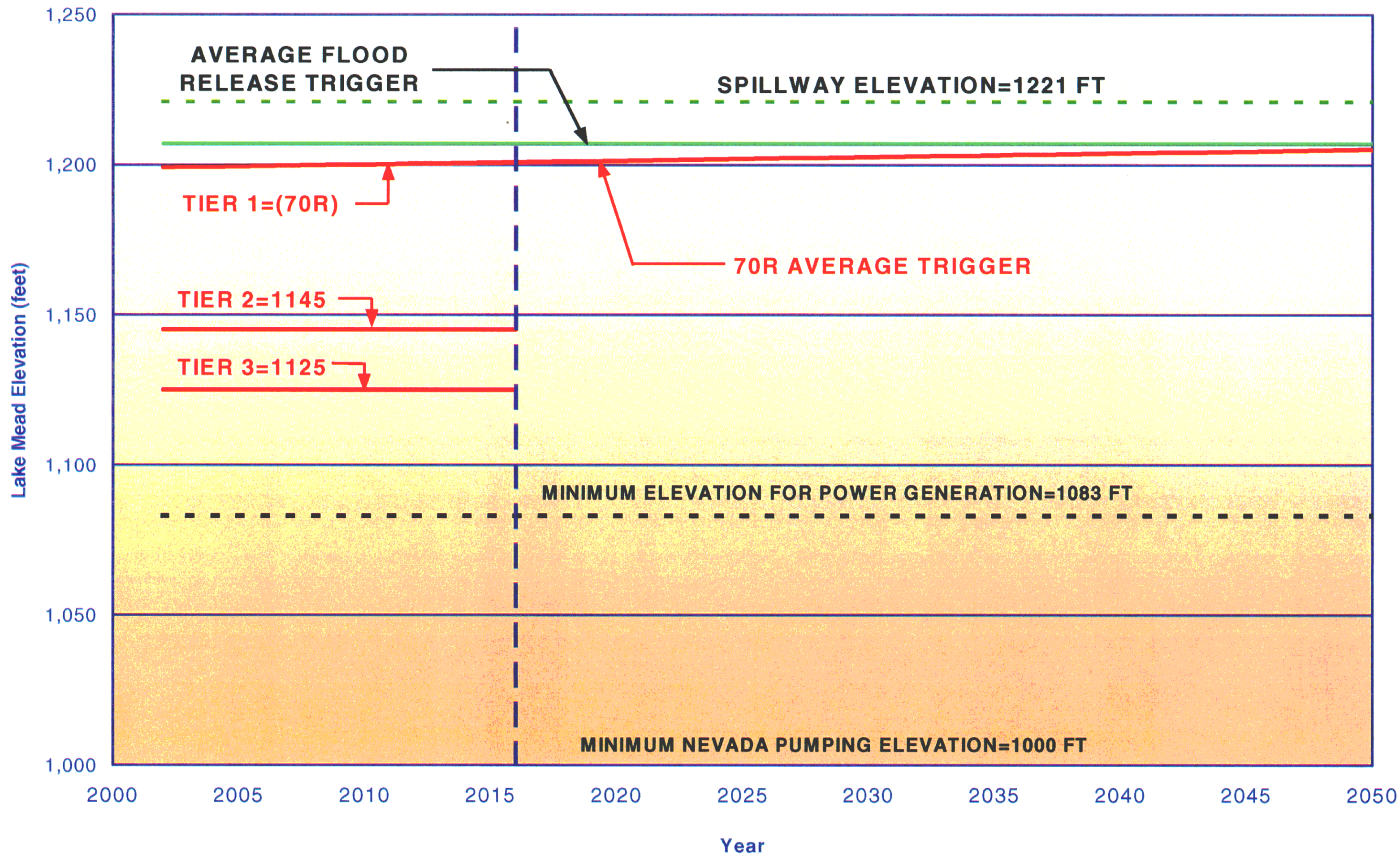


Table 2-2
Basin States Alternative Potential Surplus Water Supply
Unit: thousand acre-feet (kaf)

Year	Flood Control	Tier 1 (70R)	Tier 2 (1145 feet)	Tier 3 (1125 feet)
2002	1350	1000	650	200
2003	1350	950	600	200
2004	1350	900	550	150
2005	1350	900	550	150
2006	1400	900	500	150
2007	1450	900	500	150
2008	1500	900	450	150
2009	1550	950	450	150
2010	1600	1000	450	150
2011	1600	1000	450	200
2012	1650	1000	450	200
2013	1650	1050	450	250
2014	1650	1050	450	250
2015	1700	1050	450	300
2016	1700	1050	450	300

The surplus amounts quantified for each tier in Table 2-2 are estimated annual quantities of water and are the Secretary's best estimate of the amounts of surplus water that could be made available during the 15-year period of the interim surplus guidelines. These estimates are based on the most current available data regarding projected Colorado River water use demands by existing contractors. The methodology that was used to prepare the demand schedules that underlie the surplus tables in this section is based upon the definitions of "domestic," "Direct Delivery Domestic Use" and "Off-Stream Banking," as used in the information submitted to the Secretary by the Colorado River Basin states (65 *Federal Register* 48531, 48535 [Aug. 8, 2000]). The quantities in each Tier are developed by using these definitions as set forth in the Basin States submission (see Table 2-2). Under these definitions, the quantity of estimated surplus quantities is based, in part, on supplying particular types of uses within the Lower Division states, with a higher priority for supplying domestic uses than that for irrigation uses or groundwater banking activities to supply future uses.

While the Secretary, as an initial matter, would make surplus water available in amounts consistent with the percentages identified in Article II(B)(2) of the Decree, it is expected that water orders from Colorado River contractors will be submitted to reflect forbearance arrangements made by Lower Division states and individual contractors. The Secretary will deliver water to contractors in a manner consistent with these arrangements, to the extent that the water orders from contractors reflect these arrangements. The Secretary expects to make the specified quantities of water available during the 15-year period. However, the precise annual surplus quantities will continue to be reviewed on an annual basis during the preparation of the AOP, as required by applicable federal law, based on actual operating experience and updated information on the demand for Colorado River water by Lower Division contractors.

2.3.2.1.1 Basin States Alternative Tier 1 (70R)

The Basin States Alternative Tier 1 Lake Mead surplus trigger elevations are based on the 70R strategy and range from approximately 1199 feet msl to 1201 feet msl. In years when the Secretary determines that water should be released for beneficial consumptive use to reduce the risk of potential flood control releases based on the 70R operating strategy, the Secretary would determine the quantity of surplus water available and allocate it as follows: 50 percent to California, 46 percent to Arizona and 4 percent to Nevada.

Regardless of the quantity of surplus water determined under Tier 1, surplus deliveries under Tier 2 (discussed below) would be met.

2.3.2.1.2 Basin States Alternative Tier 2 (1145 feet msl)

The Basin States Alternative Tier 2 Lake Mead surplus trigger elevation is 1145 feet msl. At or above this Tier 2 elevation (and below the Tier 1 elevation), surplus water would be available for use by the Lower Division states in the estimated amounts in Table 2-2.

2.3.2.1.3 Basin States Alternative Tier 3 (1125 feet msl)

The Basin States Alternative Tier 3 Lake Mead surplus trigger elevation is 1125 feet msl. At or above this Tier 3 elevation (and below the Tier 2 elevation), surplus water would be available for use by the Lower Division states in the estimated amounts on Table 2-2. At Lake Mead levels below the Tier 3 trigger surplus water would not be made available.

2.3.2.2 DRAFT GUIDELINES

Draft guidelines for implementation of the Basin States Alternative are presented in Attachment I. These guidelines describe in more detail the relationships between the implementation of interim surplus criteria under this alternative and the AOP process through which the Secretary would determine whether surplus water is available and how much is available.

2.3.3 FLOOD CONTROL ALTERNATIVE

2.3.3.1 APPROACH TO SURPLUS WATER DETERMINATION

Under the Flood Control Alternative, a surplus condition is determined to exist when flood control releases from Lake Mead are occurring or projected to occur in the subsequent year. The method of determining need for flood control releases is based on flood control regulations published by the Los Angeles District of the Corps and the Field Working Agreement between the Corps and Reclamation, which are discussed in Section 1.3.6, Flood Control Operation.

2.3.3.2 FLOOD CONTROL ALTERNATIVE SURPLUS TRIGGERS

Under the flood control strategy, a surplus is determined when the Corps flood control regulations require releases from Lake Mead in excess of downstream demand. The specific operating provisions are described in Section 1.3.6, Flood Control Operation. If flood control releases are required, surplus conditions are determined to be in effect. This strategy is illustrated on Figure 2-3, which shows the average Lake Mead water surface elevation that would trigger flood control releases. The average triggering elevation is a level line at approximately 1211 feet msl. In practice, flood control releases are not based on the average trigger line shown, but would be determined each month by following the Corps regulations. The graph is a visual representation to illustrate the differences between the alternatives. When a flood control surplus is determined, surplus water would be made available for all established uses by contractors for surplus water in the Lower Division states. Table 2-3 lists the annual amounts of surplus water estimated to be available under the Flood Control Alternative.

Table 2-3
Flood Control Alternative
Potential Surplus Water Supply
Unit: thousand acre-feet (kaf)

Year	Flood Control
2002	1350
2003	1350
2004	1350
2005	1350
2006	1400
2007	1450
2008	1500
2009	1550
2010	1600
2011	1600
2012	1650
2013	1650
2014	1650
2015	1700
2016	1700

2.3.4 SIX STATES ALTERNATIVE

2.3.4.1 APPROACH TO SURPLUS WATER DETERMINATION

The Six States Alternative specifies ranges of Lake Mead water surface elevations to be used through 2015 for determining the availability of surplus water through 2016. The elevation ranges are coupled with specific uses of surplus water in such a way that, if Lake Mead's surface elevation were to decline, the amount of surplus water would be reduced. The interim criteria would be reviewed at five-year intervals with the LROC and as needed based upon actual operational experience.

Figure 2-3
Flood Control Alternative Surplus Trigger Elevations

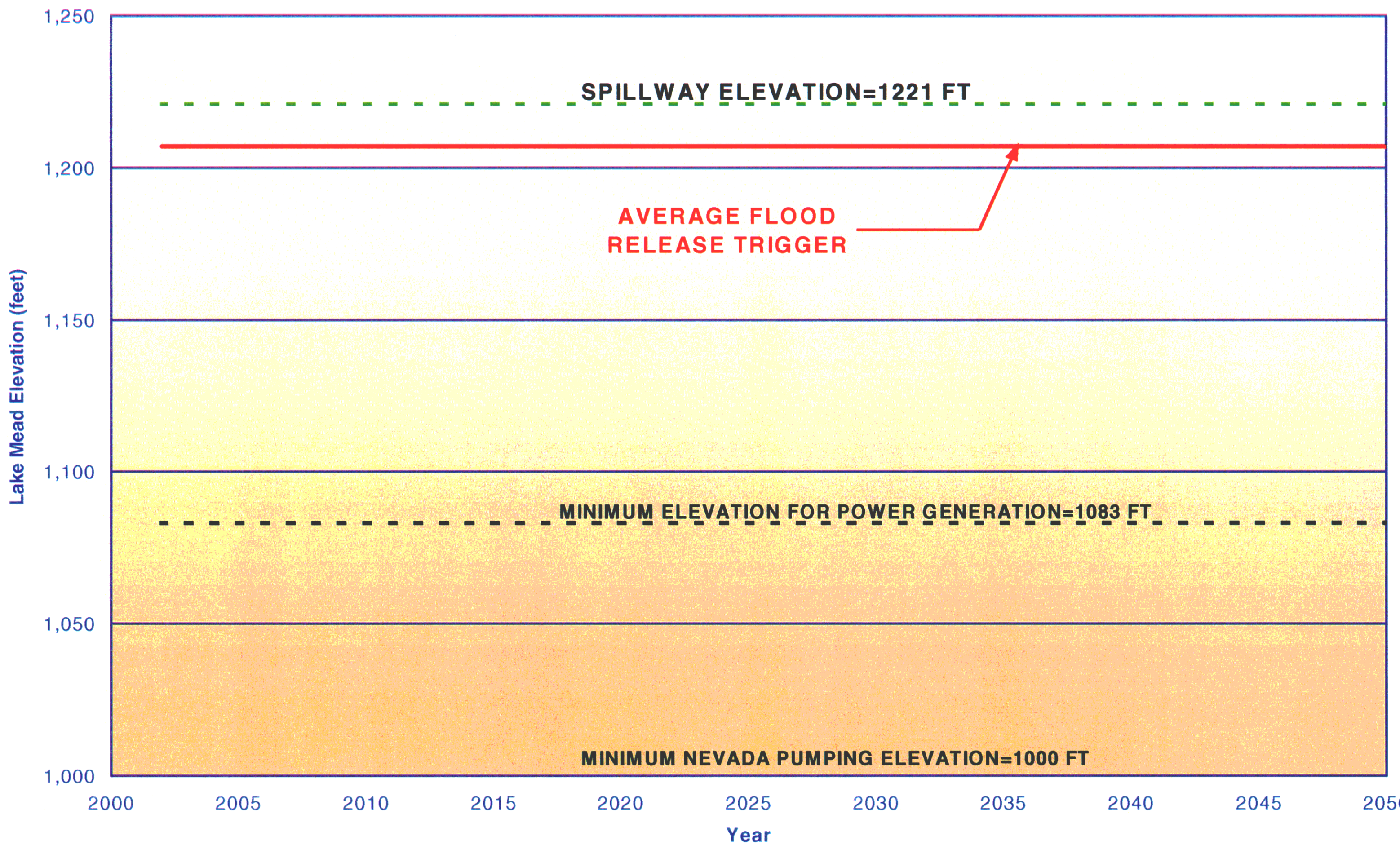
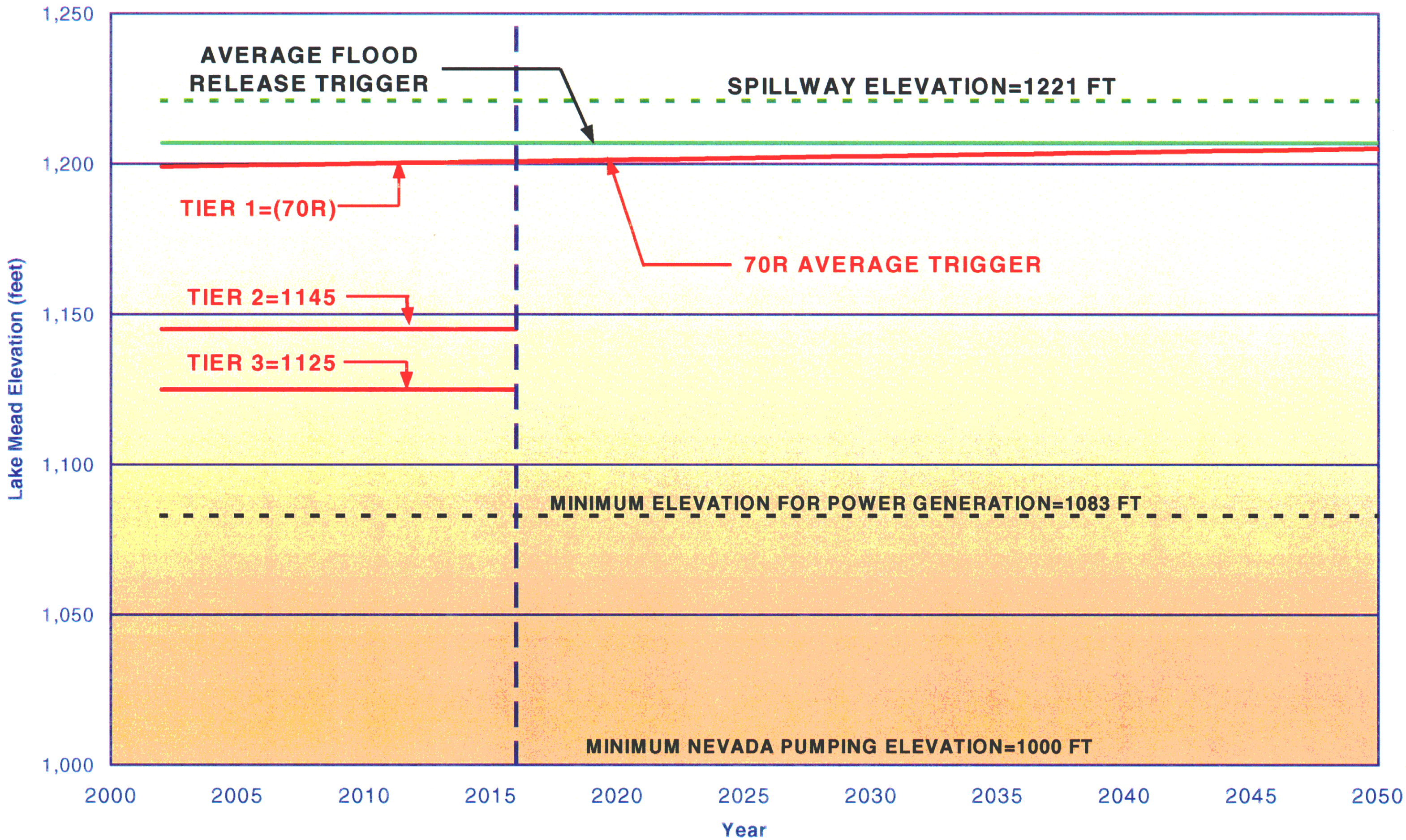


Figure 2-4
Six States Alternative Surplus Trigger Elevations



2.3.4.2 SIX STATES ALTERNATIVE SURPLUS TRIGGERS

The surplus determination elevations under the Six States Alternative consist of the tiered Lake Mead water surface elevations listed below, each of which is associated with certain stipulations on the purposes for which surplus water could be used. The tiered elevations are shown on Figure 2-4. They are as follows, proceeding from higher to lower water levels:

Tier 1 - 70R Line (approximately 1199 to 1201 feet msl)
Tier 2 - 1145 feet msl
Tier 3 - 1125 feet msl

The following sections describe the various tiers and the estimated amounts of surplus water available at those tiers under the Six States Alternative. When flood control releases are made, any and all beneficial uses would be met, including unlimited off-stream storage.

2.3.4.2.1 Six States Alternative Tier 1 (70R)

Six States Alternative Tier 1 Lake Mead surplus trigger elevations are based on the 70R strategy and range from approximately 1199 feet msl to 1201 feet msl during the interim period. When Lake Mead surface elevations are at or above the 70R line (and below the average flood release trigger line shown in Figure 2.4), surplus water would be available. Table 2-4 lists the estimated annual amounts of surplus water that would be available to the Lower Division states under the Basin States Alternative, when Lake Mead is at or above the Tier 1 trigger. The table also lists the estimated amounts of surplus water that would be available to the Lower Division states when flood control releases are required.

Table 2-4
Six States Alternative Potential Surplus Water Supply
Unit: thousand acre-feet (kaf)

Year	Flood Control	Tier 1	Tier 2	Tier 3
2002	1350	1350	600	350
2003	1350	1350	550	300
2004	1350	1350	500	250
2005	1350	1350	500	250
2006	1400	1400	450	200
2007	1450	1450	450	200
2008	1500	1500	450	150
2009	1550	1550	400	150
2010	1600	1600	400	150
2011	1600	1600	400	150
2012	1650	1650	400	150
2013	1650	1650	400	150
2014	1650	1650	400	150
2015	1700	1700	400	150
2016	1700	1700	400	150

2.3.4.2.2 Six States Alternative Tier 2 (1145 feet msl)

The Six States Alternative Tier 2 Lake Mead surplus trigger elevation is 1145 feet msl. At or above this Tier 2 elevation (and below the Tier 1 elevation), surplus water would be available for use by the Lower Division states in the estimated amounts on Table 2-4.

2.3.4.2.3 Six States Alternative Tier 3

The Six States Alternative Tier 3 Lake Mead surplus trigger elevation is 1125 feet msl. At or above this Tier 3 elevation (and below the Tier 2 elevation). Surplus water would be available for use by the Lower Division states in the estimated amounts on Table 2-4.

When Lake Mead water levels are below the Tier 3 trigger elevation, surplus water would not be available.

2.3.5 CALIFORNIA ALTERNATIVE

2.3.5.1 Approach to Surplus Water Determination

The California Alternative specifies Lake Mead water surface elevations to be used for the interim period through 2015 for determining the availability of surplus water through 2016. The elevation ranges are coupled with specific uses of surplus water in such a way that, if Lake Mead's surface elevation declines, the amount of surplus water would be reduced.

2.3.5.2 California Alternative Surplus Triggers

The Lake Mead elevations at which surplus conditions would be determined under the California Alternative are indicated by a series of tiered, sloping lines from the present to 2016. Each tiered line would be coupled with limitations on the amount of surplus water available at that tier. Figure 2-5 shows the structure of these tiered lines. Each tier is defined as a trigger line that rises gradually year by year to 2016, in recognition of the gradually increasing water demand of the Upper Division states. The elevations associated with the three tiers are as follows:

Tier 1 - 1160 feet msl to 1166 feet msl
Tier 2 - 1116 feet msl to 1125 feet msl
Tier 3 - 1098 feet msl to 1102 feet msl

Each tier under the California Alternative would be subject to adjustment during the interim period based on changes in Upper Basin demand projections or other factors during the five-year reviews or as a result of actual operating experience. The following sections describe the California Alternative tiers. When flood control releases are made, any and all beneficial uses would be met, including unlimited off-stream storage.

2.3.5.2.1 California Alternative Tier 1

California Alternative Tier 1 Lake Mead surplus trigger elevation increases from an initial elevation of 1160 feet msl to 1166 feet msl at the end of the interim period (based on Upper Basin demand projections). Lake Mead water surface elevations at or above the Tier 1 trigger line would permit surplus water deliveries to the Lower Division states in the estimated amounts on Table 2-5. The table also lists the estimated amounts of surplus water that would be available to the Lower Division states when flood control releases are required.

Table 2-5
California Alternative Potential Surplus Water Supply
Unit: thousand acre-feet (kaf)

Year	Flood Control	Tier 1	Tier 2	Tier 3
2002	1350	1350	650	550
2003	1350	1350	600	500
2004	1350	1350	550	400
2005	1350	1350	550	400
2006	1400	1400	500	400
2007	1450	1450	450	350
2008	1500	1500	450	350
2009	1550	1550	450	350
2010	1600	1600	400	300
2011	1600	1600	400	300
2012	1650	1650	400	300
2013	1650	1650	400	300
2014	1650	1650	400	300
2015	1700	1700	400	300
2016	1700	1700	400	300

2.3.5.2.2 California Alternative Tier 2

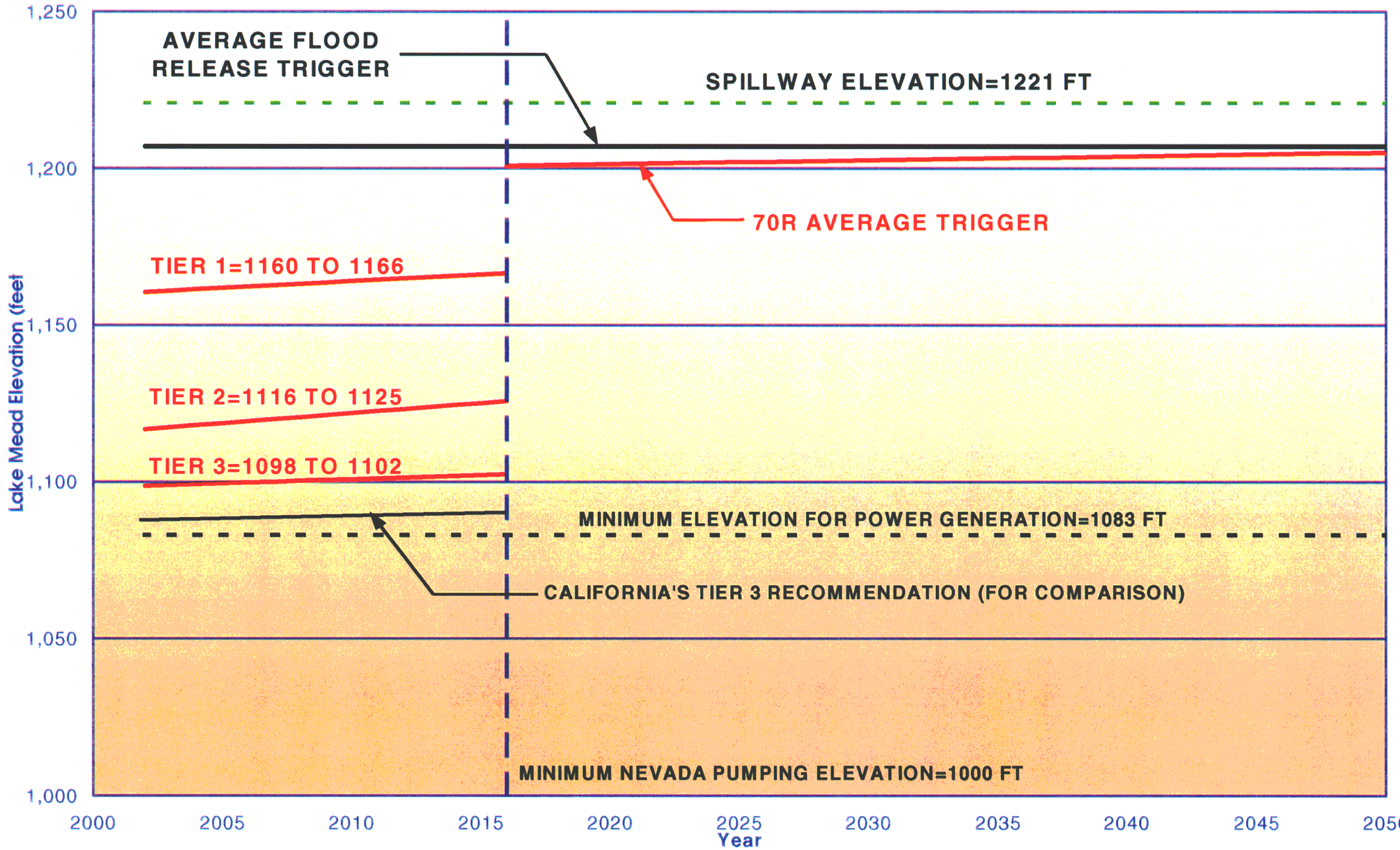
California Alternative Tier 2 Lake Mead surplus trigger elevation increases from 1116 feet msl to 1125 feet msl (based on Upper Basin demand projections). Lake Mead water surface elevations at or above the Tier 2 line (and below the Tier 1 line) would permit surplus water diversions for use by the Lower Division states in the estimated amounts on Table 2-5.

2.3.5.2.3 California Alternative Tier 3

California Alternative Tier 3 trigger elevation increases from 1098 feet msl to 1102 feet msl (based on Upper Basin demand projections). Lake Mead water surface elevations at or above the Tier 3 line (and below the Tier 2 line) would permit surplus water diversions for use by the Lower Division states in the estimated amounts on Table 2-5.

When Lake Mead water levels are below the Tier 3 trigger elevation, surplus water would not be made available.

Figure 2-5
California Alternative Surplus Trigger Elevations



2.3.6 SHORTAGE PROTECTION ALTERNATIVE

2.3.6.1 APPROACH TO SURPLUS WATER DETERMINATION

The Shortage Protection Alternative is based on maintaining an amount of water in Lake Mead necessary to provide a normal annual supply of 7.5 maf for the Lower Division, 1.5 maf for Mexico and storage necessary to provide an 80 percent probability of avoiding future shortages. The modeling assumptions for shortage protection are discussed in Section 3.3.3.4, Lake Mead Water Level Protection Assumptions.

2.3.6.2 SURPLUS TRIGGERS

The surplus triggers under this alternative range from an approximate Lake Mead initial elevation of 1126 feet msl to an elevation of 1155 feet msl at the end of the interim period, as shown on Figure 2-6. At Lake Mead elevations above the surplus trigger, surplus conditions would be determined to be in effect and surplus water would be available for use in the Lower Division states in the estimated amounts on Table 2-6. Below the trigger elevation, surplus water would not be made available.

Table 2-6
Shortage Protection Alternative
Potential Surplus Water Supply
Unit: thousand acre-feet (kaf)

Year	Flood Control	Surplus Amount
2002	1350	1350
2003	1350	1350
2004	1350	1350
2005	1350	1350
2006	1400	1400
2007	1450	1450
2008	1500	1500
2009	1550	1550
2010	1600	1600
2011	1600	1600
2012	1650	1650
2013	1650	1650
2014	1650	1650
2015	1700	1700
2016	1700	1700

2.4 SUMMARY TABLE OF IMPACTS

Table 2-7 presents a summary of the potential effects of the baseline operation and the interim surplus alternatives. Chapter 3 contains detailed descriptions of these effects.

Figure 2-6
Shortage Protection Alternative Trigger Elevations

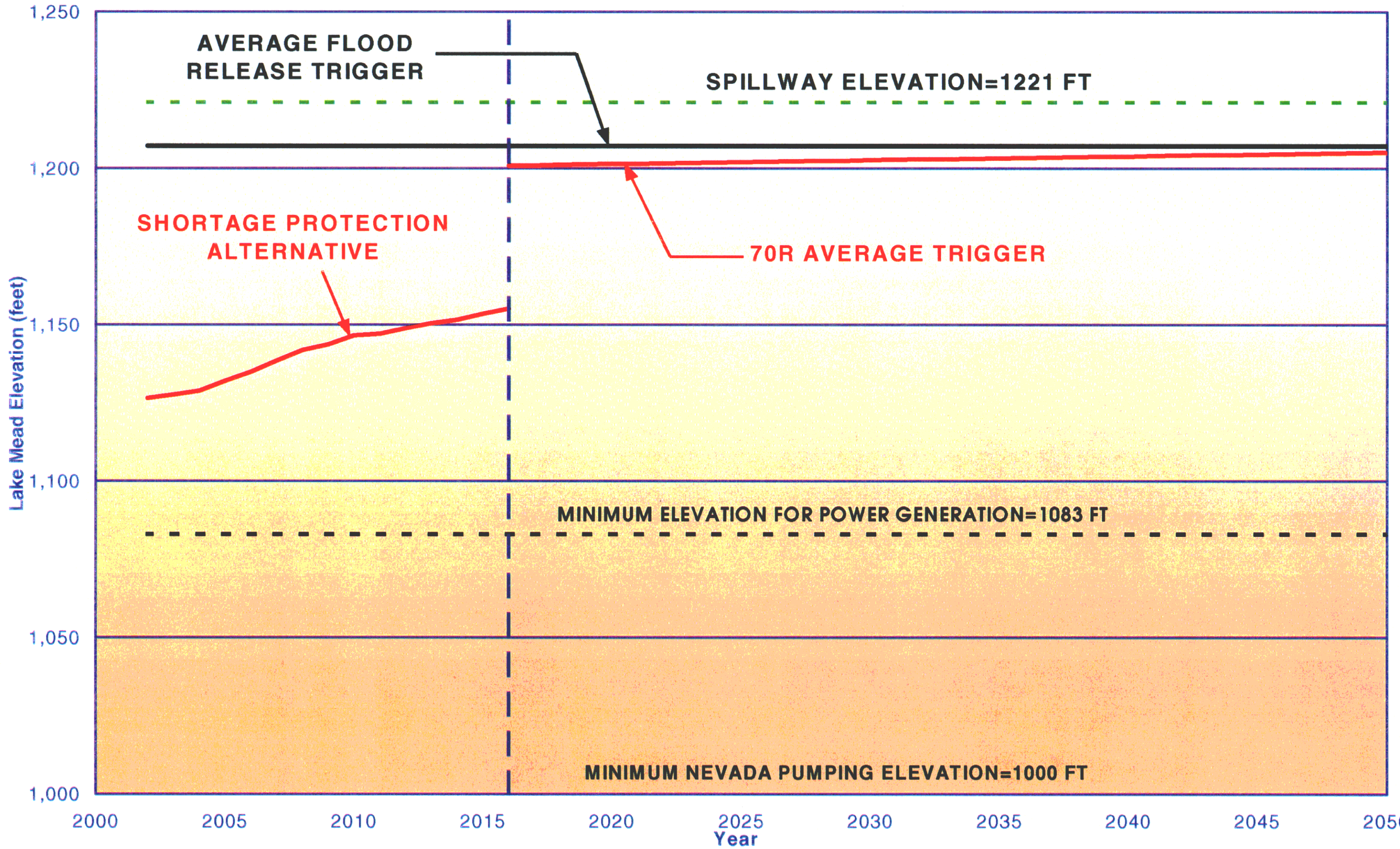


Table 2-7
Summary of Potential Effects of Implementing Interim Surplus Criteria[1]

Resource/Issue	Baseline Conditions/No Action	Effects of Alternatives[2]
Reservoirs Elevations and River Flows		
Lake Powell Water Surface Elevations Potential changes in Lake Powell water surface elevations.	Reservoir water levels exhibit a gradual declining trend during the interim surplus criteria period as a result of increasing Upper Division states consumptive use. The median water surface elevation in 2016 is 3665 feet msl. The probability of Lake Powell being full[3] in 2016 is 27%. After 2016, median levels stabilize, then rise and fall slightly, due to 602(a) storage requirements and less frequent equalization releases.	Median Elevations in 2016 for each of the alternatives are as follows: Basin States 3664 feet msl Flood Control 3665 feet msl Six States 3664 feet msl California 3660 feet msl Shortage Protection 3659 feet msl After 2016, Lake Powell water levels under all five alternatives tend to stabilize similar to baseline conditions. Water levels under the Basin States, Flood Control, Six States, California and Shortage Protection alternatives tend to converge with the baseline conditions by about year 2030.
Lake Mead Water Surface Elevations Potential changes in Lake Mead water surface elevations.	Reservoir water levels exhibit a gradual declining trend during the interim surplus criteria period as a result of Lower Basin consumptive use exceeding long-term inflow. The median water surface elevation in 2016 is 1162 feet msl. After 2016, median water surface elevations continue to decline, although at a lower rate, due to less frequent Lower Basin surplus deliveries.	Median Elevations in 2016 for each of the alternatives are as follows: Basin States 1143 feet msl Flood Control 1162 feet msl Six States 1146 feet msl California 1131 feet msl Shortage Protection 1130 feet msl After 2016, median surface elevations continue to decline. By about 2035, all alternatives converge to elevations similar to baseline conditions.
River Flows Glen Canyon and Hoover Dam releases and flows downstream of Lake Mead.	Flows downstream of Glen Canyon Dam would be managed in accordance with the 1995 Glen Canyon Dam EIS and the 1996 ROD. Flows downstream of Hoover Dam are governed by downstream demand or Hoover Dam flood control releases.	Flood Control Alternative: Similar to baseline conditions. Other alternatives: Flows below Glen Canyon Dam would be similar to baseline conditions. Flows from Hoover Dam to Parker Dam would be moderately higher until 2016 because of surplus deliveries. After 2016, flows would be similar to baseline conditions.

Table 2-7
Summary of Potential Effects of Implementing Interim Surplus Criteria[1]

Resource/Issue	Baseline Conditions/No Action			Effects of Alternatives[2]
Water Supply				
California Water Supply Probabilities of normal, surplus and shortage[4] conditions.	Normal:	2002 through 2016 2017 through 2050	100% 100%	Flood Control Alternative: Similar to baseline conditions. Other Alternatives: Greater probability of surplus through 2016. The probability is similar to baseline conditions from 2017 through 2050. Deliveries less than the normal apportionment (4.4 mafy) do not occur under the alternatives at any time through 2050.
	Surplus:	2002 through 2016 2017 through 2050	47% 21%	
	Shortage:	2002 through 2016 2017 through 2050	0% 0%	
Arizona Water Supply Probabilities of normal, surplus and shortage[4] conditions.	Normal:	2002 through 2016 2017 through 2050	>96% 50%	Flood Control Alternative: Similar to baseline conditions. Other Alternatives: Greater probability of surplus through 2016 under the California and Shortage Protection alternatives and slightly lower (26%) under the Basin States and Six States alternatives. The probability of surplus under the alternatives is about the same as baseline from 2017 to 2050. The probability of shortage condition deliveries under the alternatives is slightly higher (7% to 14%) through 2016. From 2017 to 2050, the probability of shortages under the alternatives is similar to baseline conditions.
	Surplus:	2002 through 2016 2017 through 2050	29% 21%	
	Shortage:	2002 through 2016 2017 through 2050	< 4% 50%	
Nevada Water Supply Probabilities of normal, surplus and shortage[4] conditions.	Normal:	2002 through 2016 2017 through 2050	96% 50%	Flood Control Alternative: Similar to baseline conditions. Other Alternatives: Greater probability of surplus through 2015; same as baseline from 2017 to 2050. The probability of shortage condition deliveries is slightly higher (7% to 14%) for the alternatives through 2016. From 2017 to 2050, the probability of shortage condition deliveries is higher (3% to 5%) under the alternatives.
	Surplus:	2002 through 2016 2017 through 2050	47% 21%	
	Shortage:	2002 through 2016 2017 through 2050	< 4% 50%	
Mexico Treaty Delivery Probabilities of meeting Treaty delivery obligations.	Normal:	2002 through 2016 2017 through 2050	100% 100%	The Flood Control Alternative would provide slightly higher (1%) probabilities of surplus than under baseline conditions through 2016. The rest of the alternatives provide slightly lower (3% to 7%) probabilities of surplus through 2016 and about the same level as baseline through 2050. Deliveries less than the treaty apportionment (1.5 mafy) do not occur under the alternatives at any time through 2050.
	Surplus:	2002 through 2016 2016 through 2050	26% 19%	
	Shortage:	2002 through 2016 2017 through 2050	0% 0%	

Table 2-7
Summary of Potential Effects of Implementing Interim Surplus Criteria[1]

Resource/Issue	Baseline Conditions/No Action	Effects of Alternatives[2]
Water Quality		
Colorado River Salinity Potential change in salinity below Hoover Dam.	Baseline projections assume compliance with numeric criteria along the river. The Basin States are committed to meeting the numeric criteria.	Modeling indicates potential for slight reductions in salinity under each alternative as compared to baseline.
Lake Mead Water Quality and Las Vegas Water Supply Contaminant concentrations in Boulder Basin of Lake Mead, in proximity to the SNWS intakes at Saddle Island.	Increased potential for lower Lake Mead levels and increased inflow channel lengths under baseline projections could increase potential of elevated contaminant concentrations.	The alternatives, except the Flood Control Alternative, result in slightly increased potential for increased contaminant concentrations in Boulder Basin, due to greater potential for lower Lake Mead levels than under baseline conditions.
Flow-Related Issues		
Beach/Habitat-Building Flow Releases Probability of BHBF release conditions from Glen Canyon Dam.	The average annual probability of BHBF releases is 16% through 2016 and 14% from 2017 through 2050.	The probability under the alternatives is typically less than under baseline conditions during the interim period, and converges with baseline conditions thereafter.
Low Steady Summer Flows Probability of requisite conditions for low steady summer flow releases from Glen Canyon Dam.	The average annual probability of conditions requisite for low steady summer flows is 38% through 2016 and 62% from 2017 through 2050.	The probability under the alternatives is typically less than under baseline conditions during the first seven years and similar to or slightly greater than under baseline conditions thereafter.
Flooding Downstream of Hoover Dam Probability of damaging flows below Davis and Parker Dams.	Average annual probability from 2002 through 2016: Davis Dam 9% Parker Dam 10% Average annual probability from 2017 through 2050: Davis Dam 5% Parker Dam 6%	The probability under the Flood Control Alternative is slightly greater than under baseline conditions. The probability under other alternatives is slightly less than under baseline conditions.
Aquatic Resources		
Lake Habitat and Sport Fisheries Potential effects on Lake Mead and Lake Powell fisheries and associated aquatic habitat.	Species are adapted to fluctuating reservoir levels. Therefore, increased potential for lower Lake Mead and Lake Powell surface levels is not expected to adversely affect aquatic species.	Compared with baseline conditions, slightly increased potential for higher reservoir levels under the Flood Control Alternative and increased potential for lower reservoir levels under the other alternatives would not be expected to result in substantial changes to lake habitat.

Table 2-7
Summary of Potential Effects of Implementing Interim Surplus Criteria[1]

Resource/Issue	Baseline Conditions/No Action	Effects of Alternatives[2]
Special-Status Species		
Special-Status Plants Potential effects on special-status plants for areas influenced by Lake Powell and Lake Mead water levels.	Under baseline conditions, special-status plant species would continue to be affected by fluctuating water levels, which would periodically expose and inundate areas where the plants occur.	Although reservoir elevations would differ, the effects of all alternatives would be similar to baseline conditions.
Special-Status Wildlife Potential effects on special-status wildlife species associated primarily with potential effects on riparian habitat at the Lake Mead and Virgin River deltas, and the lower Grand Canyon.	Under baseline conditions, increased potential over time for lower reservoir levels could increase potential for development of temporary riparian habitat at the deltas, which would benefit special-status wildlife species that utilize such habitat.	The Flood Control Alternative would have slightly lower potential, while the other alternatives would have increased potential, for lower reservoir elevations and associated potential increases in delta habitat.
Special-Status Fish Potential effects of Lake Mead and Lake Powell reservoir level changes on special-status fish species.	Under baseline conditions, increased potential for lower elevations is not expected to have effects on special-status species fish different than those that occur at present.	Changes in potential for lower reservoir levels under the various alternatives would not change potential for effects.
Recreation		
Reservoir Marinas/Boat Launching Potential effects on shoreline recreation facilities from changes in Lake Mead and Lake Powell surface elevations.	Baseline condition projections indicate increased potential for reservoir levels lower than those considered within the normal operating range that some existing facilities may be able to accommodate. Such occurrence would likely result in modification of facilities to accommodate lower surface elevations.	The Flood Control Alternative has a slightly decreased potential for lower reservoir levels; each of the other alternatives have increased potential for lower levels and necessary relocations.
Reservoir Boating/Navigation Potential effects on reservoir boating that may result from changes in Lake Mead and Lake Powell surface elevations.	Baseline condition projections indicate an increased potential for the occurrence of lower Lake Mead and Lake Powell reservoir levels, which may result in potential increases in navigation hazards and decreased safe boating capacity (due to decreased reservoir surface area).	The Flood Control Alternative has slightly lower potential, and each of the other alternatives have higher potential, for each of navigation hazards and reduced carrying capacity.
River and Whitewater Boating Potential effects on river boating at Lake Powell and Lake Mead inflow areas.	Boaters may have reduced take-out opportunities due to increased potential for lower reservoir surface elevations.	The Flood Control Alternative has lower potential, and each of the other alternatives have increased potential, for reduced take-out opportunities resulting from lower reservoir elevations.

Reservoir Sport Fishing Potential effects on sport fishing in Lake Mead and Lake Powell.	Potential effects on sport fisheries are minimal under baseline conditions.	Changes in reservoir elevations under each of the alternatives would not be expected to adversely affect sport fisheries or fishing in either reservoir.
Recreation Facilities Relocation Costs Increased costs associated with relocating shoreline facilities to remain in operation at lower reservoir elevations.	Baseline condition projections indicate increased relocation costs associated with future increased potential for lower reservoir levels.	The Flood Control Alternative is similar to baseline conditions. Other alternatives have greater potential for increased relocation costs, based on an average cost per foot associated with relocating facilities.
Energy Resources		
Hydroelectric Power Production Potential for changes in energy production at Glen Canyon and Hoover powerplants.	Glen Canyon Powerplant average annual energy production: 4532 GWh through 2016; 4086 GWh from 2017 through 2050. Hoover Powerplant average annual energy production: 4685 GWh through 2016; 3903 GWh from 2017 through 2050.	The Flood Control Alternative is similar to baseline conditions. Average annual power production under the other alternatives is greater than under baseline conditions for the first six to eight years, then is less for the remaining years. Averaged from 2002 to 2050, Glen Canyon annual power production is from 12 to 30 GWh less than baseline conditions, while Hoover power production is from 51 to 127 GWh less.
Pumping Power Needs for SNWS Potential change in the cost of power to pump Lake Mead water through the SNWS.	Future lower average Lake Mead water levels would require more energy and increased pumping costs for the SNWS intake.	The increase over baseline conditions of annual pumping costs for each alternative follows: Basin States $229,395 Flood Control $ 32,685 Six States $214,779 California $544,843 Shortage Protection $532,635

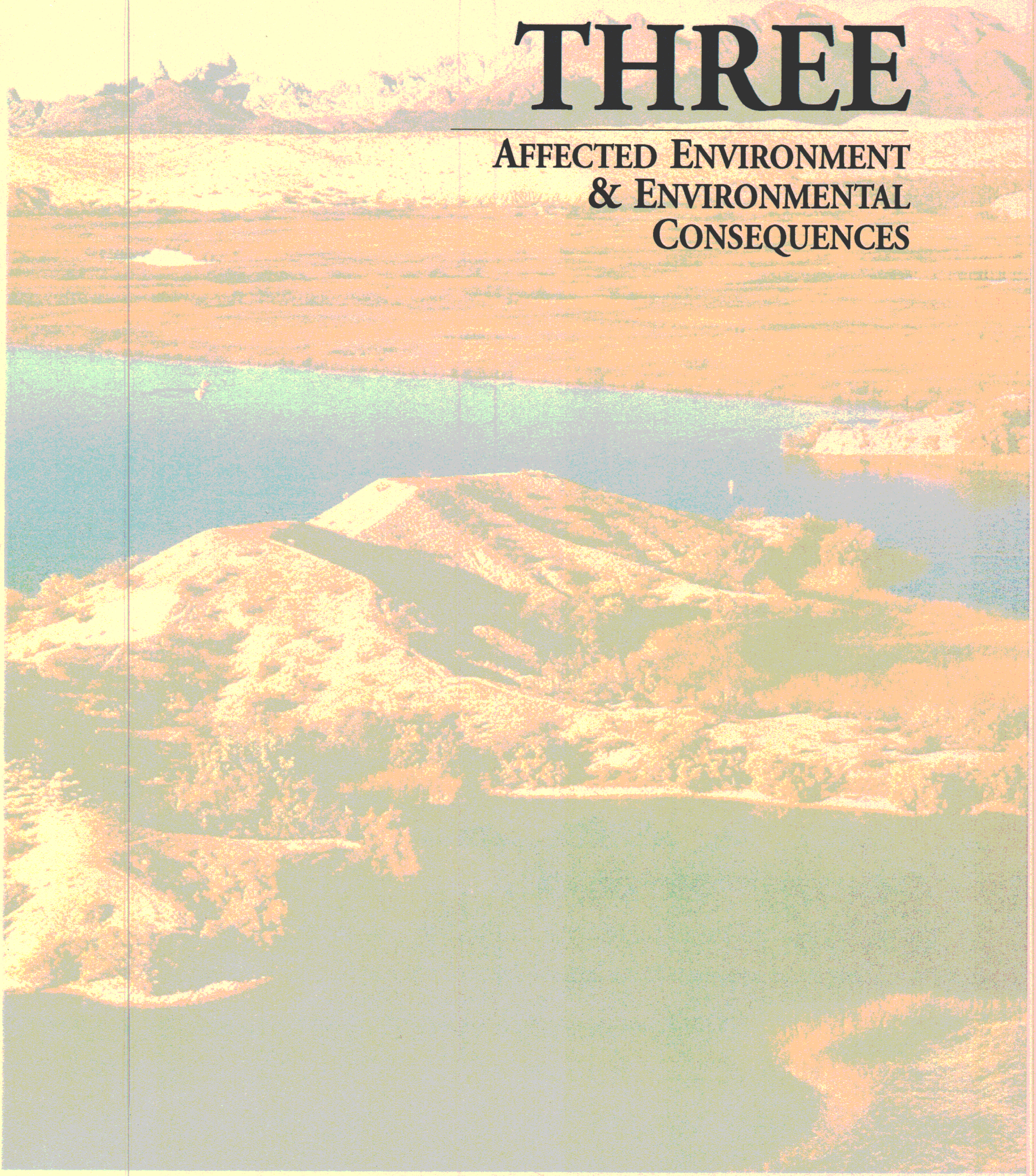
Intake Energy Requirements at Lake Powell Potential change in the cost of power to pump Lake Powell water to the Navajo Generating Station and the City of Page.	Future lower average Lake Powell water levels would require more energy and increased pumping costs for the Navajo Generating Station and the City of Page.	The increase over baseline conditions of annual pumping costs for each alternative follows: **Navajo Generating Station** Basin States $2,216 Flood Control $ 0 Six States $2,129 California $4,651 Shortage Protection $4,660 **City of Page** Basin States $ 529 Flood Control $ 0 Six States $ 508 California $1,110 Shortage Protection $1,112
Air Quality		
Fugitive Dust Emissions from Exposed Reservoir Shoreline Potential for fugitive dust emissions from shoreline exposure at Lake Mead and Lake Powell.	Increased potential for lower reservoir levels would increase potential for shoreline exposure under baseline conditions. Increases in fugitive dust emissions would be minimal due to low emission potential of shoreline.	Slightly decreased shoreline exposure under Flood Control Alternative would lower fugitive dust emission potential. Other alternatives would have slightly increased potential for increased fugitive dust emissions. Minimal changes in area-wide fugitive dust emissions would be expected.
Visual Resources		
Visual Attractiveness of Reservoir Scenery, Lake Mead and Lake Powell Potential effects of lower reservoir elevations on scenic quality.	Increased probability of temporary degradation in visual attractiveness of shoreline vistas resulting from increasing potential for lower water levels in Lake Mead and Lake Powell.	Flood Control Alternative: Same as baseline conditions. Other alternatives: Higher probability of degradation of visual attractiveness through 2016 due to accelerated decline of minimum reservoir levels.
Cultural Resources		
Effects on Historic Properties in Operational Zone of Reservoir and River Reaches.	Not significant due to past water level fluctuations. Impacts have already occurred.	Not significant due to past water level fluctuations. Impacts have already occurred.
Indian Trust Assets		
Effects on water supply for Indian Tribes and Communities	The water available to members of Ten Tribes Partnership would not be affected by future changes under baseline conditions. There is a probability of shortages of CAP priority water for tribes in central Arizona.	No effect on water available to members of Ten Tribes Partnership. Greater probability of shortages of CAP priority water for tribes in central Arizona under all alternatives with the exception of the Flood Control Alternative.

Environmental Justice		
Exposure of Minority or Low Income Communities to Health or Environmental Hazards	No effects are anticipated.	No effects anticipated.
Transboundary Effects		
Treaty Water Delivery Obligations Probabilities of meeting Treaty delivery obligations	Normal: 2002 through 2016 100% 2017 through 2050 100% Surplus: 2002 through 2016 26% 2016 through 2050 19% Shortage: 2002 through 2016 0% 2017 through 2050 0%	The Flood Control Alternative would provide slightly higher (1%) probabilities of surplus than under baseline conditions 2016. The rest of the alternatives provide slightly lower (3% to 7%) probabilities of surpluses through 2016 and about the same level as baseline through 2050. Deliveries less than the treaty apportionment (1.5 mafy) do not occur under the alternatives at any time through 2050.
Flow Below Morelos Dam Amount of excess flow that may reach the Colorado River delta.	Probability of excess flows below Morelos Dam would gradually decline under baseline conditions.	Flood Control Alternative: Similar to baseline. Other alternatives: Small reduction in probability of excess flows.
Potential Effects on Species and Habitat in Mexico	Probability of excess flows below Morelos Dam would gradually decline.	Under the Basin States Alternative there would be no effect on desert pupfish, Vaquita, Yuma clapper rail, California black rail, Clarks grebe; and there is not likely to be any adverse affect on totoaba, Southwestern willow flycatcher, Yellow-billed cuckoo, Elf owl or Bell's vireo.

1. Effects identified are based on probabilities developed through modeling of possible future conditions through 2050, discussed in detail in Chapter 3.
2. In general, the differences between the alternatives and baseline conditions would be greatest at or near 2016, the year in which the interim surplus criteria would terminate.
3. Lake Powell is considered to be essentially full when the lake elevation reaches 3695 feet msl (5 feet below the top of the spillway gates).
4. Probabilities of shortage are based on the modeling assumption of protecting a Lake Mead elevation of 1083 feet msl. There are no established shortage criteria for the operation of Lake Mead.

CHAPTER THREE

AFFECTED ENVIRONMENT & ENVIRONMENTAL CONSEQUENCES



3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 INTRODUCTION

Chapter 3 presents the analysis conducted and identifies potential effects that could occur as a result of implementation of the interim surplus criteria alternatives under consideration. Section 3.1 describes the: 1) structure of the resource sections in this chapter; 2) role of modeling in the analysis; 3) baseline used for measuring potential effects of the alternatives; 4) general approach used for determining potential effects; 5) period of analysis; and 6) environmental commitments associated with interim surplus criteria.

Section 3.2 presents a general discussion of the geographic area within which potential effects of the interim surplus criteria were analyzed, and Section 3.3 describes the modeling methods and general results of Colorado River system modeling. The remaining sections of Chapter 3 present resource-specific analyses of potential effects using information obtained from the modeling.

3.1.1 STRUCTURE OF RESOURCE SECTIONS

Beginning with Section 3.4, the sections in this chapter each present a general resource category, such as water supply, recreation and aquatic resources. Within each resource category is contained analyses of one or more specific issues identified for consideration through scoping, public review and comment, and internal review. A discussion of the methodology, affected environment and environmental consequences is provided for each issue. Environmental commitments are proposed for impacts to various resource issues as appropriate.

Methodology discussions identify the specific methods used for determining the affected environment and potential environmental consequences of the alternatives. The affected environment discussions then identify the specific context within which the issue being analyzed exists. This includes a discussion of general environmental characteristics associated with each issue, as well as important Colorado River system conditions that may be associated with each issue. Finally, the potential effects of interim surplus criteria compared to baseline conditions (as discussed in more detail below) are presented in the environmental consequences discussions.

3.1.2 USE OF MODELING TO IDENTIFY POTENTIAL FUTURE COLORADO RIVER SYSTEM CONDITIONS

To determine the potential effects of the interim surplus criteria alternatives, modeling of the Colorado River system was conducted (a complete description of the modeling procedure is included in Section 3.3). Modeling provides projections of potential future Colorado River system conditions (i.e., reservoir surface elevations, river flows, salinity, etc.). The modeling results allow a comparison of potential future conditions under the various interim surplus criteria alternatives and baseline conditions. As such, much of the analyses contained within this FEIS are based upon potential effects of changed flows and water levels within the Colorado River and mainstream reservoirs.

3.1.3 BASELINE CONDITIONS

As discussed in Chapter 2, the No Action Alternative does not provide consistent specific criteria for determining surplus conditions. As such, it is not possible to precisely model the No Action Alternative. However, in order to provide a reasonable analytical projection of potential future system conditions without interim surplus criteria, a baseline surplus strategy (70R) was utilized. This baseline represents definable surplus criteria based on recent operational decisions. The 70R strategy is based upon recent secretarial operating decisions and was modeled to develop a projection of baseline conditions for comparison with the alternatives in this FEIS.

3.1.4 IMPACT DETERMINATION

The analysis of potential effects for each issue considered is based primarily upon the results of modeling. Following the identification of conditions important to each issue, the potential effects of various system conditions over the general range of their possible occurrence (as identified by the range of modeling output for various parameters) are identified for each issue. The potential effects of the various interim surplus criteria alternatives are then presented in terms of the incremental differences in probabilities (or projected circumstances associated with a given probability) between baseline conditions and the alternatives.

3.1.5 PERIOD OF ANALYSIS

This FEIS addresses interim surplus criteria that would be used during the years 2001 through 2015 for determining whether surplus water would be available during the years 2002 through 2016. Due to the potential for effects beyond the 15-year interim period, the modeling and impact analyses extend through the year 2050. It is important to note that modeling output and associated impact analyses become more uncertain over time as a result of increased uncertainty of future system conditions (including hydrologic conditions), as well as uncertainty with regard to future operational decisions that will affect circumstances within the Colorado River system.

3.1.6 ENVIRONMENTAL COMMITMENTS

As discussed, impacts identified in Chapter 3 are associated with changes in the difference between probabilities of occurrence for specific resource issues under study when comparing the action alternatives to baseline conditions. Reclamation has determined that most of the potential impacts identified are not of a magnitude that would require specific mitigation measures to reduce or eliminate their occurrence because the small changes in probabilities of occurrence are within Reclamation's current operational regime and authorities under applicable federal law. However, in recognition of potential effects that could occur under baseline conditions or with implementation of the interim surplus criteria alternatives under consideration, Reclamation has developed a number of environmental commitments that would be undertaken if interim surplus criteria are implemented. These commitments are described in relevant resource sections of this Chapter and in Section 3.17.

3.2 POTENTIALLY AFFECTED AREA

Interim surplus criteria could affect the operation of the Colorado River system (i.e., reservoir levels and river flow volumes) as a result of surplus determinations and associated water deliveries that may not have occurred in the absence of such criteria. This section describes the general geographic scope in which specific issues and potential effects associated with the interim surplus criteria alternatives were considered in this FEIS. Also discussed are the AMP, and how the program influences flows between Lake Powell and Lake Mead.

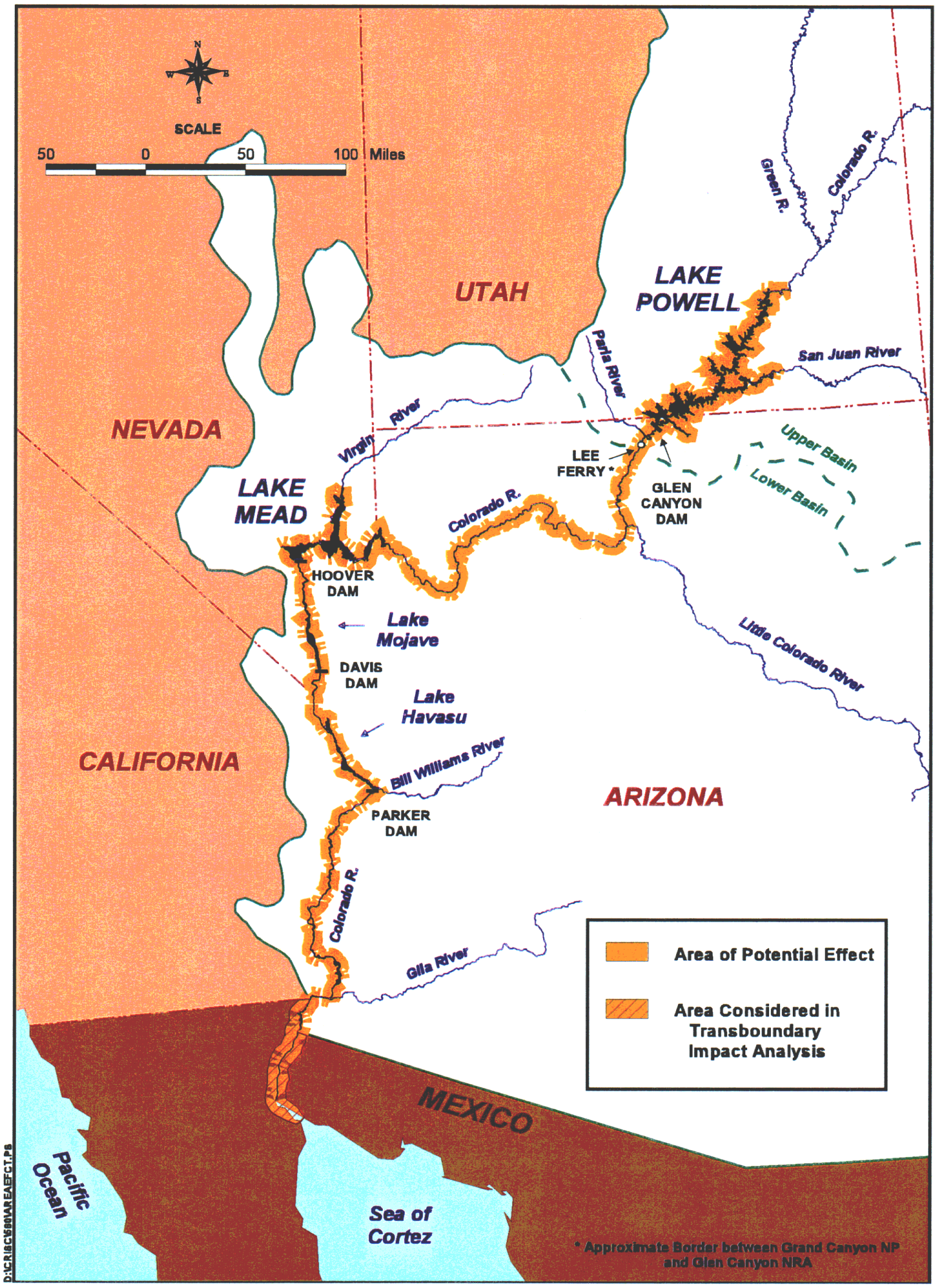
In addition to influencing conditions within the Colorado River system, it is recognized that continued delivery of surplus water that could result from interim surplus criteria would complement ongoing and proposed state actions in the Lower Basin. These actions could result in environmental effects outside of the river corridor. However, these actions have independent utility and are not caused by or dependent on interim surplus criteria for their implementation. Environmental compliance would be required on a case-by-case basis prior to their implementation. Therefore, Reclamation determined that the appropriate scope of this analysis is to consider only those potential effects that could occur within the Colorado River corridor as defined by the 100-year flood plain and reservoir maximum water surface elevations.

Interim surplus criteria are based on system conditions and hydrology. Water supply to the Lower Division states of Arizona, California and Nevada is achieved primarily through releases and pumping from Lake Mead. As a result of Lake Powell and Lake Mead equalization requirements (discussed further in Section 3.3), interim surplus criteria effects on Lake Mead surface elevations could also influence Lake Powell surface elevations and Glen Canyon Dam releases. However, operation of the other Upper Basin reservoirs is independent of Lake Powell. Therefore, the upstream limit of the potentially affected area under consideration in this FEIS is the full pool elevation of Lake Powell. The downstream limit of the potentially affected area within the United States is the SIB between the United States and Mexico. Section 3.16 of this FEIS addresses potential transboundary impacts in Mexico extending to the mouth of the Colorado River as required pursuant to Executive Order 12114 - Environmental Effects Abroad of Major Federal Actions, January 4, 1997, and the July 1, 1997 Council on Environmental Quality (CEQ) Guidelines on NEPA Analyses for Transboundary Impacts.

3.2.1 COLORADO RIVER SEGMENTS AND ISSUES ADDRESSED

As shown on Map 3.2-1, the Colorado River corridor from Lake Powell to Mexico consists of flowing river reaches, two large reservoirs (Lake Powell and Lake Mead) and two smaller reservoirs downstream of Lake Mead (Lake Mohave and Lake Havasu). The river corridor and adjacent areas comprise a heterogeneous composite of various geographic and hydrologic regimes, which differ in their resource composition and resource management administration.

Map 3.2-1
Area of Potential Effect



For the purposes of presentation, and to focus analysis of the potential effects of the interim surplus criteria, the river corridor has been divided into four areas: Lake Powell, the Colorado River between Glen Canyon Dam and Lake Mead, Lake Mead, and the Colorado River between Hoover Dam and the SIB. The following sections discuss the areas segmented for this analysis and introduce the issues considered within each area.

3.2.1.1 LAKE POWELL

Lake Powell is a large reservoir on the Colorado River formed by Glen Canyon Dam. The reservoir is narrow and long (over 100 miles). Lake Powell provides water storage for use in meeting delivery requirements to the Lower Basin.

The normal operating range of Lake Powell is between elevations 3490 and 3700 feet msl. Elevation 3490 feet msl corresponds to minimum power pool. (Releases from Glen Canyon Dam can be made below 3490 feet msl down to elevation 3370 feet msl via the river bypass tubes.) Elevation 3700 feet msl corresponds to the top of the spillway radial gates. During floods, the elevation of Lake Powell can go above 3700 feet msl by raising the radial spillway gates, resulting in spillway releases. In 1983, Lake Powell reached a high elevation of 3708.34 feet msl.

Lake Powell is located within the GCNRA, which is administered by the NPS. Reclamation retains authority and discretion for the operation of Glen Canyon Dam and Lake Powell. Issues considered in this FEIS associated with Lake Powell include: hydrology (i.e., projected reservoir surface elevations); salinity; aquatic resources; special-status species; recreational facilities, boating and sport fishing; power generation from Glen Canyon Dam; changes in pumping costs for Navajo Generating Station and the City of Page; visual and air quality effects associated with exposed reservoir shoreline; environmental justice; cultural resources; and Indian Trust Assets (ITAs).

3.2.1.2 COLORADO RIVER FROM 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. Flows within this reach of the river consist primarily of releases from Glen Canyon Dam as discussed in Section 3.3.1. Issues considered in this FEIS within this segment of the river address those associated with a program of low steady summer flows and Beach/Habitat-Building Flow (BHBF) releases, as discussed in Section 3.2.2.

3.2.1.3 LAKE MEAD

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 1219.61 and 1083 msl. Elevation 1083 msl corresponds to the minimum power pool. (Releases can be made from Hoover Dam below 1083 msl down to 895 feel msl via the intake towers.) During floods, the elevation of Lake Mead can go above 1219.61 msl. The top of the raised spillway gates is at 1221.0 msl. Since its initial filling in the late 1930s, the reservoir water level has fluctuated from a high of 1225.85 feet msl (as occurred in July, 1983) to a low of 1083.21 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. Issues considered in this FEIS associated with Lake Mead include: hydrology; water supply for Nevada; salinity; water quality associated with Las Vegas Wash and SNWA intakes; aquatic resources; special-status species; recreational facilities, boating and sport fishing; power generation from Hoover Dam; visual and air quality effects associated with exposed reservoir shoreline; environmental justice; cultural resources; and ITAs.

3.2.1.4 COLORADO RIVER FROM HOOVER DAM TO THE SOUTHERLY INTERNATIONAL BOUNDARY

The Colorado River 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. 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 LMNRA. The lower reach is bordered by a combination of federal, Tribal and private land. The last 22 miles (approximately) is along the international border with Mexico. Reclamation retains authority and discretion for river operations in the reaches of this segment.

Under the BCPA and the Decree, discussed previously in Chapter 1, 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 Corps' flood control criteria, as discussed in Chapter 1 or for other purposes consistent with the BCPA and the Decree.

Issues considered in this FEIS associated with this river segment include hydrology; water supply for Arizona, California, Nevada and Mexico; costs of flood damages downstream of Hoover Dam; water quality; potential effects of changes in flows on special-status species; potential effects of changes in the temperature of water released from Hoover Dam on sport fisheries and fishing; environmental justice; cultural resources; and ITAs.

3.2.2 ADAPTIVE MANAGEMENT PROGRAM INFLUENCE ON GLEN CANYON DAM RELEASES

In March 1995, Reclamation completed an EIS on the operation of Glen Canyon Dam. The EIS developed and analyzed alternative operation scenarios designed to meet statutory responsibilities for conserving downstream resources, while meeting other authorized project purposes, and protecting Native American interests. Major issues of concern included native and endangered species, beach erosion, recreation (including white-water boating, sport fishing, and camping), vegetation, wildlife habitat and food base, water supply, hydroelectric power generation, cultural resources, and Native American interests. The Secretary signed a ROD on October 8, 1996, which specified certain types of releases from Glen Canyon Dam. Prior to the ROD, Glen Canyon Dam was operated as a peaking power facility, maximizing the value of power produced. The patterns of releases resulting from this type of operation were recognized to be detrimental to downstream resources and were therefore modified by the ROD. Reclamation also consulted with the Service under the ESA. The Service issued a biological opinion containing a recommendation for a reasonable and prudent alternative, which was incorporated into the ROD (see Section 1.4.2.1).

To determine if the operation of Glen Canyon Dam under the ROD is meeting the objectives of downstream resource protection, an AMP was instituted as described in Section 1.4.2.1. Through this process, the effects of dam operations and the status of resources are monitored and studied. The results are used to formulate potential recommendations to the Secretary on refinements to dam operations to ensure that the purposes of the Grand Canyon Protection Act are met. As long as the AMP continues to successfully function, the natural and cultural resources within the Colorado River corridor between Glen Canyon Dam and Separation Canyon (just upstream of Lake Mead) will be protected and conserved.

Two types of releases from Glen Canyon Dam, BHBFs and low steady summer flows, are part of a program of experimental flows being developed and refined through the AMP, as called for in the Biological Opinion (USFWS, 1994). The change in the frequency with which BHBFs and low steady summer flows would be triggered under each of the alternatives has been analyzed (see Section 3.6). Flows from Glen Canyon Dam, which could be affected by the adoption of interim surplus criteria, will remain within the range of flows analyzed in detail in the Glen Canyon Dam EIS. Therefore, effects of potential changes in the frequencies of these flows on downstream resources require no further analysis outside of the Glen Canyon Dam ROD and the AMP.

3.3 RIVER SYSTEM OPERATIONS

This section addresses the operation of the Colorado River system, the modeling process used to simulate river operation and potential changes that may occur from implementation of the interim surplus criteria. The term *system management* refers to how the water is managed once it enters the Colorado River system and includes operation of the system reservoirs, dams and other Colorado River system facilities. The environmental and socioeconomic effects of the interim surplus criteria alternatives stem from changes in the operation of the Colorado River system under the surplus alternatives relative to the baseline conditions.

3.3.1 OPERATION OF THE COLORADO RIVER SYSTEM

Operation of the Colorado River system and delivery of Colorado River water to the seven Basin States and Mexico are conducted in accordance with the *Law of the River* as discussed in Section 1.3.2.1. 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 Decree. The principal facilities that were built 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 LROC and the AOP. The AOP is required by the 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 as discussed in Section 3.4. 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. Daily changes in water orders are made to accommodate emergencies, temperature and weather.

A minimum of 1.5 maf is delivered annually to Mexico in accordance with the Treaty. The Treaty contains provisions for delivery of up to 200,000 af above the 1.5 maf when 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.

3.3.1.1 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 forecasted 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 Colorado Basin River Forecast Center (CBRFC) provides the monthly forecasts of expected inflow into Lake Powell. The CBRFC uses a satellite-telemetered network of hundreds of data collection points within the Upper Colorado River Basin that gather data on snow water content, precipitation, temperature and streamflow. Regression and real-time conceptual computer models are used to forecast inflows that are then used by Reclamation to plan future release volumes. 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 forecasted 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 draw the reservoir level down, 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.

Scheduling of BHBF releases from Glen Canyon Dam are discussed in Section 3.6.2.2.

Daily and hourly releases are made according to the parameters of the ROD for the Operation of Glen Canyon Dam Final Environmental Impact Statement and published in the *Glen Canyon Dam Operating Criteria* (62 CFR 9447, Mar. 3, 1997), as shown in Table 3.3-1.

Table 3.3-1
Glen Canyon Dam Release Restrictions

Parameter	Cubic Feet per Second	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 the 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.

3.3.1.2 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' obligation to Mexico. 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 cubic feet per second (cfs) to 49,000 cfs. The upper value is the maximum flow-through capacity through the powerplant at Hoover Dam (49,000 cfs). However, because these flows enter Lake Mohave downstream, the affected zone of fluctuation is only a few miles.

Releases of water from Hoover Dam may also be affected by the Secretary's determinations relating to normal, surplus or shortage water supply conditions, as discussed in Section 1.3.4.1. Another type of release includes flood control releases. For Hoover Dam, flood control releases are defined in this FEIS as releases in excess of the downstream demands.

Flood control was specified as a primary project purpose by the BCPA, the act authorizing Hoover Dam. The Corps is responsible for developing the flood control operation plan for Hoover Dam and Lake Mead as indicated in 33 CFR 208.11. The plan is the result of a coordinated effort by the Corps and Reclamation. However, the Corps is responsible for providing the flood control regulations and has authority for final approval of the plan. Any deviations from the flood control operating instructions provided by the plan must be authorized by the Corps. 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 1219.61 and 1229.0, is defined as exclusive flood control space. Within this capacity allocation, 1.218 maf of flood storage is above elevation 1221.0, 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 1221.0 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 in specified upstream reservoirs: Powell, Navajo, Blue Mesa, Flaming Gorge and Fontenelle. The minimum required to be reserved exclusively for flood control storage in Lake Mead is 1.5 maf. Table 3.3-2 presents the amount of required flood storage space within the Colorado River system by date:

Table 3.3-2
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 forecasted 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 Corps' regulations is based on increasing releases in six steps as shown on Table 3.3-3.

Table 3.3-3
Minimum Flood Control Releases at Hoover Dam

Step	Amount of Cubic Feet/Second
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 powerplant capacity of Parker Dam. The third step, 28,000 cfs, corresponds to the Davis Dam Powerplant capacity. The fourth step in the Corps 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 nondamaging 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 forecasted inflow exceeds downstream demands, available storage space at lakes Mead and 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 Corps regulations set the procedures for releasing the volume that cannot be impounded, as discussed above.

Average monthly 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–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, the end-of-month Lake Mead elevations are driven by consumptive use needs, Glen Canyon Dam releases and Treaty deliveries to Mexico. 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 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.

3.3.2 NATURAL RUNOFF AND STORAGE OF WATER

Most of the natural flow in the Colorado River system originates in the Upper Basin and is highly variable from year to year. The natural flow represents an estimate of runoff flows that would exist without storage or depletion by man and was used in the modeling of the baseline conditions and interim surplus criteria alternatives. 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 Lees Ferry is calculated at 15.1 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, the annual river gains from tributaries, groundwater discharge and occasional flash floods from side canyons average 900,000 af. Immediately downstream of Hoover Dam, the river flows consist almost entirely of water released from Lake Mead. Downstream of Hoover Dam, the river gains additional water 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. The various reservoirs that provide storage in the Colorado River system and their respective capacities were discussed in Section 1.3.2.

Figure 3.3-1 presents an overview of the historical natural flow calculated at Lees Ferry for calendar years 1906 through 1999. The natural flow represents an estimate of the flows that would originate or exist above Lees Ferry without storage or depletion by man. This is different than the recorded or historical stream flows that represent actual measured flows. Figure 3.3-2 presents an overview of the historical flows recorded at Lees Ferry for the period 1922 through 1999 (calendar year).

Figure 3.3-1
Natural Flow at Lees Ferry Stream Gage

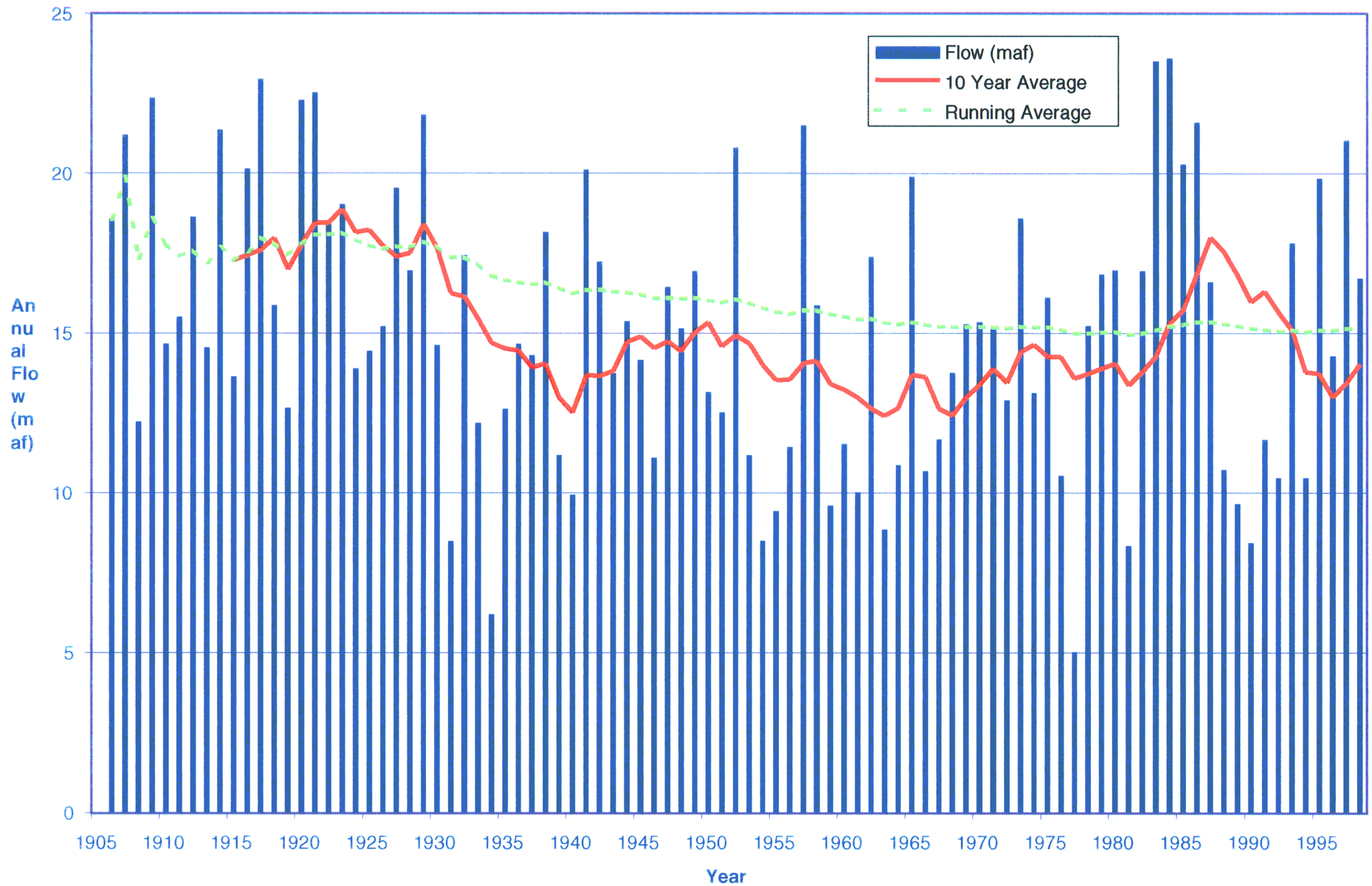
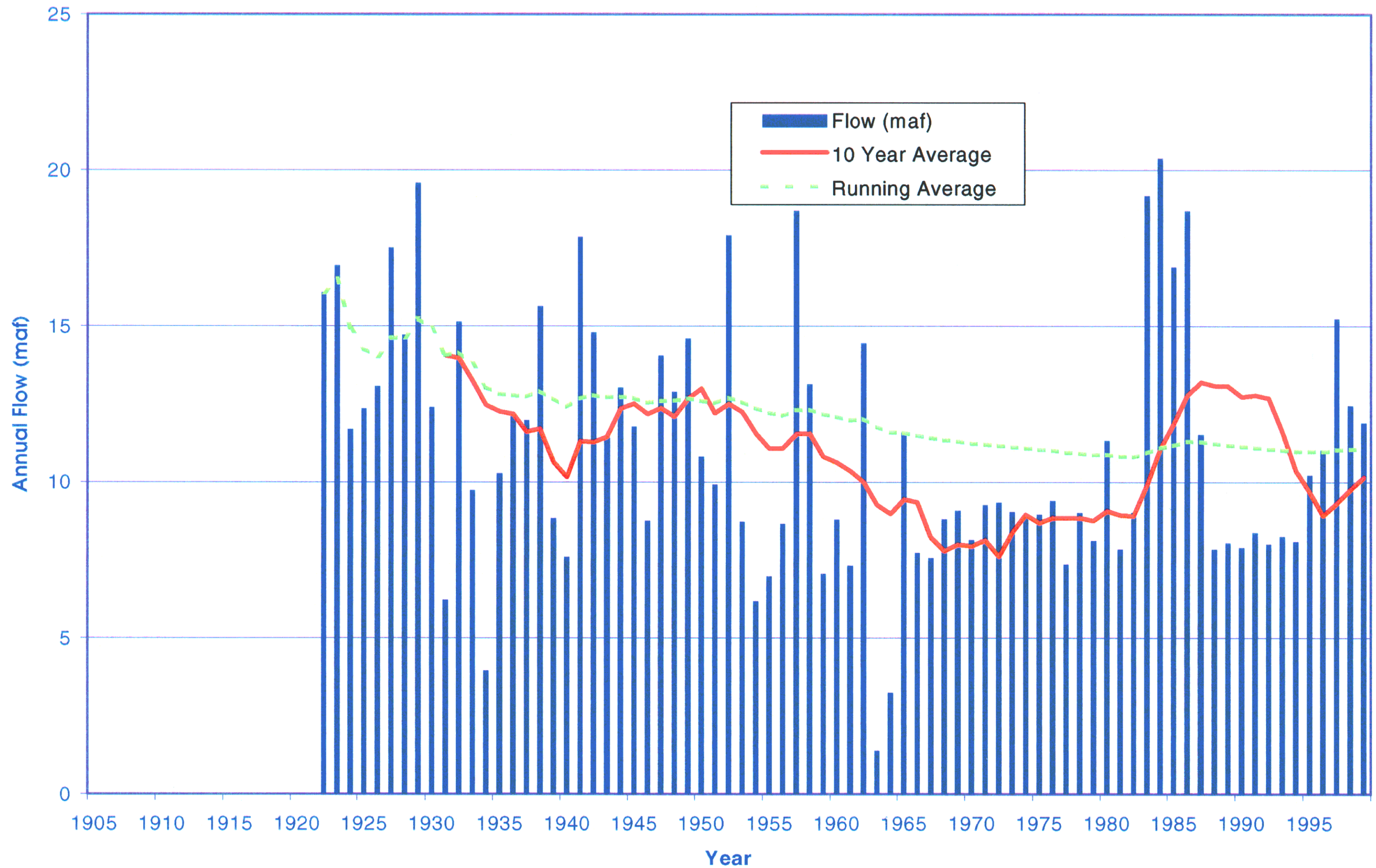


Figure 3.3-2
Historic Annual Flow at Lees Ferry Stream Gage



3.3.3 MODELING AND FUTURE HYDROLOGY

3.3.3.1 MODEL CONFIGURATION

Future Colorado River system conditions under baseline conditions and the surplus alternatives were simulated using a computerized model. The model framework used for this process is a commercial river modeling software called RiverWare. RiverWare was developed by the University of Colorado through a cooperative process with Reclamation and the Tennessee Valley Authority. RiverWare was configured to simulate the Colorado River System and its operation and integrates the Colorado River Simulation System (CRSS) model that was developed by Reclamation in the early 1970s. River operation parameters modeled and analyzed include the water entering the river system, storage in system reservoirs, releases from storage, river flows, and the water demands of and deliveries to the Basin States and Mexico.

The water supply used by the model consists of the historic record of natural flow in the river system over the 85-year period from 1906 through 1990, from 29 individual inflow points on the system.

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. Return flow credits are applied when a portion of the diverted water is returned to the river system. In cases where there are no return flow credits associated with the diversions, the depletion is equal to the diversion. The simulated operation of Glen Canyon Dam, Hoover Dam and other elements of the Colorado River system was consistent with the LROC, applicable requirements for storage and flood control management, water supply deliveries to the Basin States, Indian tribes, and Mexico, and flow regulation downstream of the system dams.

3.3.3.2 INTERIM SURPLUS CRITERIA MODELED

As discussed in Chapter 2, seven operational scenarios are considered in this FEIS. The seven scenarios considered and modeled consist of two different baseline conditions and the five surplus alternatives. The two baseline conditions are similar except that one includes the modeling of California's intrastate water transfers while the other does not. The five surplus alternatives consist of the Basin States, Flood Control, Six States, California and the Shortage Protection alternatives.

Surplus deliveries to the Lower Division states and Mexico are provided under baseline conditions and all surplus alternatives. Common to baseline conditions and all alternatives, a surplus is determined when flood control releases are made from Lake Mead. As a general modeling assumption, Mexico receives surplus deliveries only under this condition.

As noted above, two different baseline conditions were modeled and evaluated (baseline conditions with transfers and baseline conditions without transfers). The normal schedules of the three California entities involved in the transfers (Metropolitan Water District, Imperial Irrigation District, and Coachella Water Valley District) are tabulated in Attachment H. The comparative analysis of the two baseline conditions is presented in Attachment L. The baseline conditions with transfers were selected for use in the comparative analysis of the surplus alternatives. The reason for this is a desire to maintain consistency. All of the surplus alternatives include intrastate water transfers and therefore, it was prudent to compare the baseline conditions with transfers to focus and isolate the potential impacts of the interim surplus criteria from that of transfers.

3.3.3.3 GENERAL MODELING ASSUMPTIONS

Definitions and descriptions of the baseline conditions and the surplus alternatives and their operational criteria were provided in Chapter 2. The modeling of river system operations for the analysis presented in this FEIS also required certain assumptions about various aspects of water delivery and system operation. Some important modeling assumptions are listed below. Other modeling details and assumptions are presented in Attachment J.

Assumptions Common to Baseline and All Alternatives:

- The current Upper Basin reservoir operating rules are equivalent under all surplus alternatives and the baseline conditions.
- The Lake Mead flood control procedures are always in effect.
- Reservoir starting conditions (all system reservoirs) are based on projected water level elevations for January 1, 2002. Reclamation's 24 month study model (also a model implemented in RiverWare) was used to project these elevations, using actual elevations as of August 2000 and projected operations for the 2001 water year.
- The Upper Basin States' depletion projections are as provided by the Upper Colorado River Commission (December 1999) and subsequently modified to include new Indian tribe schedules provided during the preparation of the DEIS. (See Attachments K and Q.)
- Water deliveries to Mexico are pursuant to the requirements of the Treaty. This provides minimum annual deliveries of 1.5 maf to Mexico and up to 1.7 maf under Lake Mead flood control release conditions.
- Mexico's principal diversion is at Morelos Dam where most of its Colorado River apportionment of 1.5 maf is diverted. In practice, up to 140 thousand acre-feet (kaf) is delivered to Mexico near the Southerly International Boundary (SIB). The model, however, extends to just south of the Northerly International Boundary (NIB) to include the diversion at Morelos Dam and accounts for the

entire Treaty delivery at that point. Under normal conditions, the model sets the diversion and depletion schedule for the Mexican Treaty delivery at Morelos Dam to 1.515 mafy. The additional 15,000 af accounts for typical scheduling errors and over-deliveries.

- The modeled Colorado River water deliveries under the baseline conditions and surplus alternatives assumed that all Arizona shortages would be absorbed by the Central Arizona Project. Reclamation acknowledges that under the current priority framework, there would be some sharing of Arizona shortage between the Central Arizona Project and other Priority 4 users. However, the bases or formula for the sharing of Arizona shortages is the subject of current negotiations and as such, could not be adequately modeled for the FEIS. The water supply conditions modeled for the FEIS were used to evaluate the relative differences in water deliveries to each state under baseline conditions and the surplus alternatives. The normal, surplus and shortage condition water depletion schedules modeled in the FEIS are consistent with the depletion schedules prepared by the Basin states for this purpose.
- For the modeling presented in the FEIS, the Yuma Desalting Plant depletion schedule for bypass to Mexico was set to 120,000 acre-feet per year (afy) from 2002-2021, representing the water provided by the U.S. to the Cienega. For modeling purposes, this depletion is not counted as part of the Treaty delivery. The desalting plant is assumed to operate beginning 2022, reducing the bypass to 52,000 afy. Similarly, for modeling purposes, this depletion is not counted as part of the Treaty delivery. It should be noted that 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 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.
- Lake Mead is operated to meet depletion schedules provided by the Lower Division states, Indian tribes, and Mexico. (See Attachments H and Q.)
- Lake Mohave and Lake Havasu are operated in accordance with their existing rule curves.
- The water supply conditions modeled under the surplus alternatives and baseline conditions considered the intrastate water transfers being planned by California.
- There are no established shortage criteria that define when Lower Basin water users would receive shortage condition deliveries. However, the model is configured to provide approximately an 80 percent protection for Lake Mead water elevation of 1083 feet msl (minimum power generation elevation).

Assumptions Specific to Surplus Alternatives:

- The respective surplus criteria for the surplus alternatives are assumed to be effective for a specified period of 15 years. The effective period that was modeled is defined as the 15-year period beginning on January 1, 2002 and ending December 31, 2016. At the conclusion of the 15-year period, the modeled operating criteria for each of the surplus alternatives is assumed to revert to the operating criteria used to model baseline conditions (baseline conditions with transfers).
- The surplus depletion schedules for Arizona, California and Nevada vary under each surplus alternative and the baseline conditions and are presented in Attachment H.

3.3.3.4 Lake Mead Water Level Protection Assumptions

There are no established shortage criteria for the operation of Lake Mead. However, it was necessary to include some shortage criteria in the model simulation to address concerns related to low Lake Mead water levels. Three important Lake Mead water elevations were selected for analysis. The significance of these selected elevations relates to known economic and/or socioeconomic impacts that would occur if Lake Mead water levels were lowered below the selected water levels. Elevation 1083 feet msl is the minimum water level for effective power generation at the Hoover Powerplant based on its existing turbine configuration. Elevation 1050 feet msl is the minimum water level necessary for operation of SNWA's upper water intake. Water withdrawn from the Lake Mead through this intake is delivered to Las Vegas Valley, Boulder City and other parts of Clark County. Even though SNWA has constructed a second intake at a lower elevation, the original intake at elevation 1050 feet msl is needed to meet full SNWA summer diversions. Elevation 1000 feet msl is the minimum water level necessary for operation of SNWA's lower water intake.

In the absence of specific shortage criteria, the Lake Mead level protection assumptions listed below were applied by the model to facilitate the evaluation of the baseline conditions and surplus alternatives.

First Level Shortage:

- The Lake Mead water level of 1083 feet msl was designated as a level that should be protected. Operation simulations were performed to develop a "protection line" to prevent the water level from declining below elevation 1083 feet msl with approximately an 80 percent probability (see Section 3.3.4.1). The use of an alternative 1050-foot protection line is discussed in Attachment M.
- A shortage would be determined to exist when the Lake Mead water level dropped below the protection line for elevation 1083 feet msl.

- During first level shortage conditions, the annual water delivery to CAP was set to 1.0 maf, and the SNWA was assigned four percent of the total shortage.

Second Level Shortage:

- A second level shortage would be determined to exist when the Lake Mead water surface elevation declined to 1000 feet msl.
- During second level shortage conditions, the CAP and SNWA consumptive use would be reduced as needed to maintain the Lake Mead water level at 1000 feet msl. Once the delivery to the CAP is reduced to zero, deliveries to MWD and to Mexico would be reduced to maintain the Lake Mead water level at 1000 feet msl. Such reductions to MWD and Mexico did not occur in the simulations conducted as part of this FEIS.

3.3.3.5 COMPUTATIONAL PROCEDURES

The model was used to simulate the future state of the Colorado River system on a monthly basis, in terms of reservoir levels, releases from the dams, hydroelectric energy generation, flows at various points along the system and diversions to and return flows from various water users. The input data for the model included the monthly tributary inflows, various physical process parameters (such as the evaporation rates for each reservoir) and the diversion and depletion schedules for entities in the Basin States and Mexico. The common and specific operating criteria were also input for each alternative being studied.

Despite the differences in the operating criteria for the baseline conditions and each surplus alternative, the future state of the Colorado River system (i.e., water levels at Lake Mead and Lake Powell) is most sensitive to the future inflows. As discussed in Section 3.3.2, observations over the period of historical record (1906–present) show that inflow into the system has been highly variable from year to year. Predictions of the future inflows, particularly for long-range studies, are highly uncertain. Although the model does not predict future inflows, it can be used to analyze a range of possible future inflows and to quantify the probability of particular events (i.e., lake levels being below or above certain levels).

Several methods are available for ascertaining the range of possible future inflows. On the Colorado River, a particular technique (called the Indexed Sequential Method) has been used since the early 1980s and involves a series of simulations, each applying a different future inflow scenario (USBR, 1985; Ouarda, *et al.*, 1997). Each future inflow scenario is generated from the historical natural flow record by "cycling" through that record. For example, the first simulation assumes that the inflows for 2002 through 2050 will be the 1906 through 1954 record, the second simulation assumes the inflows for 2002 through 2050 will be the 1907 through 1955 record, and so on. As the method progresses, the historical record is assumed to "wrap-around" (i.e., after 1990, the record reverts back to 1906), yielding a possible 85 different inflow scenarios. The result of the Indexed Sequential Method is a set of 85 separate simulations (referred to as "traces") for each operating criterion that is analyzed. This enables an evaluation of the respective criteria over a broad range of possible future hydrologic conditions using standard statistical techniques, discussed in Section 3.3.3.6.

3.3.3.6 POST-PROCESSING AND DATA INTERPRETATION PROCEDURES

The various environmental and socioeconomic analyses in this FEIS required the sorting and arranging of various types of model output data into tabulations or plots of specific operational conditions, or parameters, at various points on the system. This was done through the use of statistical methods and other numerical analyses.

The model generates data on a monthly time step for some 300 points (or nodes) on the river system. Furthermore, through the use of the Indexed Sequential Method, the model generates 85 possible outcomes for each node for each month over the time period 2002 through 2050. These very large data sets are generated for each surplus alternative and baseline conditions and 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 are typically aggregated to reduce the volume of data and to facilitate comparing the alternatives to baseline conditions and to each other. The type of aggregation varies depending upon the needs of the particular resource analysis. The post-processing techniques used for this FEIS fall into two basic categories: those that aggregate in time, space or both, and those that aggregate the 85 possible outcomes.

For aggregation in time and space, simple techniques are employed. For example, deliveries of Colorado River water to all California diversion nodes in the model are summed to produce the total delivery to the state for each calendar year. Similarly, lake elevations may be chosen on an annual basis (i.e., end of December) to show long-term lake level trends as opposed to short-term fluctuations. Since the interim criteria period is 2002 through 2016, some analyses may suggest aggregating over that period of time and comparing the aggregation over the remaining years (2017 through 2050). The particular aggregation used will be noted in the methodology section for each resource.

Once the appropriate temporal and spatial aggregation is chosen, standard statistical techniques are used to analyze the 85 possible outcomes for a fixed time. Statistics that may be generated include the mean and standard deviation. However, the most common technique simply ranks the outcomes at each time (from highest to lowest) and uses the ranked outcomes to compute other statistics of interest. For example, if end-of-calendar year Lake Mead elevations are ranked for each year, the median outcome for a given year is the elevation for which half of the values are below and half are above (the median value or the 50th percentile value). Similarly, the elevation for which 10 percent of the values are less than or equal to, is the 10th percentile outcome.

Several presentations of the ranked data are then possible. A graph (or table) may be produced that compares the 90th percentile, 50th percentile, and 10th percentile outcomes from 2002 through 2050 for the baseline and all alternatives. It should be noted that a statistic such as the 10th percentile is not the result of any one hydrologic trace (i.e., no historical sequence produced the 10th percentile).

3.3.4 MODELING RESULTS

This section presents general and specific discussions of the Colorado River System operation modeling results. The following sequence of topics is used to address the potentially affected river system components:

- Lake Powell water levels,
- River flows between Glen Canyon Dam and Lake Mead,
- Lake Mead water levels, and
- River flows below Hoover Dam.

As noted previously, the potentially affected portion of the Colorado River system extends from Lake Powell to the SIB. Although lakes Mohave and Havasu are within the potentially affected area, it has been determined that the interim surplus criteria would have no effect on the operation of these facilities. The operation of lakes Mohave and Havasu is pursuant to monthly operating target elevations that are used to manage the storage and release of water and power production at these facilities. Under the respective target elevations, the water level fluctuation is approximately 14 feet for Lake Mohave and approximately four feet for Lake Havasu. Under all future operating scenarios considered under this FEIS, lakes Mohave and Havasu would continue to be operated under the current respective monthly target elevations.

3.3.4.1 GENERAL OBSERVATIONS CONCERNING MODELING RESULTS

Some changes to the modeling assumptions were anticipated in the DEIS and were made for the FEIS as noted in Section 3.3.3.3. These changes included the following:

- updating the initial conditions to reflect the current state of the system;
- updating the depletion schedules for all of the Basin States, including the Indian tribes;
- changing the baseline operation from 75R to 70R (as described in Section 2.2.5); and
- updating the shortage protection triggers to incorporate the new Upper Basin depletion schedules.

The general effects of these changes are described below:

- For the DEIS, the simulation model was run from 2000 through 2050, using the historical reservoir contents as of January 1, 2000, for the initial conditions. For the FEIS, the model was run from 2002 through 2050, using forecasted reservoir contents for January 1, 2002. The forecast was obtained from Reclamation's operations model (the "24-month Study Model"), run in September, 2000. Due to the relatively low inflow observed for the 2000 water year (approximately 75 percent of normal or about 11.4 maf of natural inflow to Lake Powell), the total initial system storage decreased approximately 4.129 maf. This amounted to decreases in initial elevations of 3.5 feet and 26.0 feet at lakes Powell and Mead, respectively. The change in initial conditions affects the results of the first few years of the simulations, and then is negligible (after about 2005).

- Upper Division depletion schedules were updated to those submitted by the Upper Colorado River Commission (December, 1999), and subsequently modified to include updated Indian tribes schedules as provided by the Ten Tribes Partnership. The updated depletion schedules for the Indian Tribes and the Upper Division totals are detailed in Attachments "Q" and "K". The total increase in Upper Division scheduled depletions ranged from two to eight percent in any given year, with an average over all years of about five percent. The largest increases are in the early years (eight percent increases in years 2005 through 2010; 6.6 percent in 2016). In general, lakes Powell and Mead show a more rapid decline (observed in the 50^{th} percentile under baseline conditions) due to the increased demand in the early years. Recovery of Lake Powell after the interim period is also more rapid as the increased depletions tend to turn off equalization earlier due to the 602(a) storage provision. The long-term effect of these depletions is that lakes Mead and Powell stabilize at 2050 about 12.5 and 5.5 feet, respectively, below the levels shown in the DEIS.

- Lower Division normal depletion schedules were updated to incorporate the new Indian tribe demands and remain at each states' apportionment. Surplus depletion schedules were also updated for each alternative as provided by the entities involved and is detailed in Attachment H. The California alternative tends to be more liberal in the FEIS compared to the DEIS with regard to surplus deliveries and is now closer to the results of the Shortage Protection Alternative.

- As discussed in Section 2.2.5, the baseline surplus strategy was changed from 75R to 70R, which changes the inflow assumption used when computing the system space available. As discussed in the DEIS, the change has a negligible effect upon the baseline results.

- The shortage protection triggers were re-computed to account for the new Upper Basin depletion schedules and to investigate the issues of protecting a specified lake level with a specified degree of assurance. To ensure statistical independence, stochastically generated natural inflows above Powell were used in the study. The study used the CRSSez model and the procedure is documented in the CRSSez User's Manual (USBR, May 1988). The new triggers resulted in approximately 73 percent assurance of protecting Lake Mead elevation 1083 through the year 2040, although after 2040, the assurance level tails off rapidly (to less than 60 percent in 2050). The validity of the comparisons between surplus alternatives, however, is not compromised since all of the modeled conditions use the same shortage protection assumptions.

The following general observations apply to the overall modeling and analyses results:

- Future water levels of Lakes Powell and Mead will probably be lower than historical levels due to increasing Upper Basin depletions under the baseline conditions and the surplus alternatives. Of the five surplus alternatives, the Flood Control Alternative and baseline conditions were shown to have the least tendency to reduce reservoir water levels. The Shortage Protection and California alternatives were shown to have the highest tendency to reduce reservoir water levels. The results of the Six States and Basin States alternatives are similar and fall between those of the baseline conditions and the Shortage Protection and California alternatives.
- Median Lake Mead elevations decline throughout the period of analysis for the baseline conditions and the surplus alternatives because Lower Division depletions exceed long-term inflow. Median Lake Powell elevations decline for a number of years and then stabilize for the baseline conditions as well as all surplus alternatives. The declining trend in Lake Powell elevations for the baseline conditions and all surplus alternatives is due to increasing Upper Division depletions. For the Six State, Basin States, California, and Shortage Protection alternatives, the decline is more pronounced due to Lower Basin surplus deliveries and associated equalization releases from Lake Powell. Lake Powell elevations eventually stabilize under the baseline conditions and all alternatives. This behavior is caused by less frequent equalization releases from Lake Powell (due to the 602(a) storage requirement) as the Upper Division states continue to increase their use of Colorado River water.
- A comparative analysis of the baseline conditions with and without California intrastate transfers was conducted to assess the differences between these two modeled conditions. The modeling of the two baseline conditions yielded similar results with two exceptions. The first difference was in the water deliveries to the individual California agencies participating in the water transfers. The second difference is reduced river flow (about 200,000 to 300,000 afy) below Parker Dam associated with change in delivery points resulting from the water transfers. A summary of this comparative analysis is presented in Attachment L.
- To test the sensitivity of the results to the use of a 1083-foot shortage protection level, model runs were also conducted with a protection level of

1050 feet msl. With the 1050-foot protection level, the water levels on Lake Mead in 2016 were essentially the same under the baseline condition and Flood Control Alternative; between 10 and 20 feet lower for the Shortage Protection and California alternatives; and intermediate for the Six State Alternative. Water level plots for reservoir levels using the 1050-foot Lake Mead protection level are in Attachment M.

- Interim surplus criteria had no effect on Upper Basin deliveries as expected, including the Indian demands above Lake Powell. As noted in Section 3.4.4.4, the normal delivery schedules of all Upper Basin diversions would be met under most water supply conditions. Only under periods of low hydrologic inflow conditions and inadequate regulating reservoir storage capacity upstream of the diversion point, would an Upper Basin diversion be shorted. Although the model is not presently configured to track the relative priorities under those conditions, such effects are identical under baseline and all alternatives.

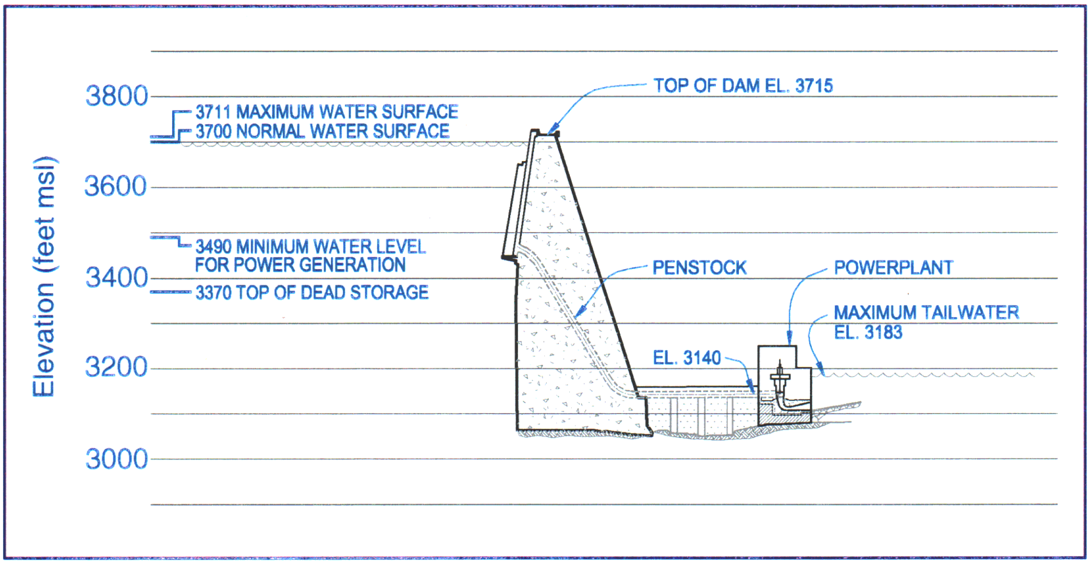
- Under normal conditions, deliveries to the Lower Basin users are always equal to the normal depletion schedules, including those for the Indian tribes. Under shortage conditions, only CAP and SNWA share in the shortage until CAP goes to zero (which was not observed in any of the modeling runs done for this FEIS). Therefore, all tribes in the 10 Tribe Partnership in the Lower Basin receive their scheduled depletion, with the exception of the Cocopah Tribe which has some Arizona Priority 4 water (see Section 3.14.2). As discussed above, as a modeling assumption, all Arizona shortages were assigned to CAP for this FEIS.

3.3.4.2 LAKE POWELL WATER LEVELS

3.3.4.2.1 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 3.3-3. Except during flood conditions, the "full reservoir" water level is 3700 feet msl, corresponding to the top of the spillway gates. Under normal operating conditions, releases from Glen Canyon Dam are made through the Glen Canyon Powerplant by means of gates on the upstream face of the dam. The minimum water level at which hydropower can be generated is elevation 3490 feet msl. Releases in excess of the powerplant capacity may be made when flood conditions are caused by high runoff in the Colorado River Basin, or when needed to provide Beach/Habitat Building Flows (BHBF) downstream of the dam, as is discussed in Section 3.6.

Figure 3.3-3
Lake Powell and Glen Canyon Dam Important Operating Elevations



3.3.4.2.2 Historic Water Levels

Glen Canyon Dam and Lake Powell were designed to operate from a normal maximum water surface elevation of 3700 feet msl to a minimum elevation of 3490 feet msl, the minimum for hydropower production. During flood conditions, the water surface elevation of Lake Powell can exceed 3700 feet msl by raising the spillway radial gates. Since first reaching equalization storage with Lake Mead in 1974, the reservoir water level has fluctuated from a high of 3708 feet msl to a low of approximately 3612 feet msl, as shown on Figure 3.3-4.

3.3.4.2.3 Baseline Conditions

Under the baseline conditions, the water surface elevation of Lake Powell is projected to fluctuate between full level and decreasingly lower levels during the period of analysis (2002 to 2050). Figure 3.3-5 illustrates the range of water levels by three lines, labeled 90th Percentile, 50th Percentile and 10th Percentile. The 50th percentile line shows the median water level for each future year. The median water level under baseline conditions is shown to decline to approximately 3663 feet msl by 2019 and remaining at this or slightly higher levels through 2050. The 10th percentile line shows there is a 10 percent probability that the water level would drop to 3615 feet msl by 2016 and to 3553 feet msl by 2050. Generally, there is about a 20-foot difference between the annual high and low water levels at Lake Powell. It should also be noted that the Lake Powell elevations depicted in Figures 3.3-5 to 3.3-8 are for modeled lake water levels at the end-of-July. The Lake Powell water level generally reaches its seasonal high in July whereas the seasonal lows occur at the end of the year.

Figure 3.3-4
Historic Lake Powell Water Levels

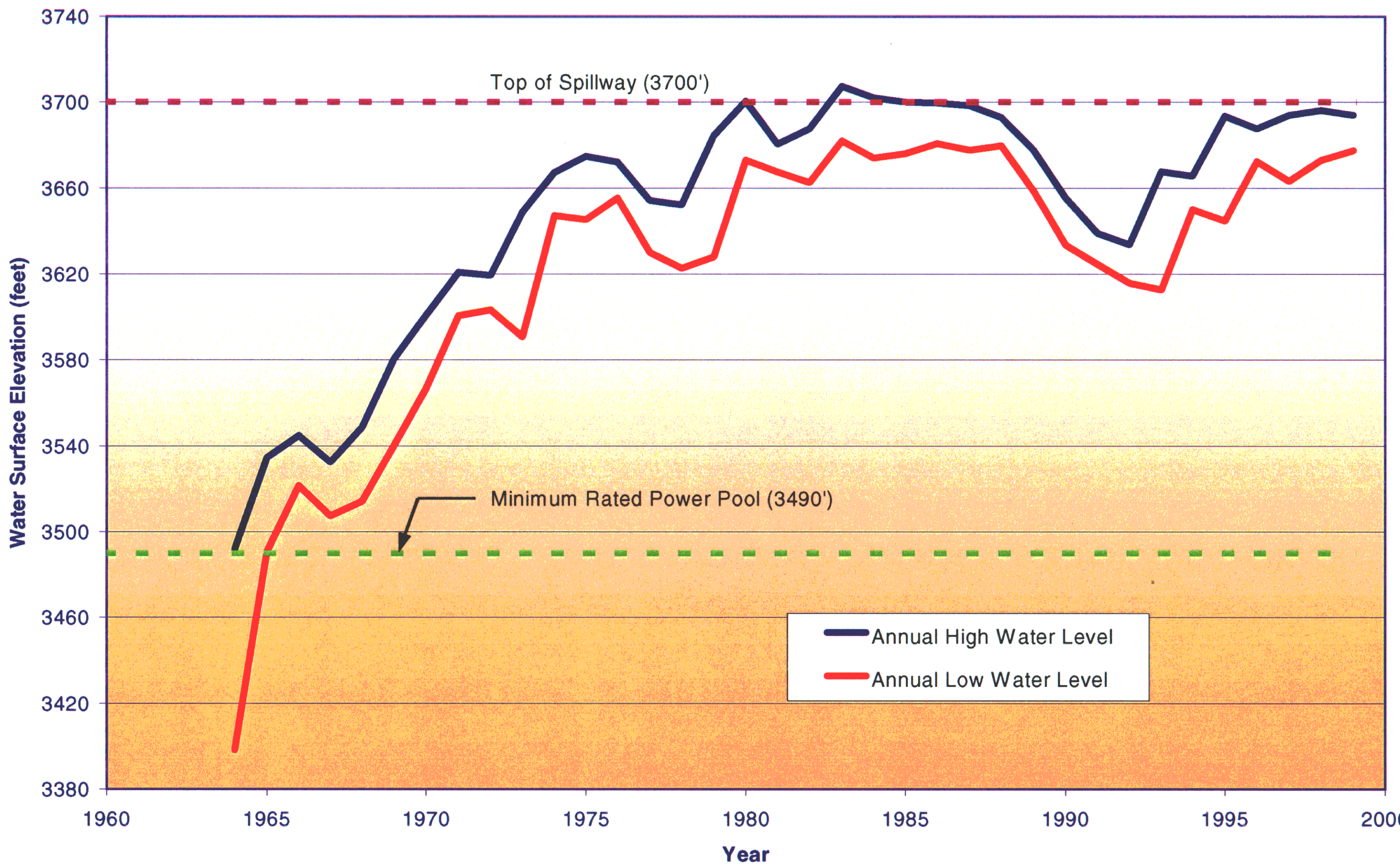
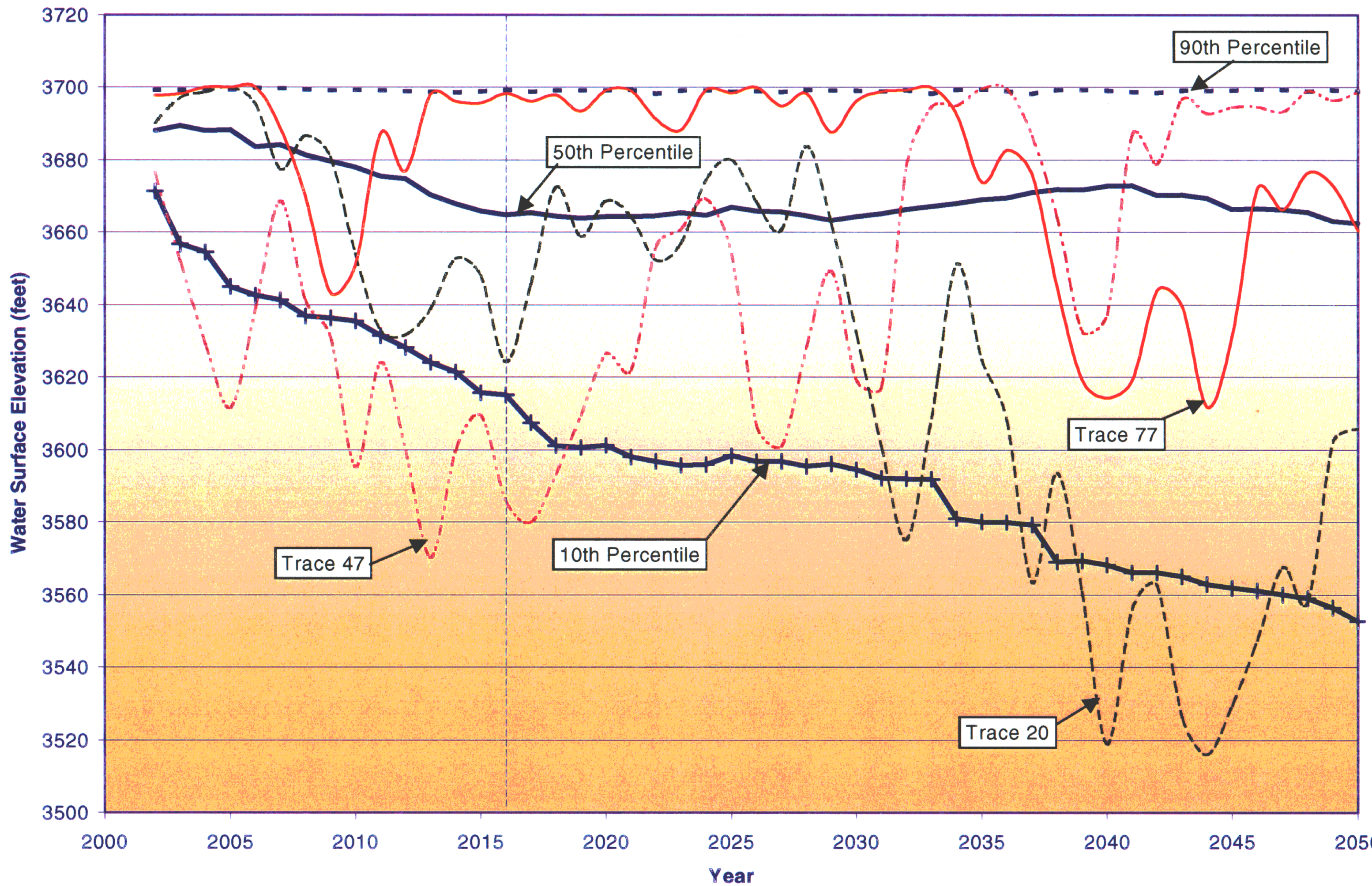


Figure 3.3-5
Lake Powell End-of-July Water Elevations Under Baseline Conditions
90th, 50th and 10th Percentile Values and Representative Traces



Three distinct traces were added to Figure 3.3-5 to illustrate what was actually simulated under the various traces and respective hydrologic sequences and to highlight that the 90th, 50th and 10th percentile lines do not represent actual traces, but rather the ranking of the data from the 85 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 10th percentile line. The trace identified as Trace 20 represents the hydrologic sequence that begins in year 1926. The trace identified as Trace 47 represents the hydrologic sequence that begins in year 1953. The trace identified as Trace 77 represents the hydrologic sequence that begins in year 1983.

In Figure 3.3-5, the 90th and 10th percentile lines bracket the range where 80 percent of the water levels simulated for the baseline conditions occur. The highs and lows shown on the three traces would likely be temporary conditions. The reservoir level would tend to fluctuate in the range through multi-year periods of above average and below average inflows. Neither the timing of water level variations between the highs and the lows, nor the length of time the water level would remain high or low can be predicted. These events would depend on the future variation in basin runoff conditions.

Figure 3.3-6 presents a comparison of the 90th, 50th and 10th percentile lines obtained for the baseline conditions to those obtained for the surplus alternatives. This figure is best used for comparing the relative differences in the general lake level trends that result from the simulation of the baseline conditions and surplus alternatives.

As illustrated in Figure 3.3-6, the Flood Control Alternative is the alternative that could potentially result in the highest Lake Powell water levels. The Shortage Protection Alternative and the California Alternative are the alternatives that could potentially result in the lowest water levels. The baseline conditions yield similar levels to those observed under the Flood Control Alternative. The water levels observed under the California alternative are similar to those observed under the Shortage Protective Alternative. The results obtained under the Six States and Basin States alternatives are similar and fall between the Baseline and Shortage Protection alternatives.

Figure 3.3-7 shows the frequency that future Lake Powell end-of-July water elevations would exceed elevation 3695 feet msl under the baseline conditions and surplus alternatives. When the Lake Powell water level is at or exceeds 3695 feet msl, the reservoir is considered to be essentially full. In year 2016, under baseline conditions, the percentage of values greater than or equal to elevation 3695 feet msl is 27 percent. In 2050, the percentage of values greater than or equal to elevation 3695 feet msl is 26 percent.

Figure 3.3-6
Lake Powell End-of-July Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
90th, 50th and 10th Percentile Values

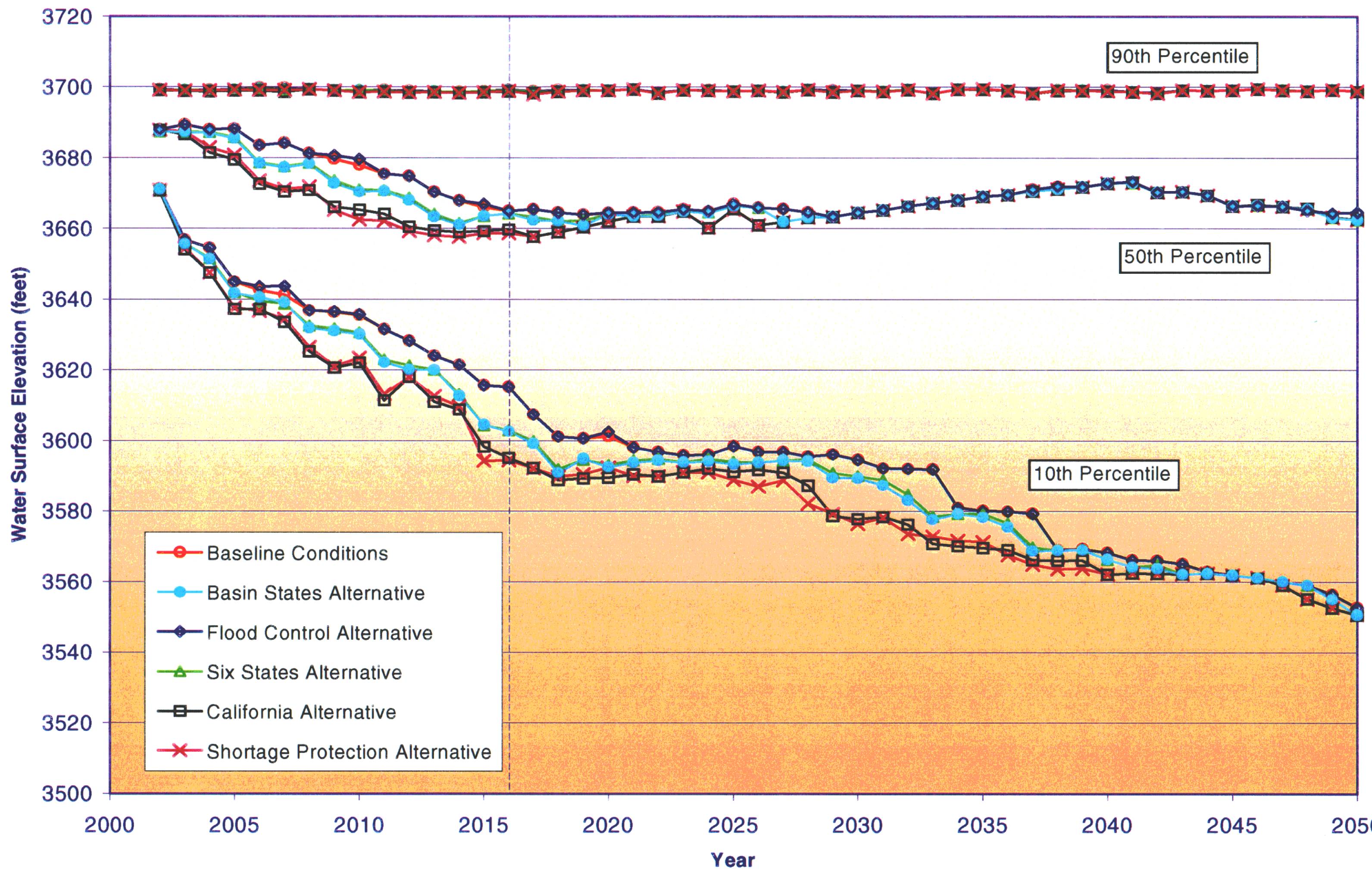


Figure 3.3-7
Lake Powell End-of-July Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 3695 Feet

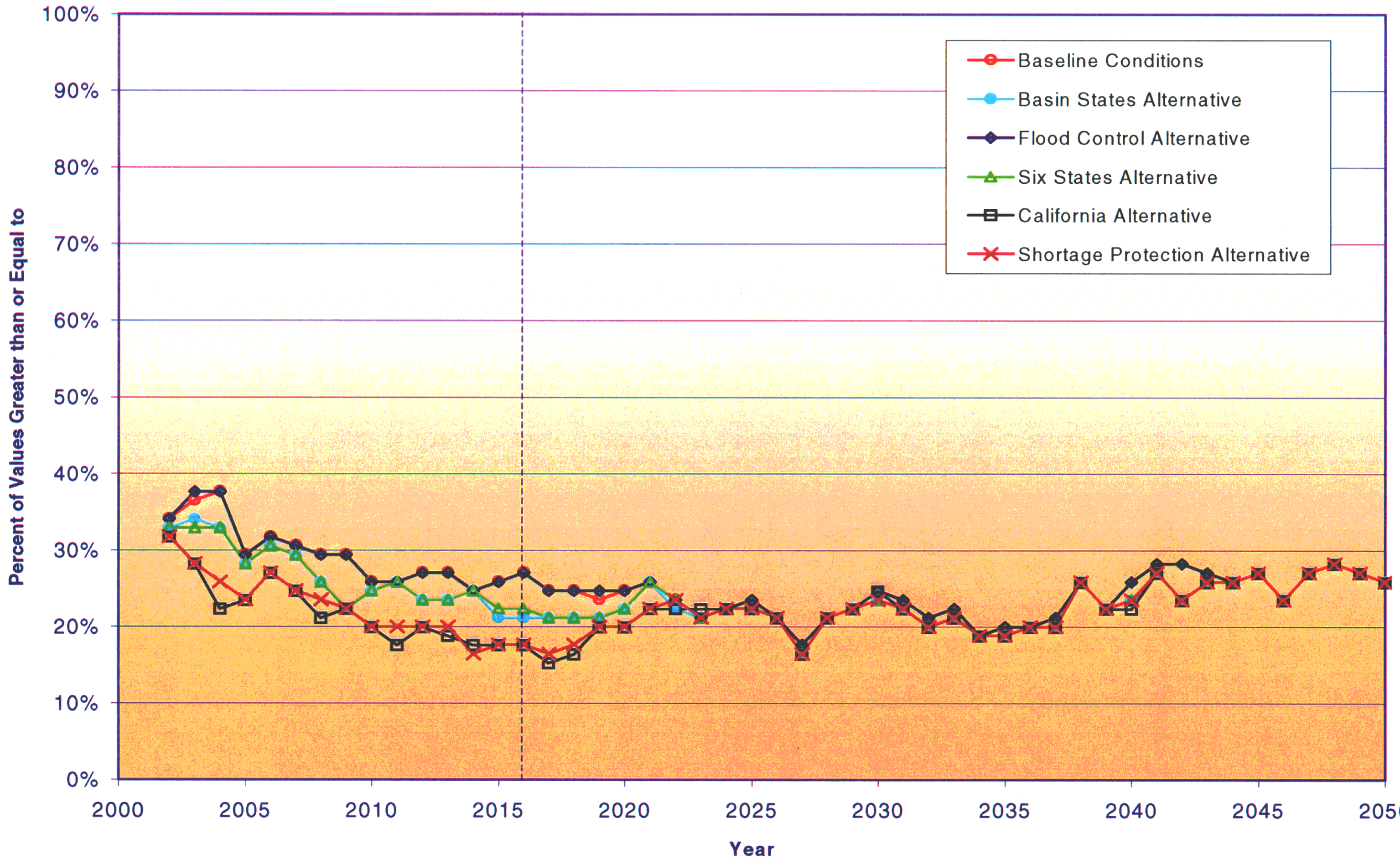


Figure 3.3-8 provides a comparison of the frequency that future Lake Powell end-of-July water elevations under baseline conditions and the surplus alternatives would be at or exceed a lake water elevation of 3612 feet msl. Lake Powell water surface elevation 3612 feet msl is used in this analysis as the low threshold elevation for marina and boat ramps at Lake Powell. This threshold elevation of 3612 feet msl is used to evaluate the baseline conditions and the effects of interim surplus criteria alternatives on shoreline facilities at Lake Powell in the Environmental Consequences section (Section 3.9.2.3.1). The lines represent the percentage of values greater than or equal to the lake water elevation of 3612 feet msl under the baseline conditions and surplus alternatives. In year 2016, under the baseline conditions, the percentage of values greater than or equal to elevation 3612 feet msl is 91 percent. In 2050, the percentage of values greater than or equal to elevation 3612 feet msl decreases to 72 percent for the baseline conditions.

3.3.4.2.4 Comparison of Surplus Alternatives to Baseline Conditions

Figure 3.3-6 compared the 90th, 50th and 10th percentile water levels of the surplus alternatives to those of the baseline conditions. As discussed above, under baseline conditions, future Lake Powell water levels at the upper and lower 10th percentiles would likely be temporary and the water level would fluctuate between them in response to multi-year variations in basin runoff conditions. The same would apply to all the surplus alternatives. The 90th percentile, median (50th percentile) and 10th percentile values of the surplus alternatives are compared to those of the baseline conditions in Table 3.3-4. The values presented in this table include those for years 2016 and 2050 only.

Table 3.3-4
Lake Powell End-of-July Water Elevations
Comparison of Surplus Alternatives and Baseline Conditions
90th, 50th and 10th Percentile Values

Alternative	Year 2016			Year 2050		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
Baseline Conditions	3699	3665	3615	3699	3663	3553
Basin States	3699	3664	3603	3699	3663	3551
Flood Control	3699	3665	3615	3699	3665	3553
Six States	3699	3664	3603	3699	3663	3551
California	3699	3660	3595	3699	3663	3551
Shortage Protection	3699	3659	3594	3699	3663	3551

Figure 3.3-7 compared the percentage of Lake Powell elevations that exceeded 3695 feet msl for the surplus alternatives and baseline conditions. Table 3.3-5 provides a summary of that comparison for years 2016 and 2050.

Figure 3.3-8
Lake Powell End-of-July Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 3612 Feet

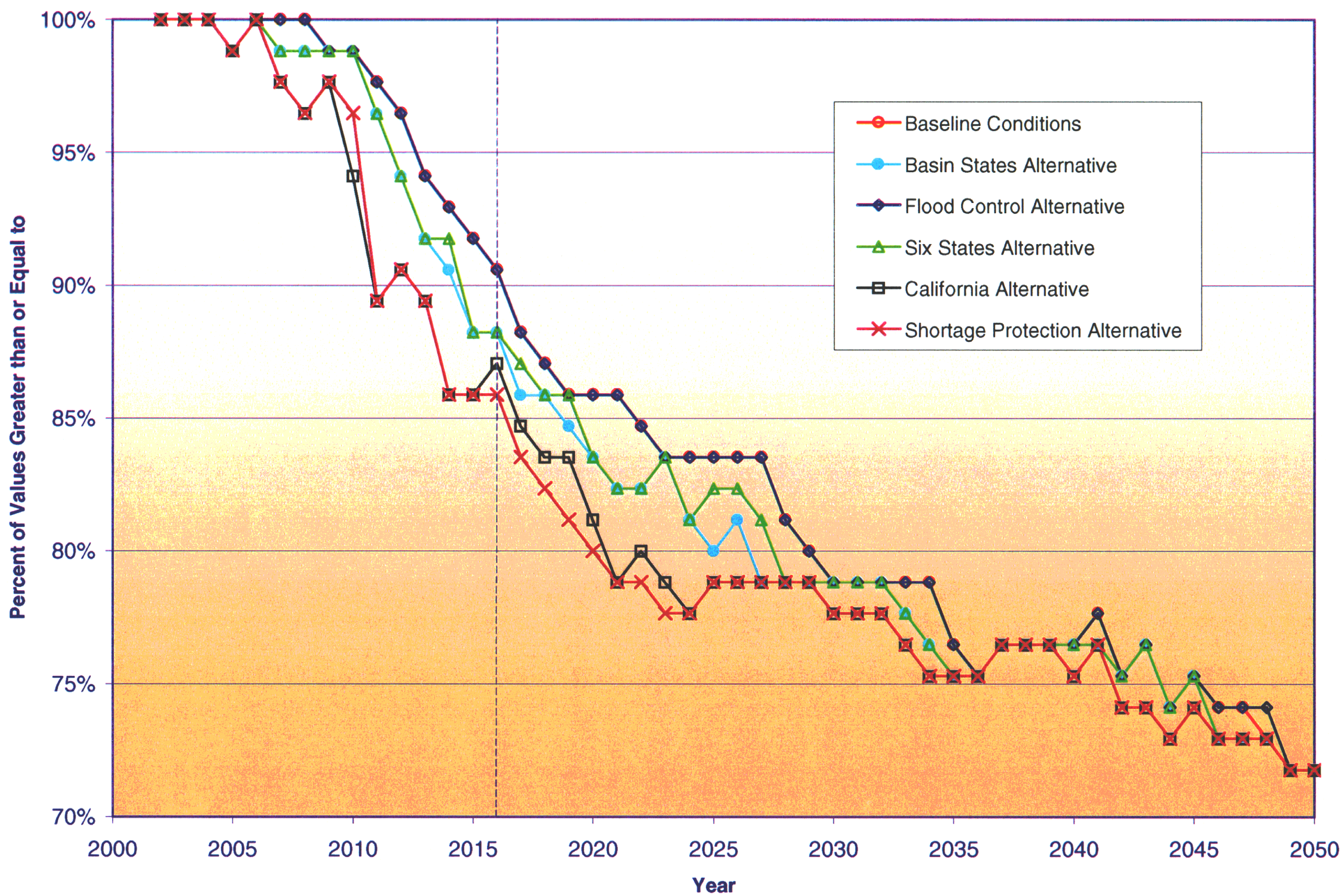


Table 3.3-5
Lake Powell End-of-July Water Elevations
Comparison of Surplus Alternatives and Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 3695 Feet

Alternative	Year 2016	Year 2050
Baseline Conditions	27%	26%
Basin States Alternative	21%	26%
Flood Control Alternative	27%	26%
Six States Alternative	22%	26%
California Alternative	18%	26%
Shortage Protection Alternative	18%	26%

Figure 3.3-8 compared the percentage of Lake Powell elevations that exceeded 3612 feet msl for the surplus alternatives and baseline conditions. Table 3.3-6 provides a summary of that comparison for years 2016 and 2050.

Table 3.3-6
Lake Powell End-of-July Water Elevations
Comparison of Surplus Alternatives and Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 3612 Feet

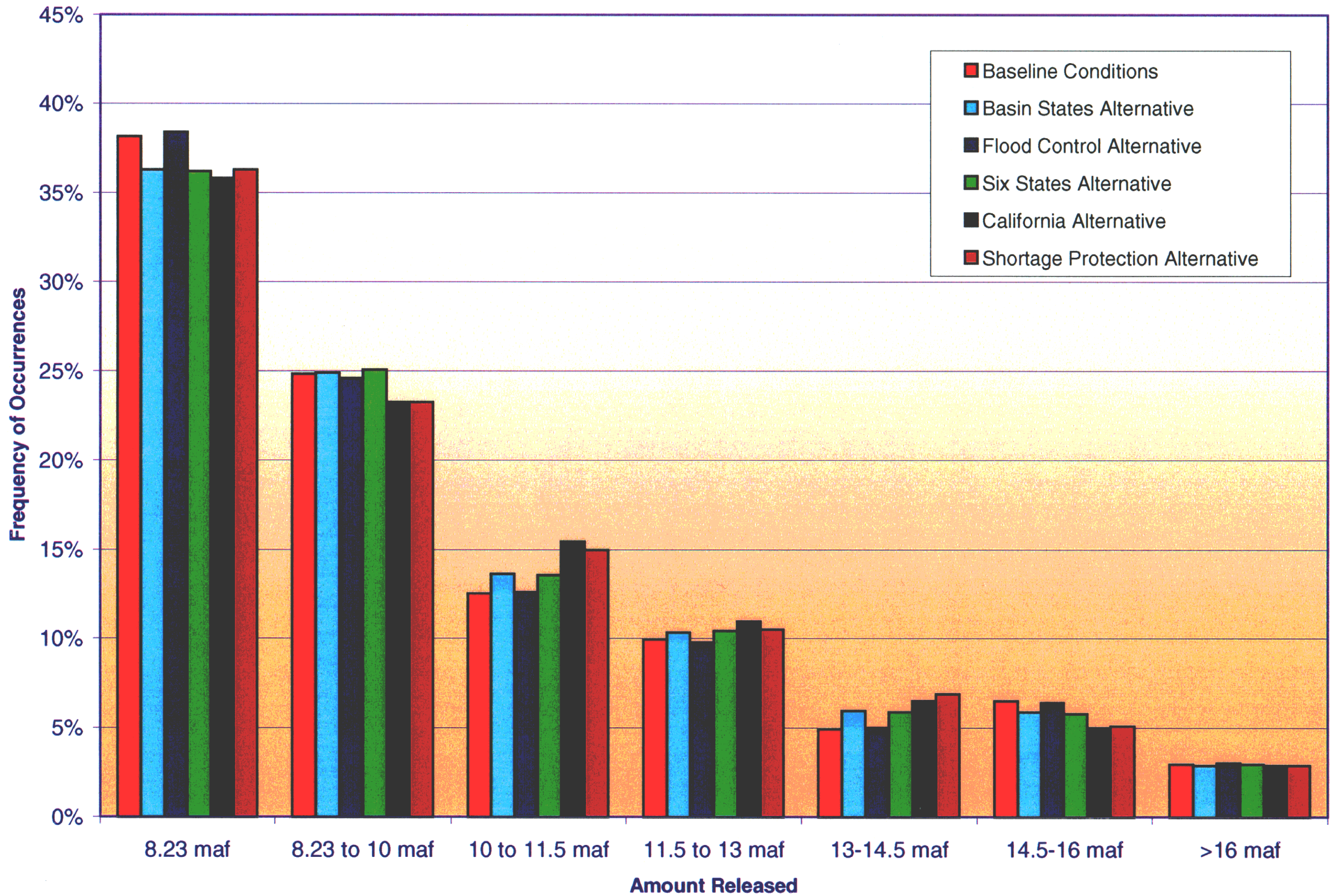
Alternative	Year 2016	Year 2050
Baseline Conditions	91%	72%
Basin States Alternative	88%	72%
Flood Control Alternative	91%	72%
Six States Alternative	88%	72%
California Alternative	87%	72%
Shortage Protection Alternative	86%	72%

3.3.4.3 RIVER FLOWS BETWEEN LAKE POWELL AND LAKE MEAD

The river flows between Glen Canyon Dam and Lake Mead result from 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 previously discussed in Sections 3.2.1.2 and 3.3.1.1. The most significant gains from perennial streams include inflow from the Little Colorado River and Paria River. However, inflow from these 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.

Figure 3.3-9 provides a comparison of the relative frequency of occurrence of annual releases from Lake Powell under the baseline conditions and surplus alternatives, during the interim surplus criteria period (through 2016). Releases between 8.23 and 11.5 maf generally correspond to years where equalization releases are being made from Lake Powell. The surplus water deliveries from Lake Mead associated with the interim surplus criteria tend to increase the relative frequency of equalization during that period compared to baseline conditions.

Figure 3.3-9
Histogram of Modeled Lake Powell Annual Releases (Water Years)
2002 to 2016 (85 Traces)



3.3.4.4 LAKE MEAD WATER LEVELS

This section provides a general description of Hoover Dam and Lake Mead, discusses historic Lake Mead water levels and summarizes the results of the future Lake Mead water level simulations under baseline conditions and the surplus alternatives.

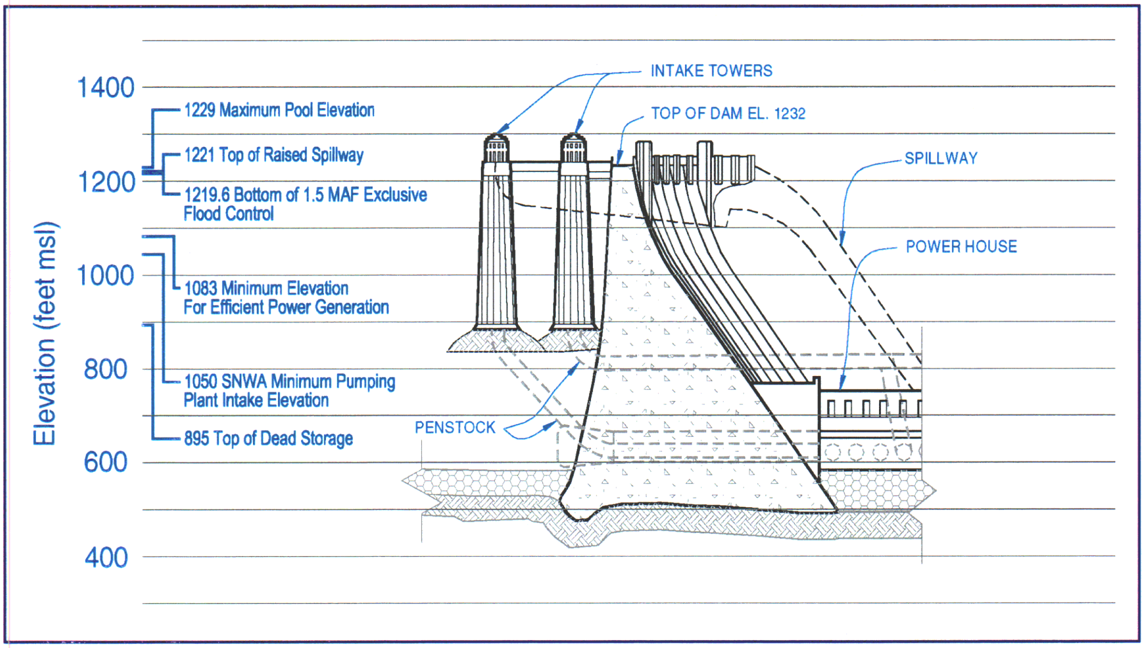
3.3.4.4.1 Dam and Reservoir Configuration

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 Boulder Canyon Project Act of 1928 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 is located 326 miles downstream of Lee Ferry. 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 27.38 maf at a maximum water surface elevation of 1229.0 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 to drive 17 generators within the dam's powerplant. The minimum water surface elevation for effective power generation is 1083 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 1219.61 and 1229.0 feet, is defined as exclusive flood control. Within this capacity allocation, 1.218 maf of flood storage is above elevation 1221.0 feet, the top of the raised spillway gates. Figure 3.3-10 illustrates some of the important Hoover Dam and Lake Mead water surface elevations that are referenced in subsequent sections.

Figure 3.3-10
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 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 normally range between 8000 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 the SNWA 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 transmission facilities for treatment and further conveyance to the Las Vegas area. The elevation of the original SNWA intake is approximately 1000 feet msl. However, the minimum required Lake Mead water level necessary to operate the pumping units at SNWA's original intake facility is 1050 feet msl. SNWA recently constructed a second pumping plant with an intake elevation of 950 feet msl. The minimum required Lake Mead water level necessary to operate the pumping units at SNWA's second intake facility is 1000 feet msl. The new 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.

3.3.4.4.2 Historic Lake Mead Water Levels

Figure 3.3-11 presents an overview of the historic annual water levels (annual maximum and minimum) of Lake Mead. As noted in Figure 3.3-11, the annual change in elevations of Lake Mead has ranged from less than ten feet to as much as 75 feet msl. The decrease in the range of the elevations within a year observed after the mid-1960s can be attributed to the regulation provided by Lake Powell.

Historic Lake Mead low water levels have dropped to the minimum rated power elevation (1083 feet msl) of the Hoover Powerplant during two periods (1954 to 1957 and 1965 to 1966). The maximum Lake Mead water surface elevation of approximately 1225.6 feet msl occurred once, in 1983.

Three Lake Mead water surface elevations of interest are shown in Figure 3.3-11. The first elevation is 1221 feet msl, the top of the spillway gates. The second elevation is 1083 feet msl, the minimum elevation for the effective generation of power. The third elevation is 1050 feet msl, the minimum elevation required for the operation of SNWA's original intake facility.

3.3.4.4.3 Baseline Conditions

Under the baseline conditions, the water surface elevation of Lake Mead is projected to fluctuate between full level and decreasingly lower levels during the period of analysis (2002 to 2050). Figure 3.3-12 illustrates the range of water levels (end of December) by three lines, labeled 90th Percentile, 50th Percentile and 10th Percentile. The 50th percentile line shows the median water level for each future year. The median water level under baseline conditions is shown to decline to 1162 feet msl by 2016 and to 1111 feet msl by 2050. The 10th percentile line shows there is a 10 percent probability that the water level would decline to 1093 feet msl by 2016 and to 1010 feet msl by 2050. It should also be noted that the Lake Mead elevations depicted in Figure 3.3-12 represent water levels at the end of December which is when lake levels are at a seasonal high. Conversely, the Lake Mead water level generally reaches its annual low in July.

Three distinct traces are added to Figure 3.3-12 to illustrate what was actually simulated under the various traces and respective hydrologic sequences and to highlight that the 90th, 50th and 10th percentile lines do not represent actual traces, but rather the ranking of the data from the 85 traces for the conditions modeled. The three traces illustrate the variability among the different traces and that the reservoir levels could temporarily decline below the 10th percentile line. The trace identified as Trace 20 represents the hydrologic sequence that begins in year 1926. The trace identified as Trace 47 represents the hydrologic sequence that begins in year 1953. The trace identified as Trace 77 represents the hydrologic sequence that begins in year 1983.

Figure 3.3-11
Historic Lake Mead Water Levels
(Annual Highs and Lows)

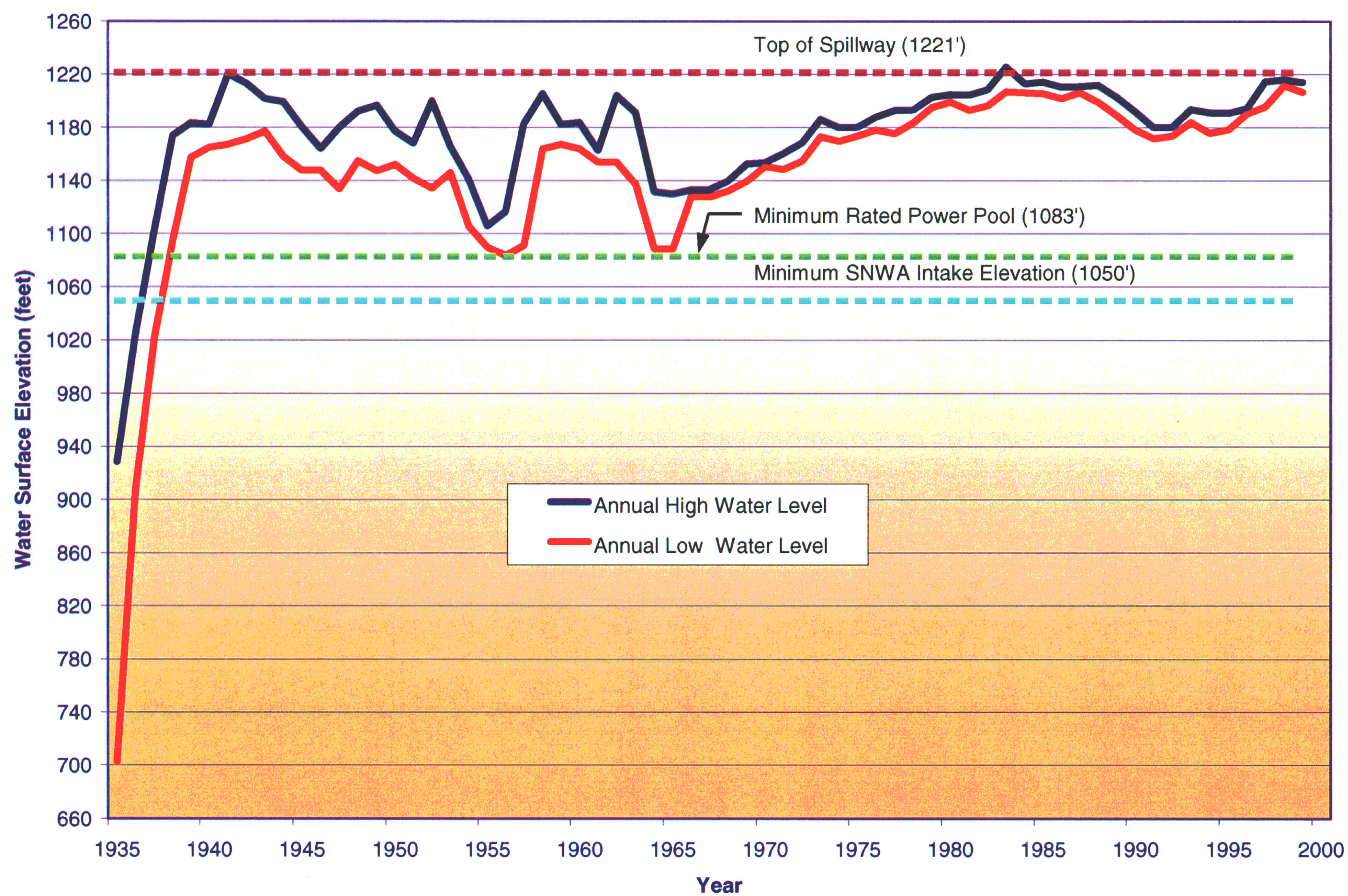
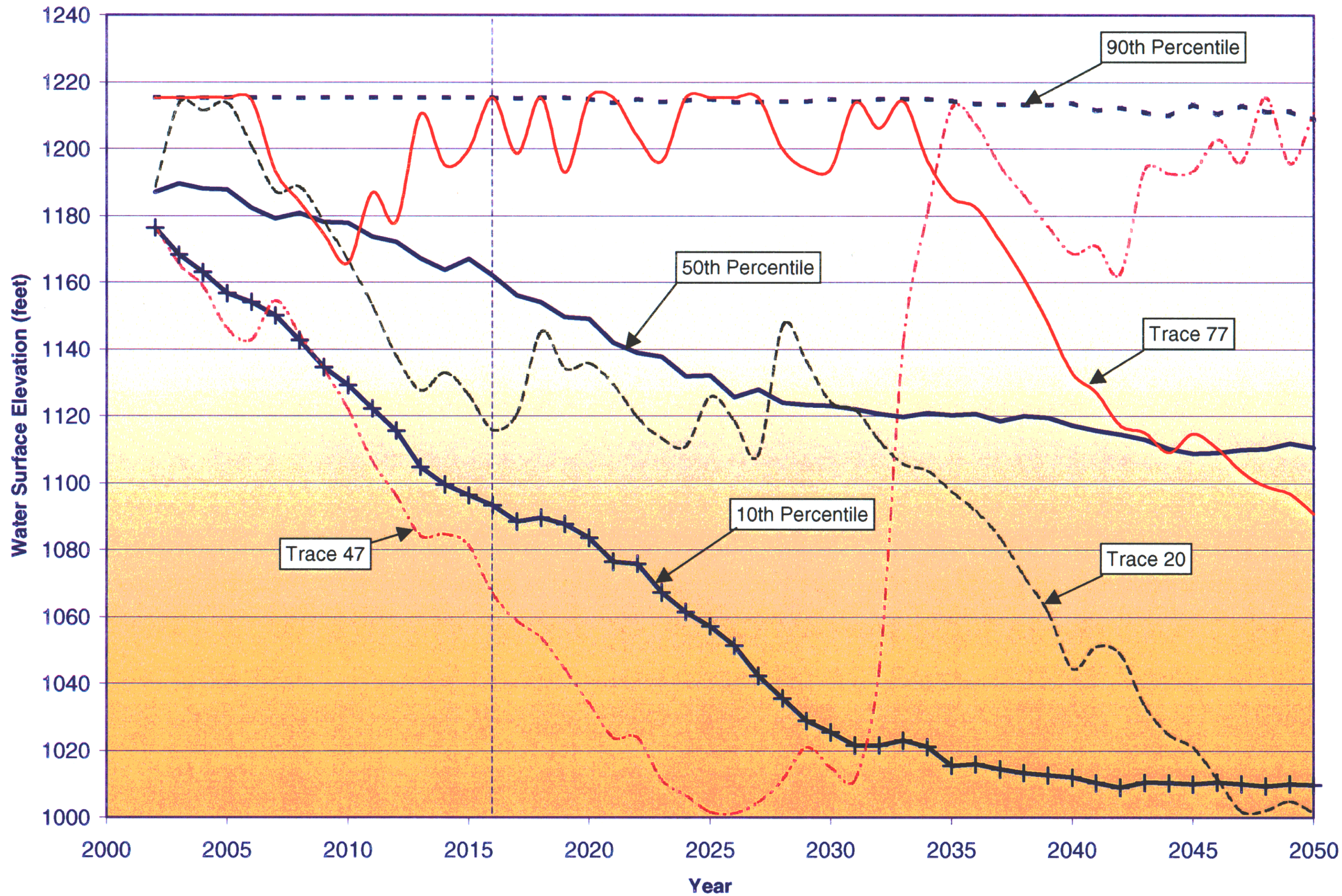


Figure 3.3-12
Lake Mead End-of-December Water Elevations Under Baseline Conditions
90th, 50th and 10th Percentile Values and Representative Traces



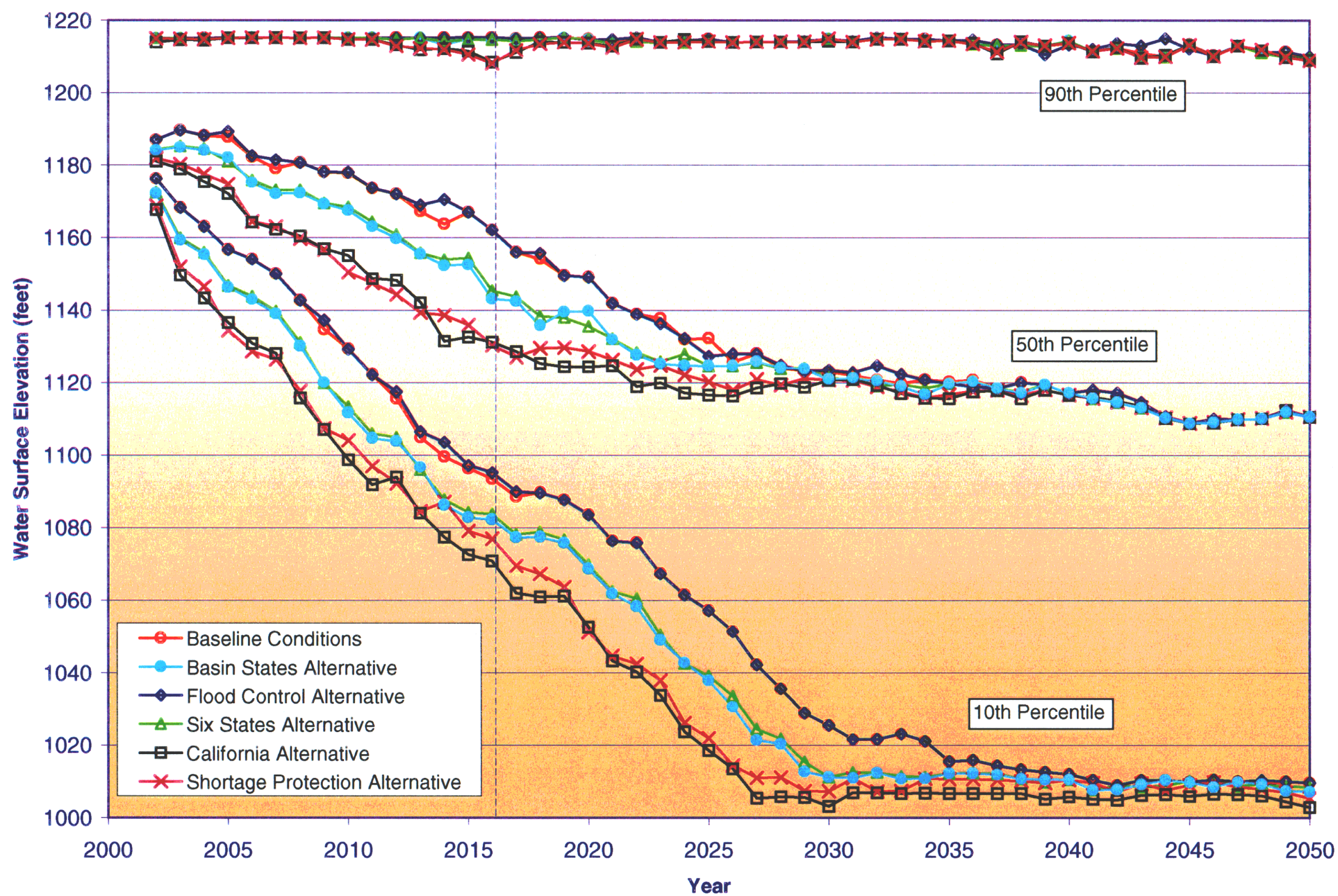
In Figure 3.3-12, the 90th and 10th percentile lines bracket the range where 80 percent of future Lake Mead water levels simulated for the baseline conditions occur. The highs and lows shown on the three traces would likely be temporary conditions. The reservoir level would tend to fluctuate through multi-year periods of above average and below average inflows. Neither the timing of water level variations between the highs and the lows, nor the length of time the water level would remain high or low can be predicted. These events would depend on the future variation in basin runoff conditions.

Figure 3.3-13 presents a comparison of the 90th, 50th and 10th percentile lines obtained for the baseline conditions to those obtained for the surplus alternatives. This figure is best used for comparing the relative differences in the general lake level trends that result from the simulation of the baseline conditions and surplus alternatives.

As illustrated in Figure 3.3-13, the Flood Control Alternative is the alternative that could potentially result in the highest Lake Mead water levels. The California Alternative is the alternative that could potentially result in the lowest water levels. The water levels observed under the Shortage Protection Alternative are similar to those of the California Alternative with some years slightly lower. The baseline conditions yield slightly lower levels than the Flood Control Alternative, but the differences are very small. The results obtained under the Six States and Basin States alternatives are similar and fall between the Flood Control and Shortage Protection alternatives.

Figure 3.3-14 provides a comparison of the frequency that future Lake Mead end of December water elevations under baseline conditions and the surplus alternatives would be at or exceed a lake water elevation of 1200 feet msl. The lines represent the percentage of values greater than or equal to the lake water elevation of 1200 feet msl under the baseline conditions and surplus alternatives. In year 2016, under the baseline conditions, the percentage of values greater than or equal to elevation 1200 feet msl is 22 percent. In 2050, the percentage of values greater than or equal to elevation 1200 feet msl decreases to 14 percent for the baseline conditions.

Figure 3.3-13
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives and Baseline Conditions 90th, 50th and 10th Percentile Values



3.3-14
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives and Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 1200 Feet

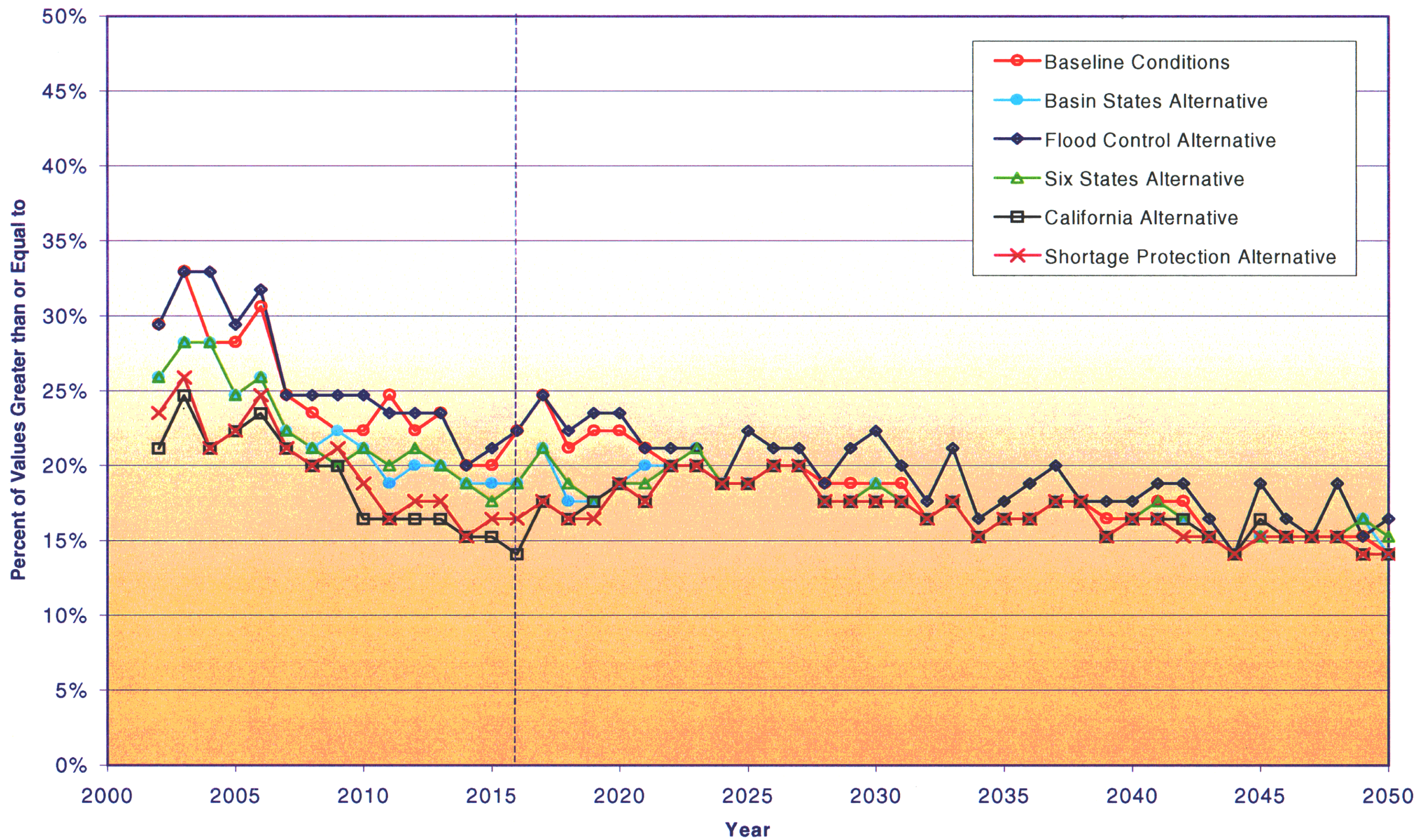


Figure 3.3-15 provides a comparison of the frequency that future Lake Mead end of December water elevations would be at or exceed a lake water elevation of 1083 feet msl under baseline conditions and the surplus alternatives. In year 2016, under the baseline conditions, the percentage of values greater than or equal to elevation 1083 feet msl is 93 percent. In 2050, the percentage of values greater than or equal to elevation 1083 feet msl decreases to 58 percent for the baseline conditions.

Figure 3.3-16 provides a comparison of the frequency that future Lake Mead end of December water elevations under baseline conditions and the surplus alternatives would be at or exceed a lake water elevation of 1050 feet msl. In year 2016, under the baseline conditions, the percentage of values greater than or equal to elevation 1050 feet msl is 100 percent. In 2050, the percentage of values greater than or equal to elevation 1050 feet msl decreases to 75 percent for the baseline conditions.

Figure 3.3-17 provides a comparison of the frequency that future Lake Mead end of December water elevations under baseline conditions and the surplus alternatives would be at or exceed a lake water elevation of 1000 feet msl. In year 2016, under the baseline conditions, the percentage of values greater than or equal to elevation 1000 feet msl is 100 percent. In 2050, the percentage of values greater than or equal to elevation 1000 feet msl decreases to 99 percent for the baseline conditions.

3.3.4.4.4 Comparison of Surplus Alternatives to Baseline Conditions

Figure 3.3-13 compared the 90th, 50th and 10th percentile water levels of the surplus alternatives to those of the baseline conditions. As discussed above, under baseline conditions, future Lake Mead water levels at the upper and lower 10th percentiles would likely be temporary and the water levels are expected to fluctuate between them in response to multi-year variations in basin runoff conditions. The same would apply to all the surplus alternatives. The 90th percentile, median (50th percentile) and 10th percentile values of the surplus alternatives are compared to those of the baseline conditions in Table 3.3-7. The values presented in this table include those for years 2016 and 2050 only.

Table 3.3-7
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives and Baseline Conditions
90th, 50th and 10th Percentile Values

Alternative	Year 2016			Year 2050		
	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
Baseline Conditions	1215	1162	1093	1209	1111	1010
Basin States	1215	1143	1082	1209	1111	1007
Flood Control	1215	1162	1095	1210	1111	1010
Six States	1215	1146	1084	1210	1111	1008
California	1208	1131	1071	1209	1111	1003
Shortage Protection	1208	1130	1077	1209	1111	1005

Figure 3.3-15
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 1083 Feet

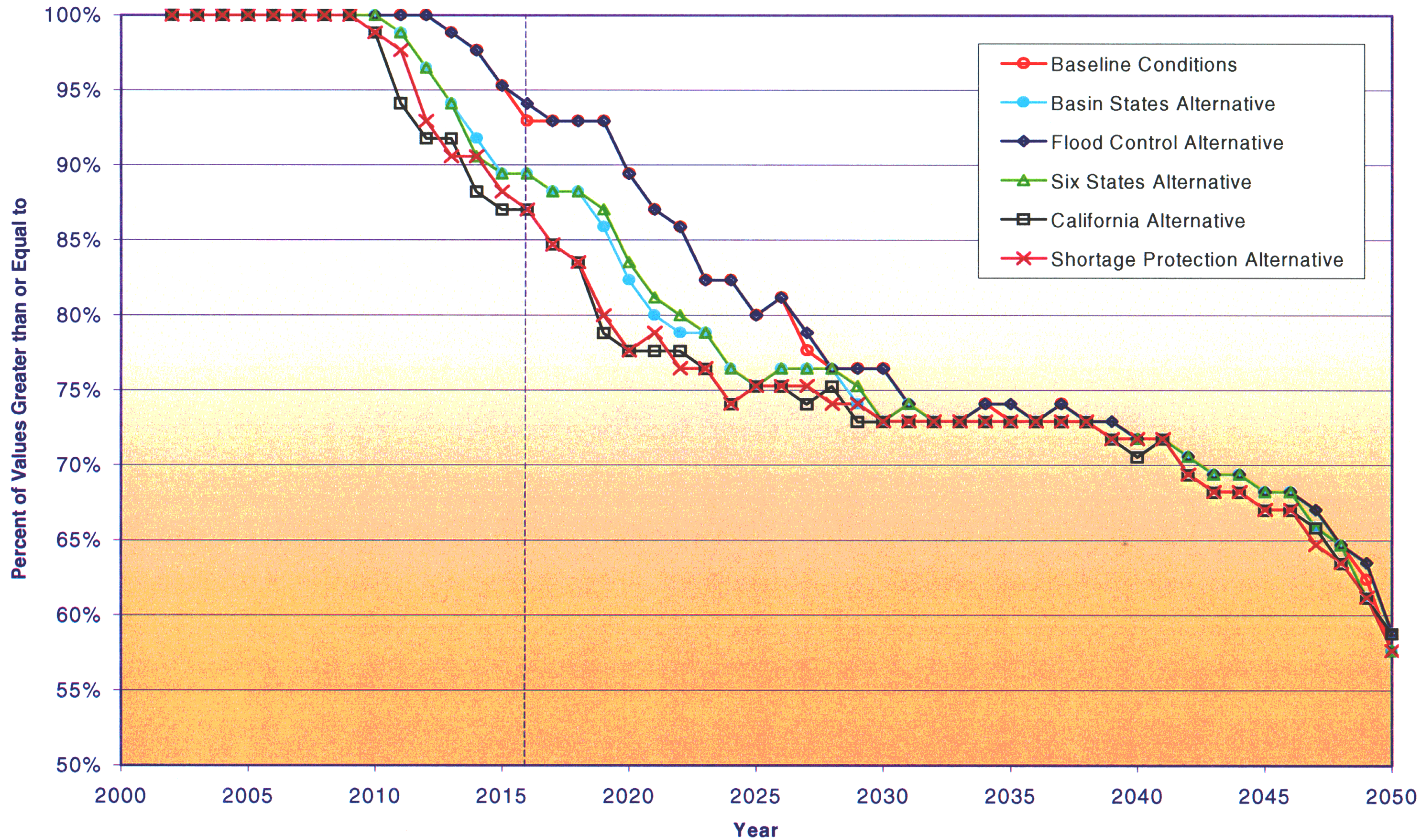


Figure 3.3-16
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 1050 Feet

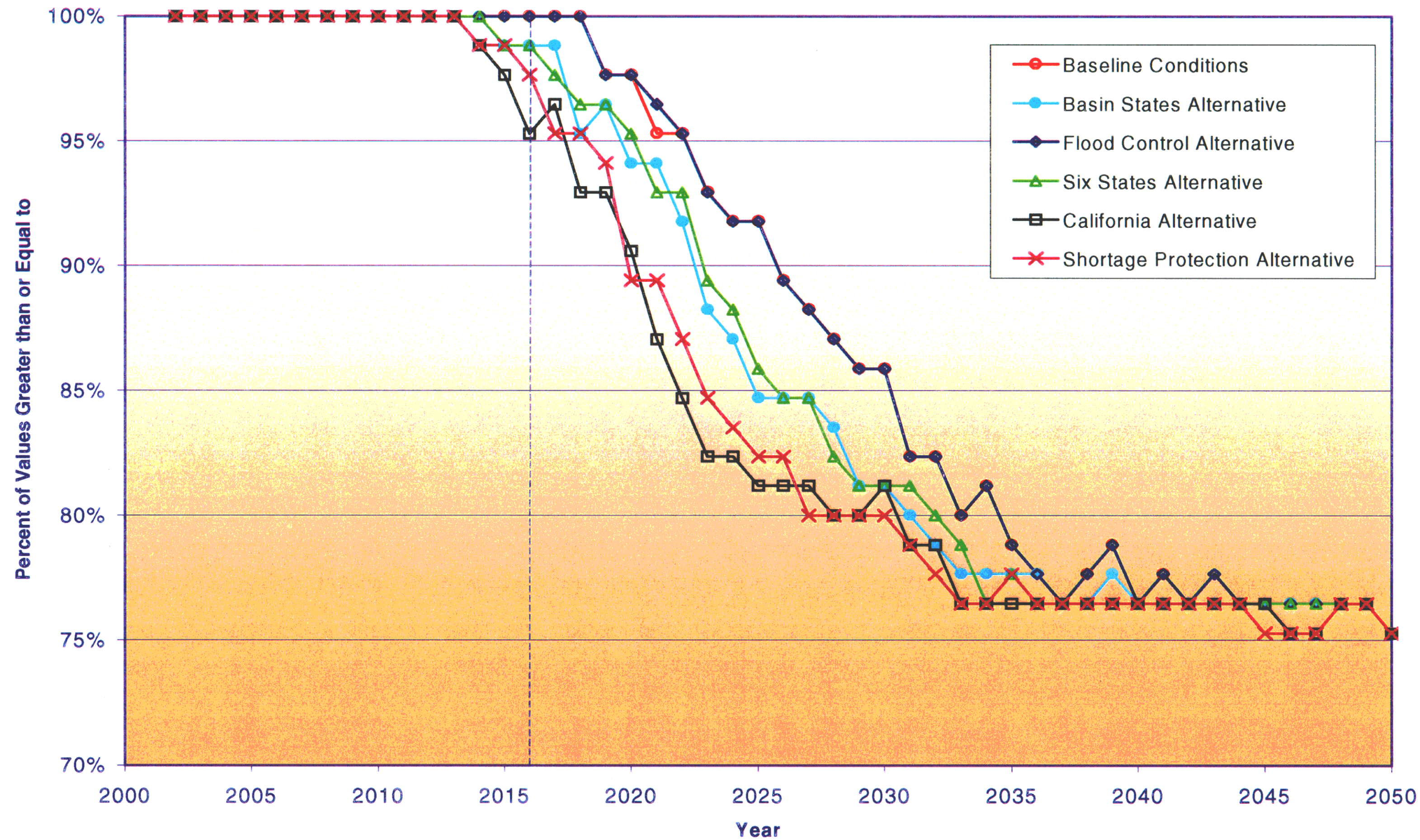


Figure 3.3-17
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 1000 Feet

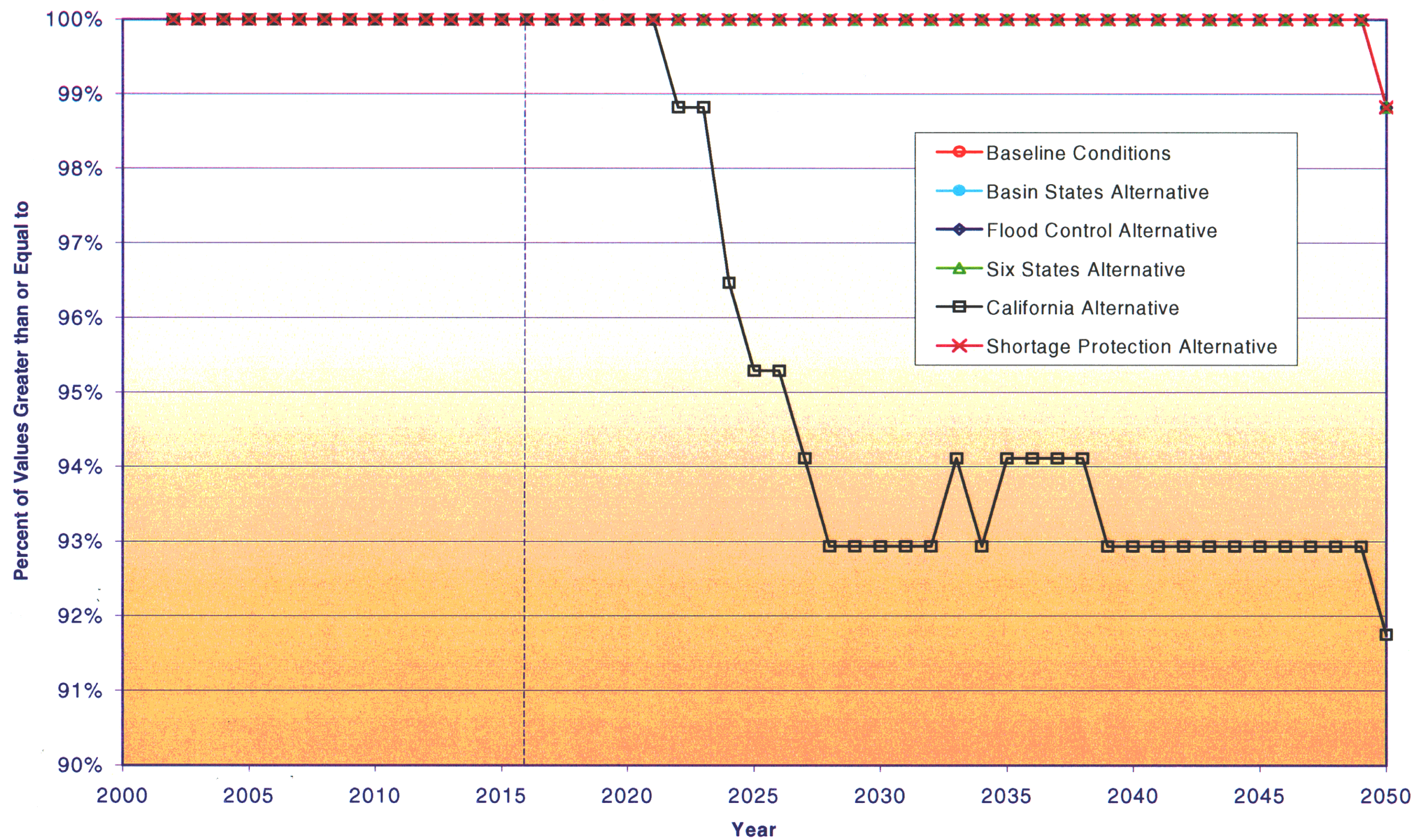


Figure 3.3-14 compared the percentage of Lake Mead elevations that exceeded 1200 feet msl for the surplus alternatives and baseline conditions. Table 3.3-8 provides a summary of that comparison for years 2016 and 2050.

Table 3.3-8
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives and Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 1200 Feet

Alternative	Year 2016	Year 2050
Baseline Conditions	22%	14%
Basin States	19%	14%
Flood Control	22%	16%
Six States	19%	15%
California	14%	14%
Shortage Protection	16%	14%

Figure 3.3-15 compared the percentage of Lake Mead elevations that exceeded 1083 feet msl for the surplus alternatives and baseline conditions. Table 3.3-9 provides a summary of that comparison for years 2015 and 2050.

Table 3.3-9
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives and Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 1083 Feet

Alternative	Year 2016	Year 2050
Baseline Conditions	93%	58%
Basin States	89%	58%
Flood Control	94%	59%
Six States	89%	58%
California	87%	59%
Shortage Protection	87%	58%

Figure 3.3-16 compared the percentage of Lake Mead elevations that exceeded 1050 feet msl for the surplus alternatives and baseline conditions. Table 3.3-10 provides a summary of that comparison for years 2016 and 2050.

Table 3.3-10
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives and Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 1050 Feet

Alternative	Year 2016	Year 2050
Baseline Conditions	100%	75%
Basin States	99%	75%
Flood Control	100%	75%
Six States	99%	75%
California	95%	75%
Shortage Protection	98%	75%

Figure 3.3-17 compared the percentage of Lake Mead elevations that exceeded 1000 feet msl for the surplus alternatives and baseline conditions. Table 3.3-11 provides a summary of that comparison for years 2016 and 2050.

Table 3.3-11
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives and Baseline Conditions
Percentage of Values Greater than or Equal to Elevation 1000 Feet

Alternative	Year 2016	Year 2050
Baseline Conditions	100%	99%
Basin States	100%	99%
Flood Control	100%	99%
Six States	100%	99%
California	100%	92%
Shortage Protection	100%	99%

3.3.4.5 Comparison of River Flows Below Hoover Dam

This section describes results of the analysis of the simulated Colorado River flows below Hoover Dam. The model of the Colorado River system was used to simulate future mean monthly flows under baseline conditions and the surplus alternatives. Four specific river locations were selected to represent flows within selected river reaches below Hoover Dam. The river reaches and corresponding flow locations are listed in Table 3.3-12 and are shown graphically on Map 3.3-1.

Table 3.3-12
Colorado River Flow Locations Identified for Evaluation

Colorado River Reach	Selected River Flow Locations	
	Description	Approximate River Mile [1]
ween Hoover Dam and Parker Dam	vasu National Wildlife Refuge (NWR)	242.3
ween Parker Dam and Palo Verde Diversion Dam	stream of Colorado River Indian Reservation	180.8
ween Palo Verde Diversion and Imperial Dam	wnstream of the Palo Verde Diversion Dam	133.8
ween Imperial Dam and SIB	ow the Mexico Diversion at Morelos Dam	23.1

[1] River miles as measured from the southerly international border with Mexico

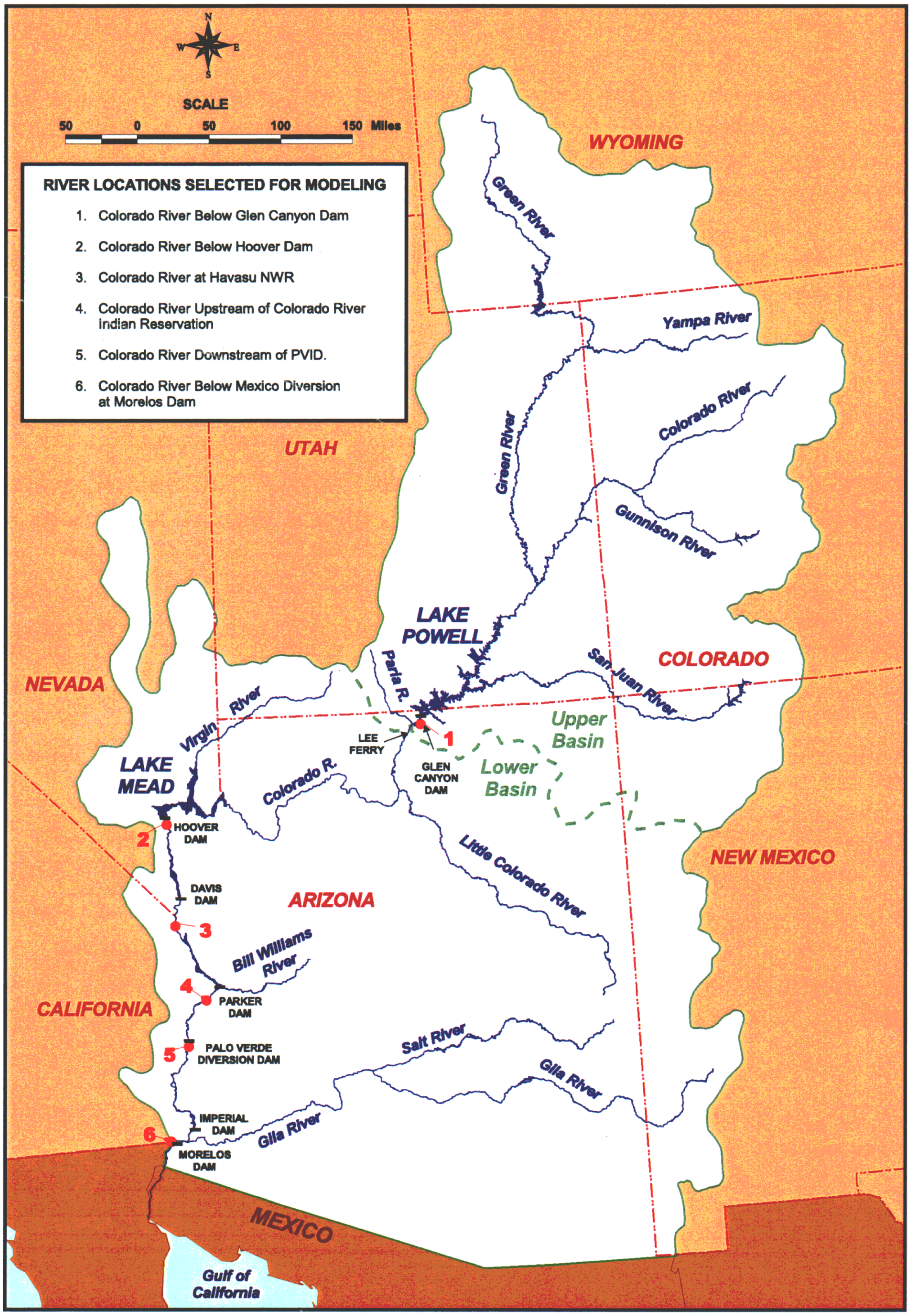
Two types of analysis of the potential of interim surplus criteria to affect river flows were conducted. In the first analysis, the potential effects on the total annual volume of flow in each reach were evaluated. In this analysis, the mean monthly flows were first summed over each calendar year. The 90th, 50th, and 10th percentiles of the annual volumes were then computed for each year. Plots of these percentiles for baseline conditions and all surplus alternatives are included in this section for each of the four river points. Cumulative distributions of the annual flow volumes are also presented for specific years to aid in the understanding of the effects. These cumulative distributions consider the year 2006, the year when the largest effects at the 90^{th} percentile are seen.

The second analysis investigated the potential effects on seasonal flows. Cumulative distributions of mean monthly flows (in cfs) were produced for specific years and selected months representative of each season. The mean monthly flows for January were used to represent the winter season flows and likewise for April, July, and October to represent spring, summer, and fall, respectively. The specific years analyzed included 2006, 2016, 2025, and 2050. Only the graphs for 2016 are presented in this section. The graphs for the other years are presented in Attachment N.

It should be noted that the monthly demand schedules used in the model are based on a distribution of the total annual demand (a percentage for each month). Although each diversion point may use a different distribution, those percentages do not change from year to year, and can not reflect potential future changes in the system that might affect the monthly distributions. Therefore, the seasonal differences are primarily governed by the overall changes in annual flow volumes, coupled with the effect of each diversion's distribution upstream of the point of interest.

Daily and hourly releases from Hoover Dam reflect the short-term demands of Colorado River water users with diversions located downstream, storage management in Lakes Mohave and Havasu, and power production at Hoover, Davis and Parker Dams. The close proximity of Lake Mohave to Hoover Dam effectively dampens the short-term fluctuations below Hoover Dam. The scheduling and subsequent release of water through Davis and Parker Dams create short-term fluctuations in river flows, depths, and water surface elevations downstream of these structures. These fluctuations of water surface elevations in the river are most noticeable in the river reaches located immediately downstream of the dams and lessen as the downstream distance increases. Interim surplus criteria, however, will have no effect on the short-term operations of Hoover, Davis and Parker Dam, and therefore, short-term fluctuations in river reaches downstream of Hoover Dam were not evaluated.

Map 3.3-1
Colorado River Locations Selected for Modeling



3.3.4.5.1 River Flows Between Hoover Dam and Parker Dam

The river flows between Hoover Dam and Parker Dam are comprised mainly of flow releases from Hoover Dam and Davis Dam. Inflows from the Bill Williams River and other intermittent tributaries are infrequent and are usually concentrated into short time periods due to their dependence on localized precipitation. Tributary inflows comprise less than one percent of the total annual flow in this reach of the river.

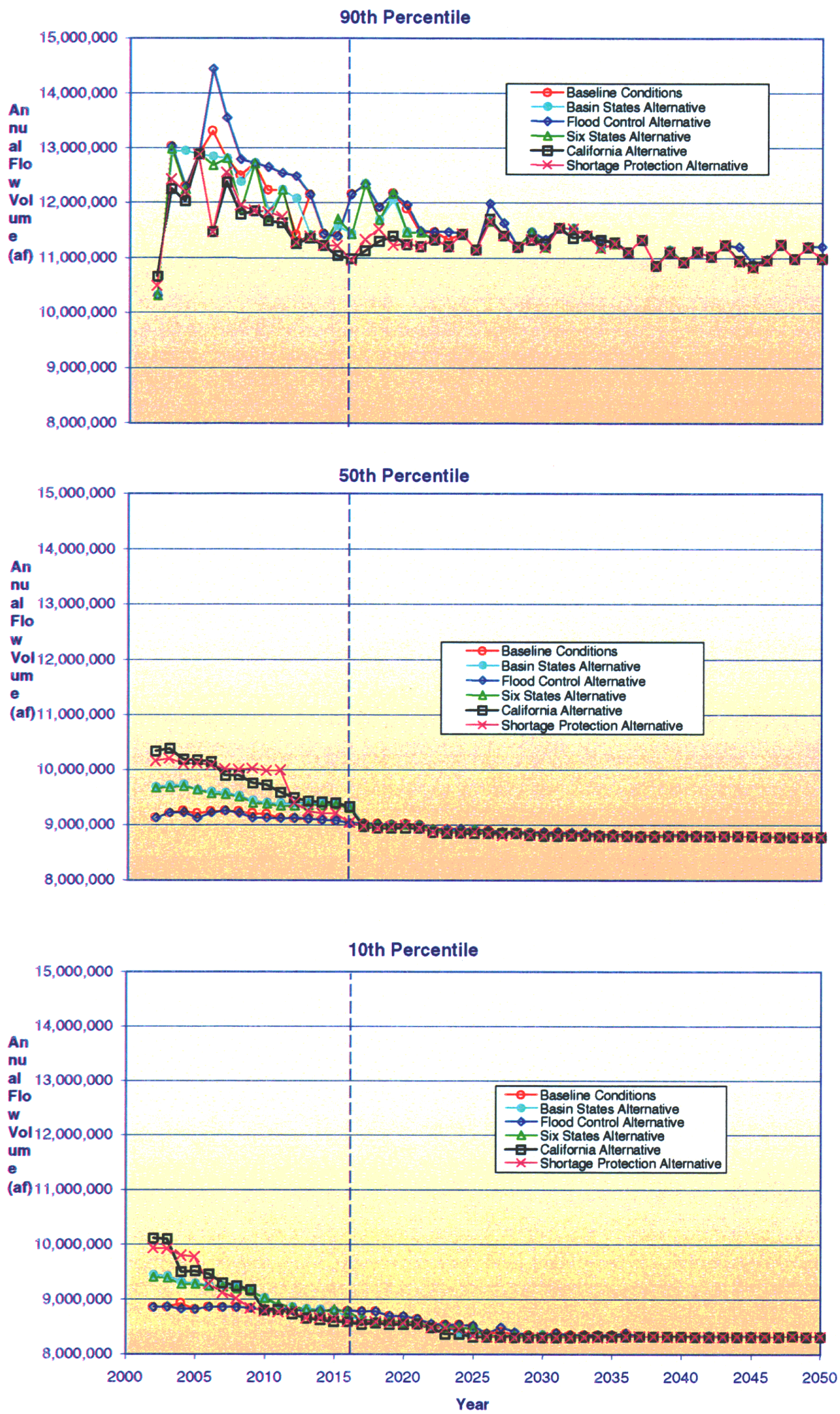
Due to the backwater effect of Lake Mohave, a point on the Colorado River downstream of Davis Dam was used to evaluate the river flows for this reach, located immediately downstream of the Havasu National Wildlife Refuge (NWR).

The 90th, 50th, and 10th percentile annual flow volumes for this reach are shown in Figure 3.3-18. As shown by the 50th percentile values, annual flow volumes in this reach can be expected to be greater for the surplus alternatives (except for the Flood Control Alternative) than for the baseline conditions during the 15-year interim surplus criteria period. This is a direct result of more frequent surplus deliveries. The largest increases from baseline conditions occur under the California Alternative and range from approximately 13 percent in the first two years down to three percent by 2016. Results for the Six States and Basin States alternatives are similar to each other, ranging from approximately a six percent increase over baseline conditions down to three percent by 2016. Beyond the 15-year interim period, the annual flow volumes under the surplus alternatives are essentially the same (within one percent) as those under the baseline conditions.

At the 10th percentile level, although the magnitudes of the annual flow volumes are different, the relative changes in surplus conditions compared to the baseline conditions are similar to those at the 50th percentile.

At the 90th percentile level, all surplus alternatives (except for the Flood Control Alternative) show annual flow volumes less than or equal to the flows under the baseline conditions. This is the result of more frequent surplus deliveries, which tend to lower Lake Mead reservoir levels. With lower reservoir levels, the frequency of flood control events (which contribute most of the flows at the 90th percentile level) is decreased, which in turn decreases the annual flow volume for a given percentile. The California and Shortage Protection alternatives exhibit the largest decreases, ranging from approximately 13 percent less than baseline conditions in 2006 to one percent less by 2023. Results for the Six States and Basin States alternatives are similar to each other, ranging from approximately six percent less than baseline conditions in 2013 to one percent less by 2023.

Figure 3.3-18
Colorado River Downstream of Havasu NWR Annual Flow Volume (af)
Comparison of Surplus Alternatives to Baseline Conditions
90th, 50th and 10th Percentile Values



In Figure 3.3-19, the cumulative distribution of annual flow volumes is shown for year 2006. This is the year of the largest differences at the 90th percentile level as shown in Figure 3.3-18. Although the annual flow volumes decrease for all surplus alternatives (except Flood Control Alternative) at a fixed percentile (i.e. at the 90th percentile) as compared to baseline, the range of annual flow volumes are the same for baseline conditions and the surplus alternatives. The frequency that a flow of a specific magnitude will occur, however, is lower under the surplus alternatives (except for the Flood Control Alternative) as shown in Figure 3.3-19.

Figures 3.3-20(a-d) present comparisons of the representative seasonal flows under baseline conditions and the surplus alternatives for 2016. For all seasons, the Flood Control Alternative is very similar to the baseline conditions. The Six States and Basin States alternatives tend to fall between the baseline conditions (and Flood Control Alternative) and the California (and Shortage Protection) alternatives.

As expected, the largest flows occur in the spring and summer seasons for baseline conditions and all alternatives due to downstream irrigation demands. For flows that are due primarily to flood control releases from Lake Mead (flows in the 90th – 100th percentile range), the range of mean monthly flows is not changed by the different surplus alternatives, since these magnitudes are dictated by the flood control regulations. These flows occur, however, less often for the surplus alternatives (except the Flood Control Alternative). This effect is less pronounced in July, when most flood control releases have ceased.

The differences in flows that are not due to flood control releases are greatest near the 70th percentile level. A numerical comparison of the 70th percentile values is shown in Table 3.3-13. The differences in mean monthly flows for the California Alternative compared to baseline conditions are approximately 16 percent in the winter, nine percent in the spring, six percent in the summer, and eight percent in the fall. For the Basin States alternative, the differences (compared to baseline conditions) in mean monthly flows are approximately three percent in the winter, one percent in the spring, and less than one percent in the summer and fall seasons.

Despite these differences, the flows for all alternatives fall well within the minimum and maximum flows for the baseline conditions, as well as within the current operational range for this reach.

Table 3.3-13
Comparison of Mean Monthly Flow (cfs) – Baseline Conditions and Surplus Alternatives
Colorado River Downstream of Havasu NWR (River Mile = 242.3)
70th Percentile Values for Year 2016

Season	Mean Monthly Flows (cfs) for Year 2016 at the 70th Percentile					
	Baseline	Basin States	Flood Control	Six States	California	Shortage Protection
Winter	8069	8347	7965	8317	9327	9223
Spring	15939	16166	15899	16072	17294	17144
Summer	15880	15957	15862	15953	16853	16644
Fall	11776	11805	11776	11686	12688	12531

Figure 3.3-19
Colorado River Annual Flow Volume Downstream of Havasu NWR
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

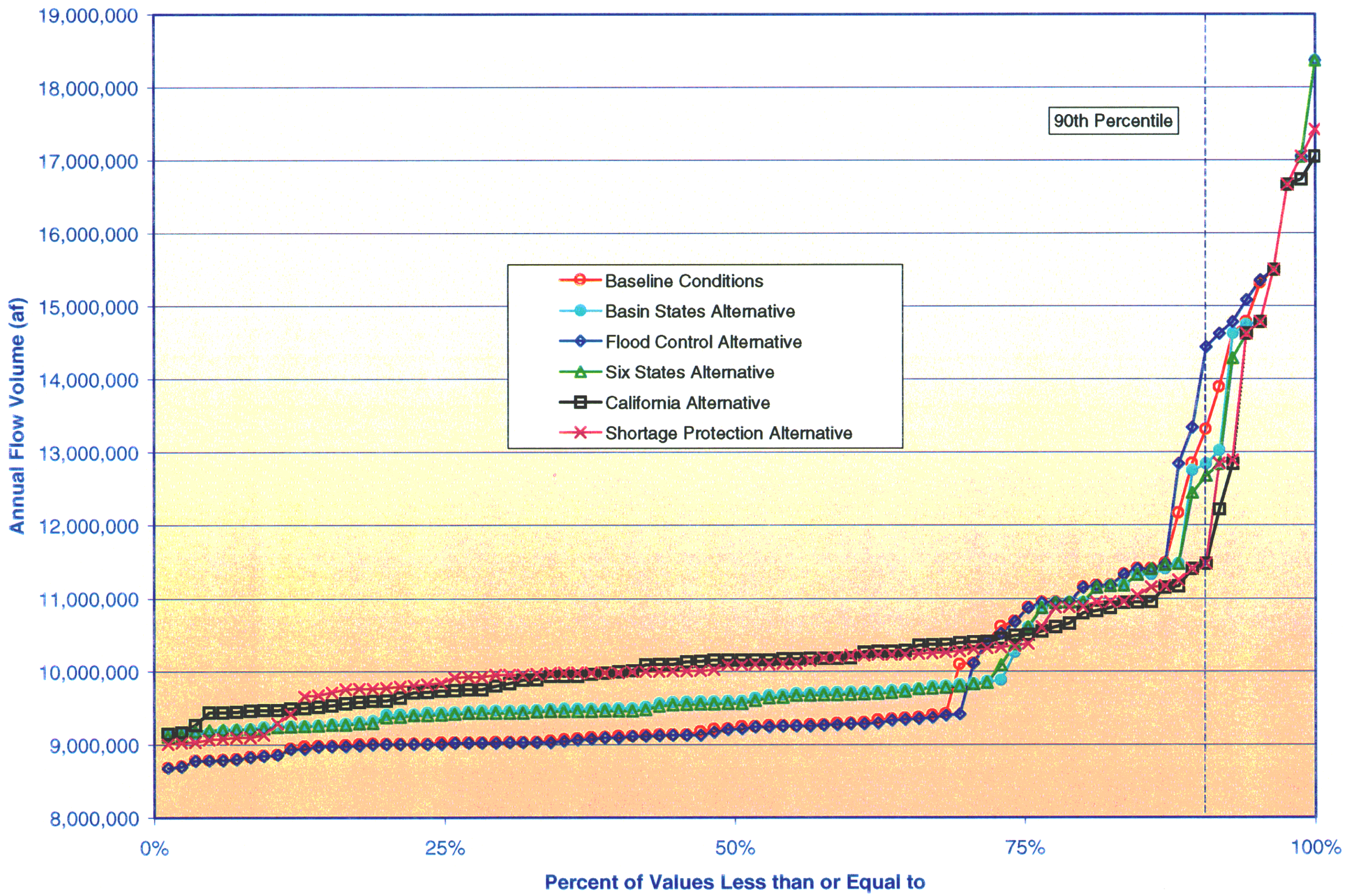


Figure 3.3-20a
Colorado River Seasonal Flows Downstream of Havasu NWR
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

Winter Season Flows
as Represented by January Flows

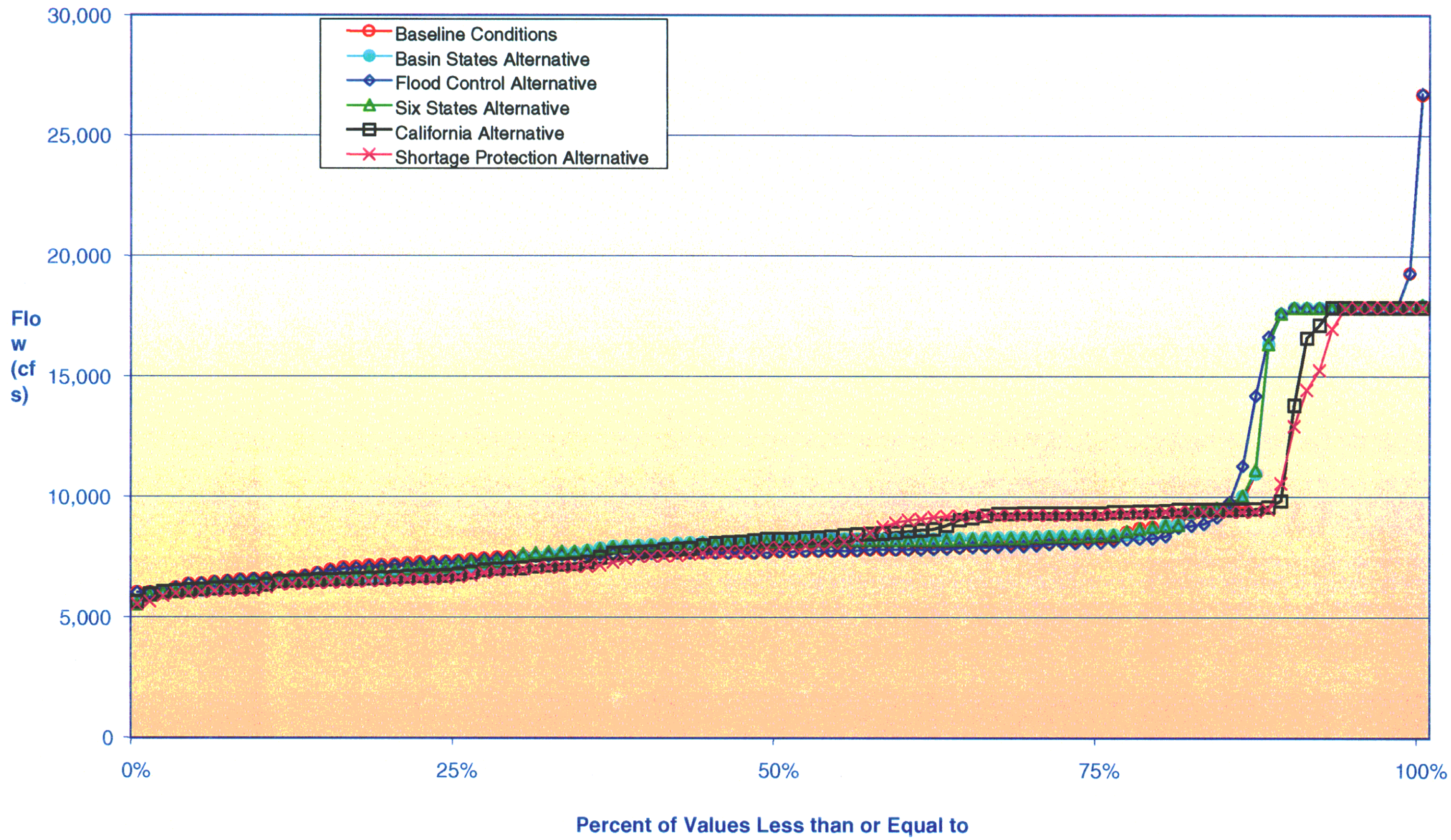


Figure 3.3-20b
Colorado River Seasonal Flows Downstream of Havasu NWR
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

Spring Season Flows
as Represented by April Flows

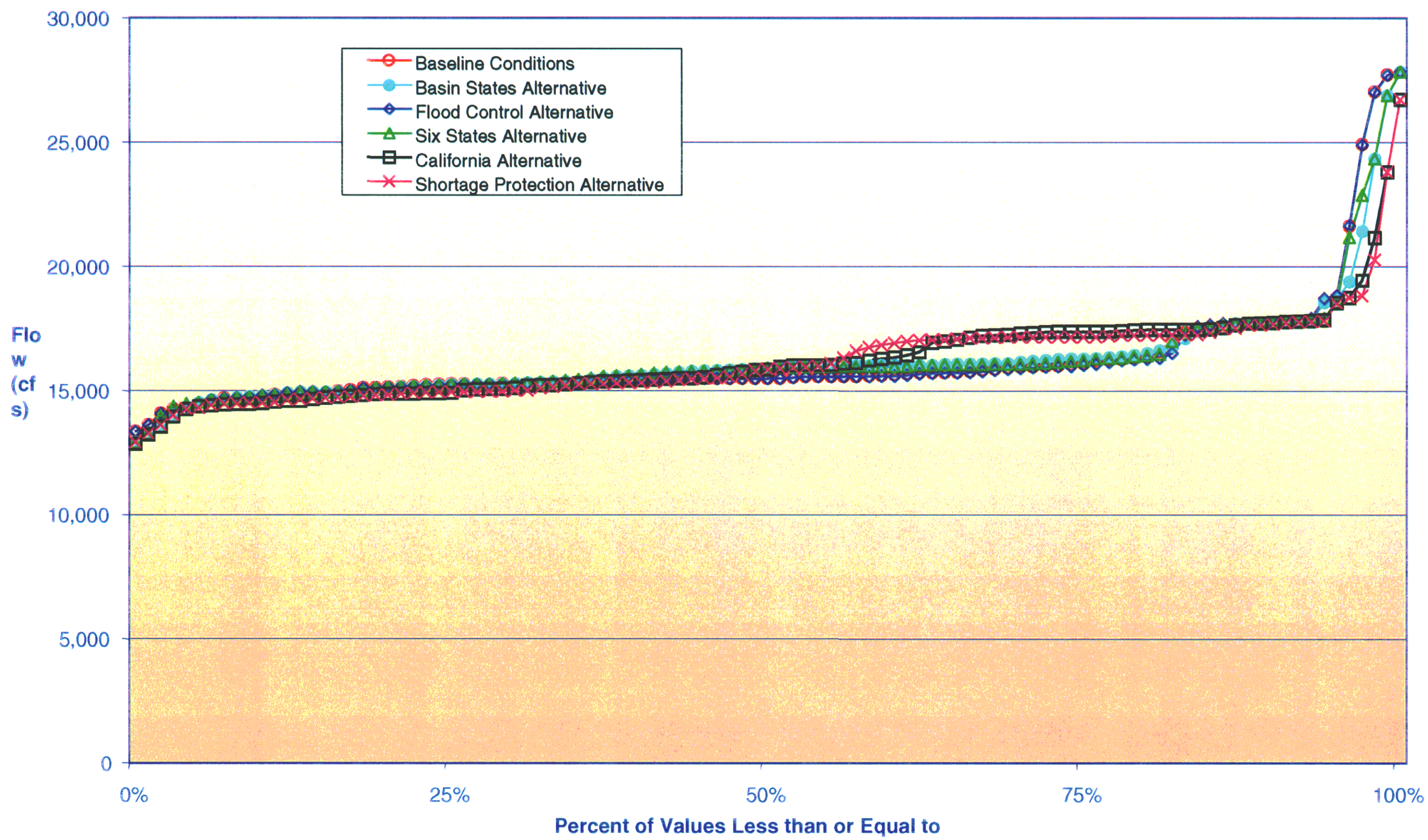


Figure 3.3-20c
Colorado River Seasonal Flows Downstream of Havasu NWR
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

Summer Season Flows
as Represented by July Flows

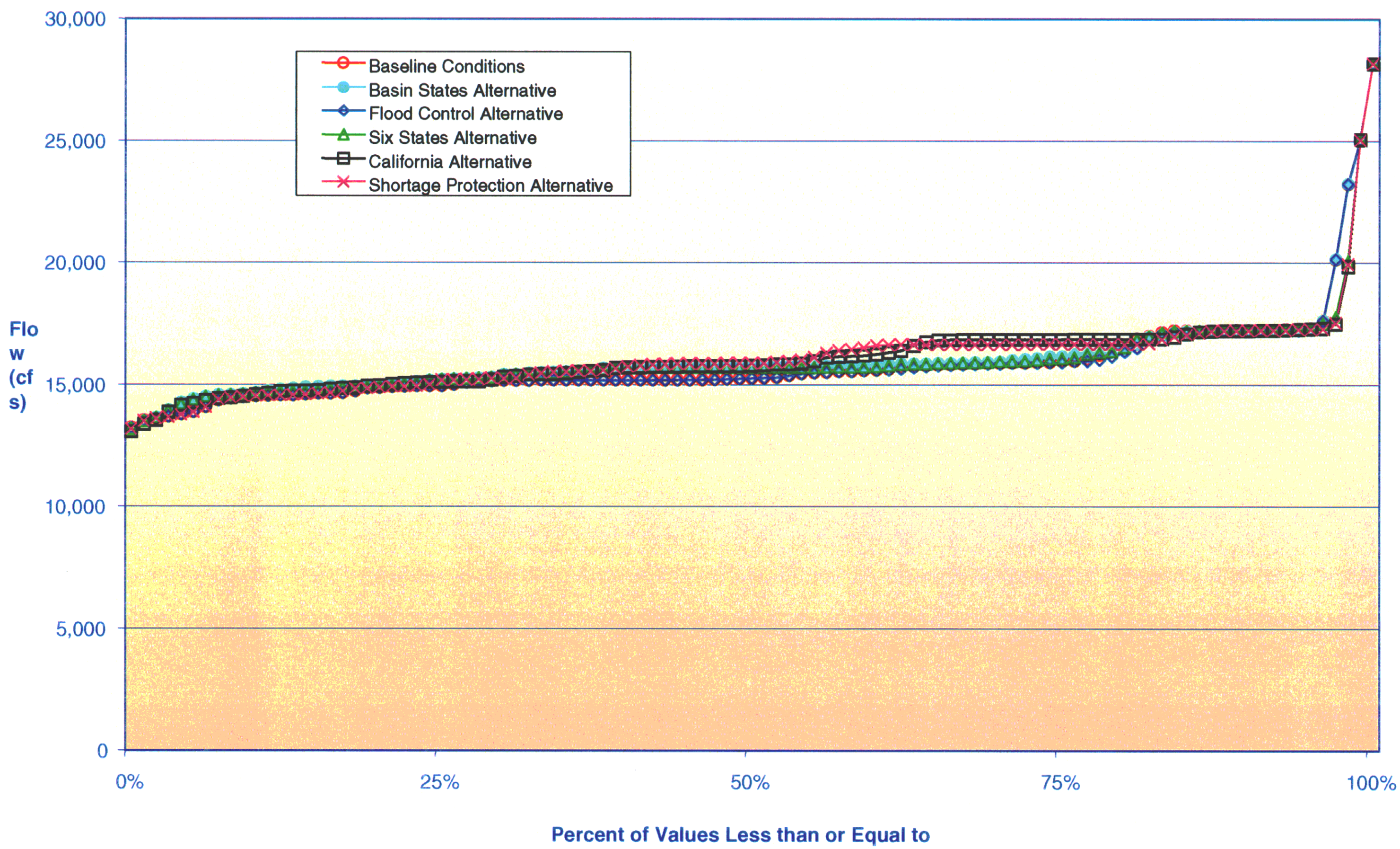
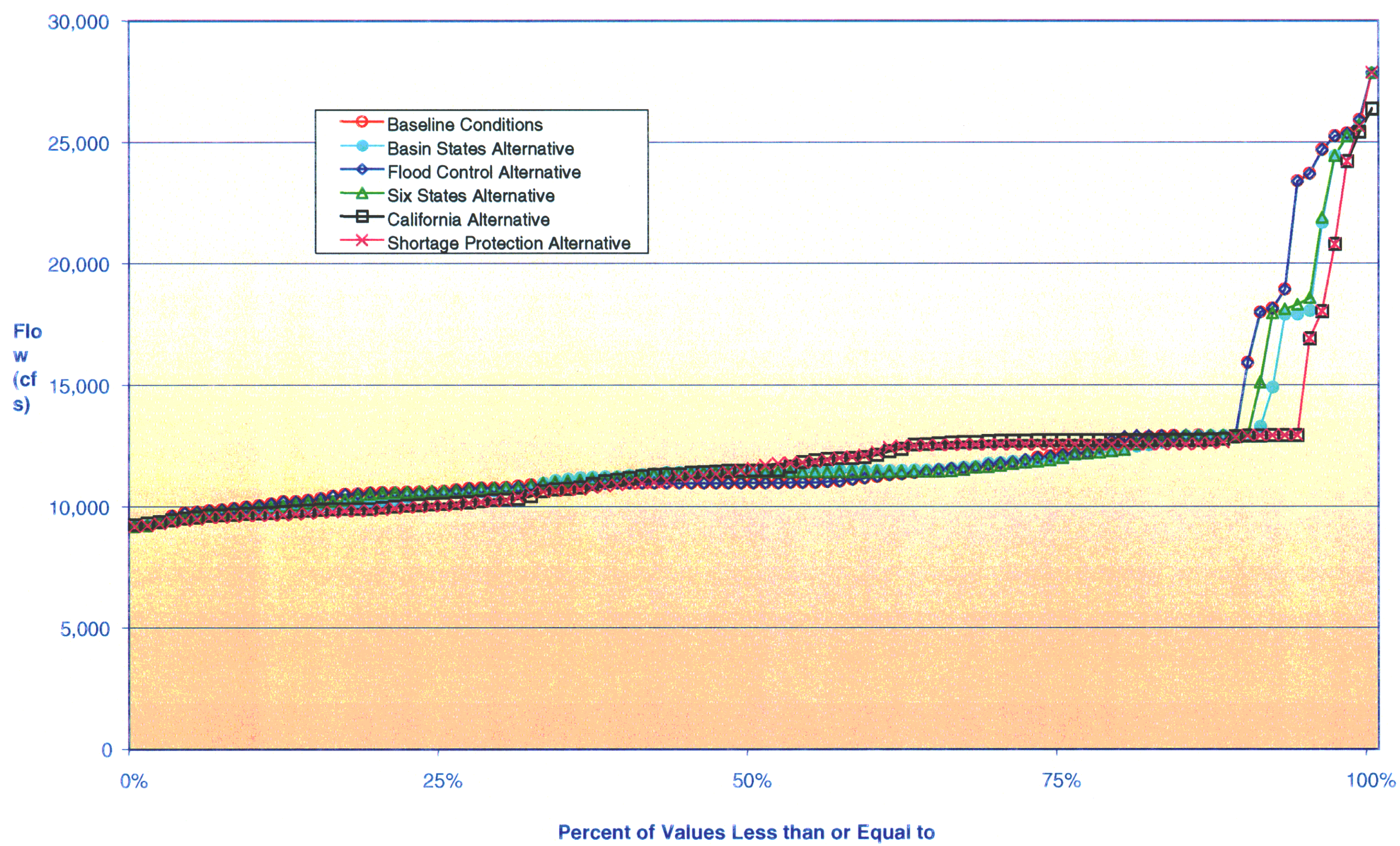


Figure 3.3-20d
Colorado River Seasonal Flows Downstream of Havasu NWR
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

Fall Season Flows
as Represented by October Flows



3.3.4.5.2 River Flows Between Parker Dam and Palo Verde Diversion

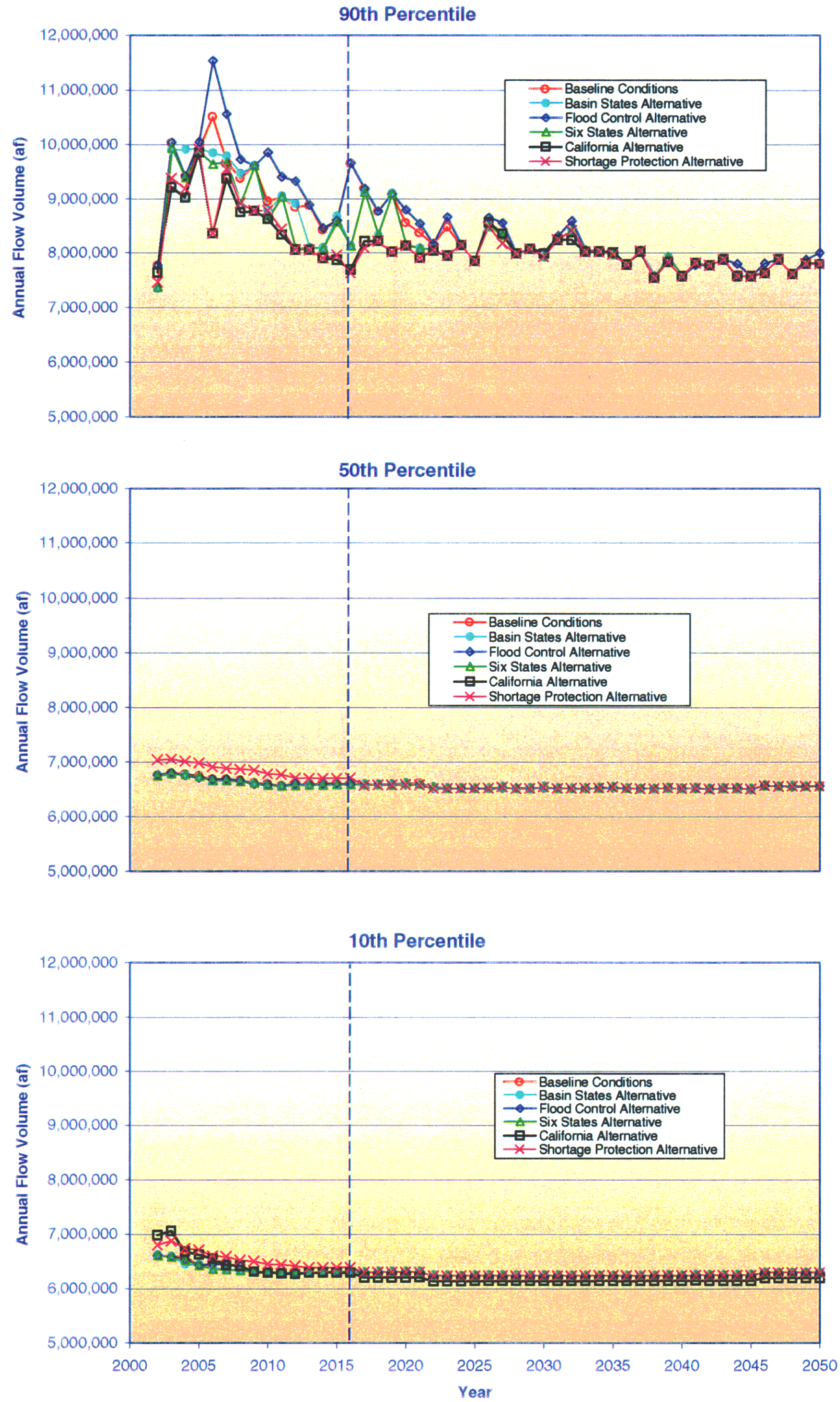
The point on the Colorado used to evaluate the river flows in the reach of the river located between Parker Dam and the Palo Verde Diversion Dam is located immediately upstream of the Colorado River Indian Reservation (CRIR) diversion. The CRIR diversion is located at Headgate Rock Dam, approximately 14 miles below Parker Dam. Flows in this reach of the river result from primarily from releases from Parker Dam (Lake Havasu).

Future flows in this reach would be affected by the proposed water transfers and exchanges between the California agricultural water agencies and MWD, which change the point of diversion. For example, under a potential transfer between IID and MWD (or SDCWA), the water that would normally be diverted at Imperial Dam would now be diverted above Parker Dam. As discussed in Section 3.3.3.2, the proposed California intrastate transfers are included in the simulation of the baseline conditions and surplus alternatives. Although the transfers themselves are not a direct result of the proposed interim surplus criteria, the transfers were modeled because they are expected to be a component of the future Lower Basin water supply management programs and to maintain consistency for comparison of the alternatives to baseline conditions. The intrastate transfers proposed by California and any potential environmental effects that would occur as a result of those actions are addressed by separate NEPA and other environmental compliance.

The 90th, 50th, and 10th percentile annual flow volumes for this reach are shown in Figure 3.3-21. As shown by the 50th percentile values, annual flow volumes in this reach can be expected to be greater for the California and Shortage Protection alternatives than for the baseline conditions and other alternatives during the 15-year interim surplus criteria period. This is the result of more frequent surplus deliveries under those two alternatives. Increases from baseline conditions under the California Alternative range from approximately seven percent in the first year down to one percent by 2013. A 1.5 percent decrease from baseline conditions is seen for the period 2017 through 2050 as a result of the modeled transfer of 100 kaf from PVID to MWD as part of the California Alternative. Increases from baseline conditions under the Shortage Protection Alternative range from approximately four percent in the first year down to two percent by 2016. The annual flow volumes for the Flood Control, Six States, and Basin States alternatives are essentially the same (less than one percent) as those under the baseline conditions for the entire period of analysis (2002 through 2050).

Similar results are seen at the 10th percentile level. Increases from baseline conditions under the California Alternative range from approximately six percent in the first year down to two percent by 2006. A 1.6 percent decrease from baseline conditions is seen for the period 2017 through 2050 as a result of the modeled transfer of 100 kaf from PVID to MWD as part of the California Alternative. Increases from baseline conditions under the Shortage Protection Alternative range from approximately three percent in the

Figure 3.3-21
Colorado River Upstream of CRIR Diversion Annual Flow Volume (af)
Comparison of Surplus Alternatives to Baseline Conditions
90th, 50th and 10th Percentile Values

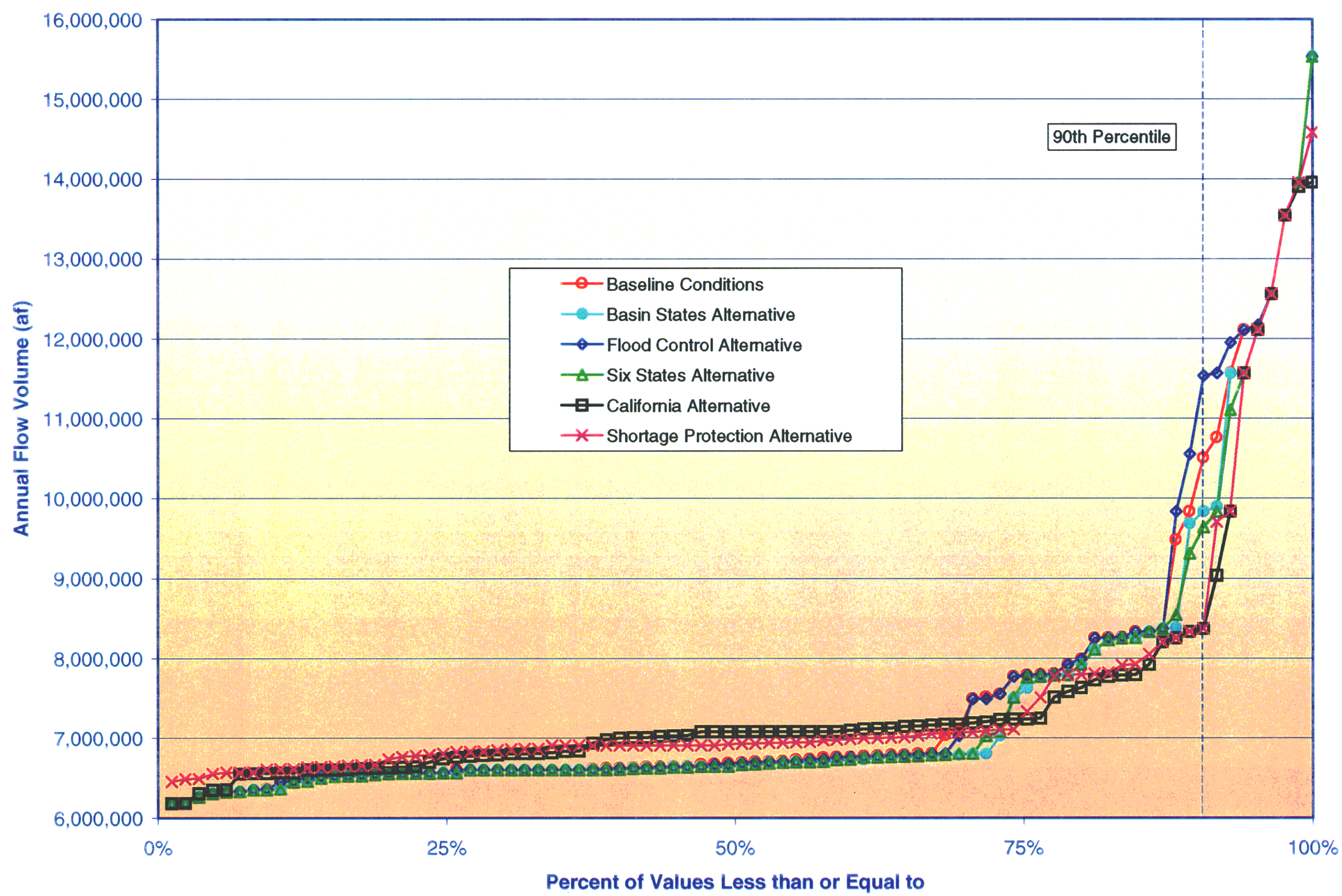


first year down to one percent by 2016. The annual flow volumes for the Flood Control, Six States, and Basin States alternatives are essentially the same (less than one percent) as those under the baseline conditions for the entire period of analysis (2002 through 2050).

At the 90th percentile level, all surplus alternatives (except for the Flood Control Alternative) show annual flow volumes less than or equal to the flows under the baseline conditions. This is the result of more frequent surplus deliveries, which tend to lower Lake Mead reservoir levels. With lower reservoir levels, the frequency of flood control events (which contribute most of the flows at the 90th percentile level) is decreased, which in turn decreases the annual flow volume for a given percentile. The California and Shortage Protection alternatives exhibit the largest decreases, ranging from two to 20 percent less than baseline conditions from 2002 through 2023, with the largest differences in 2006 and 2016. The Six States and Basin States alternatives exhibit similar behavior, ranging from two to 16 percent less than baseline conditions from 2002 through 2023, with the largest differences in 2016.

In Figure 3.3-22, the cumulative distribution of annual flow volumes is shown for year 2006. This is the year of the largest differences at the 90th percentile level as shown in Figure 3.3-21. Although the annual flow volumes decrease for all surplus alternatives (except Flood Control Alternative) at a fixed percentile (i.e. at the 90th percentile) as compared to baseline, the range of annual flow volumes are the same for baseline conditions and the surplus alternatives. The frequency that a flow of a specific magnitude will occur, however, is lower under the surplus alternatives (except for the Flood Control Alternative) as shown in Figure 3.3-22.

Figure 3.3-22
Colorado River Annual Flow Volumes Upstream of Colorado River Indian Reservation
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2006



Figures 3.3-23 (a-d) present comparisons of the representative seasonal flows under baseline conditions and the surplus alternatives for 2016. As expected, the largest flows occur in the spring and summer seasons for baseline conditions and all alternatives due to downstream irrigation demands. For flows that are due primarily to flood control releases from Lake Mead (flows in the 90th – 100th percentile range), the range of mean monthly flows is not changed by the different surplus alternatives, since these magnitudes are dictated by the flood control regulations. These flows occur, however, less often for the surplus alternatives (except the Flood Control Alternative). This effect is less pronounced in July, when most flood control releases have ceased.

The differences in flows that are not due to flood control releases are similar for all alternatives and baseline conditions. A numerical comparison of the 70th percentile values is shown in Table 3.3-14. The differences in mean monthly flows for the California Alternative compared to baseline conditions are approximately six percent in the winter, three percent in the spring, one percent in the summer, and less than one percent in the fall. For the Basin States alternative, the differences (compared to baseline conditions) in mean monthly flows are less than one percent for all seasons.

Table 3.3-14
Comparison of Mean Monthly Flow (cfs) – Baseline Conditions and Surplus Alternatives
Colorado River Upstream of CRIR Diversion (River Mile = 180.8)
70th Percentile Values for Year 2016

Season	Mean Monthly Flows (cfs) for Year 2016 at the 70th Percentile					
	Baseline	Basin States	Flood Control	Six States	California	Shortage Protection
Winter	3897	3895	3880	3897	4117	4012
Spring	11690	11690	11690	11690	12009	11793
Summer	13025	12990	12989	13025	13194	12984
Fall	8005	7934	8064	8005	7987	7895

Figure 3.3-23a
Colorado River Seasonal Flows Upstream of Colorado River Indian Reservation
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

Winter Season Flows
as Represented by January Flows

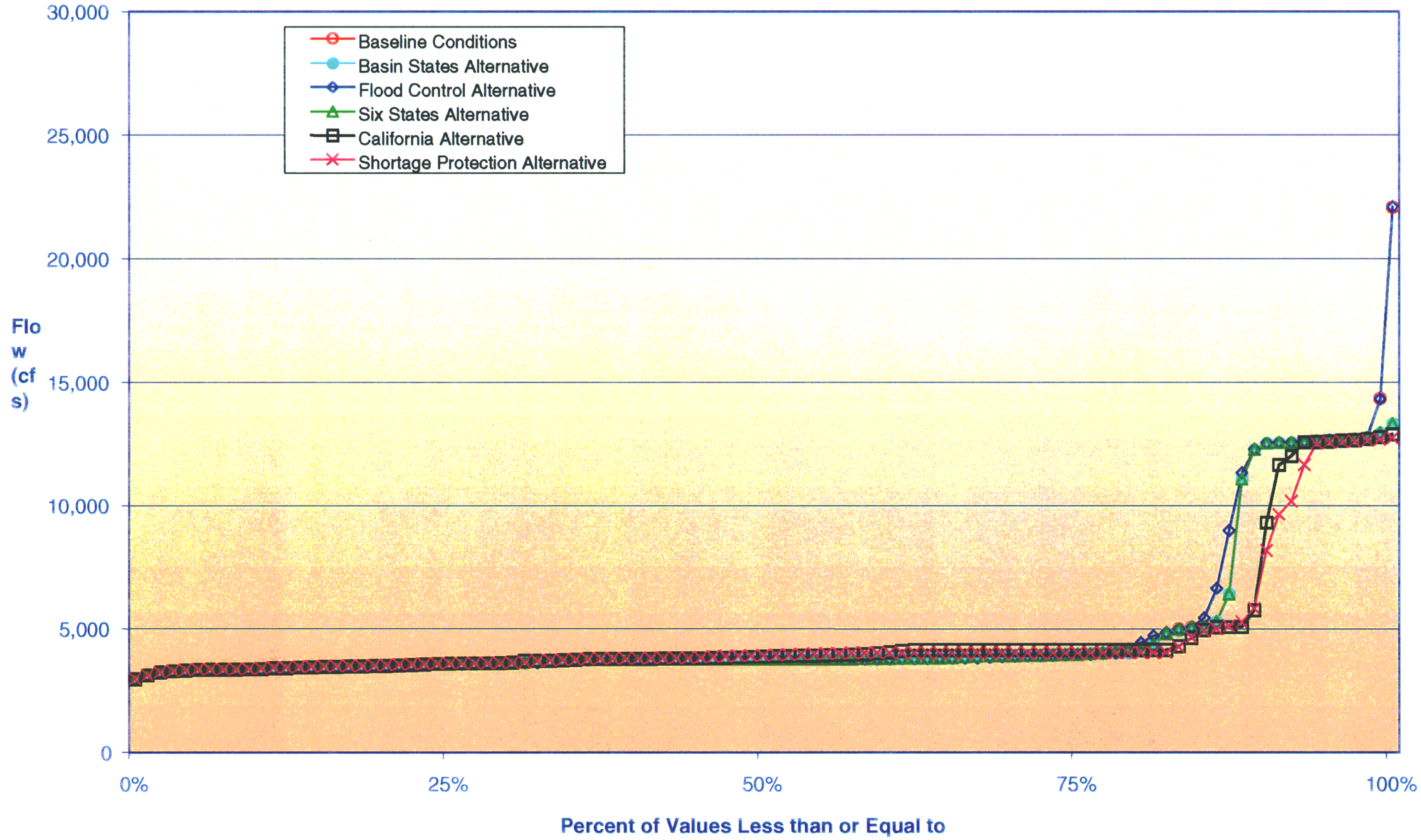


Figure 3.3-23b
Colorado River Seasonal Flows Upstream of Colorado River Indian Reservation
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

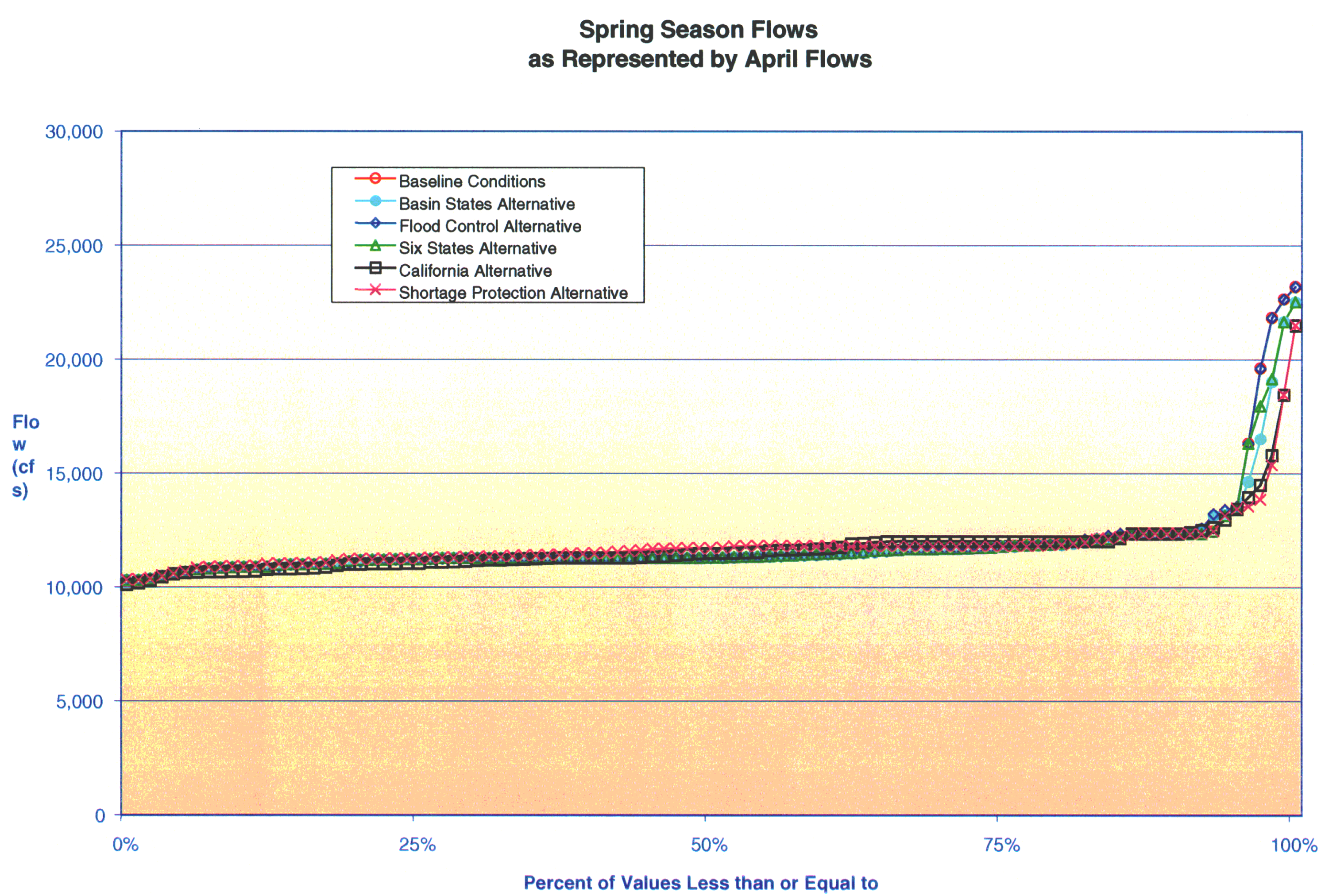


Figure 3.3-23c
Colorado River Seasonal Flows Upstream of Colorado River Indian Reservation
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

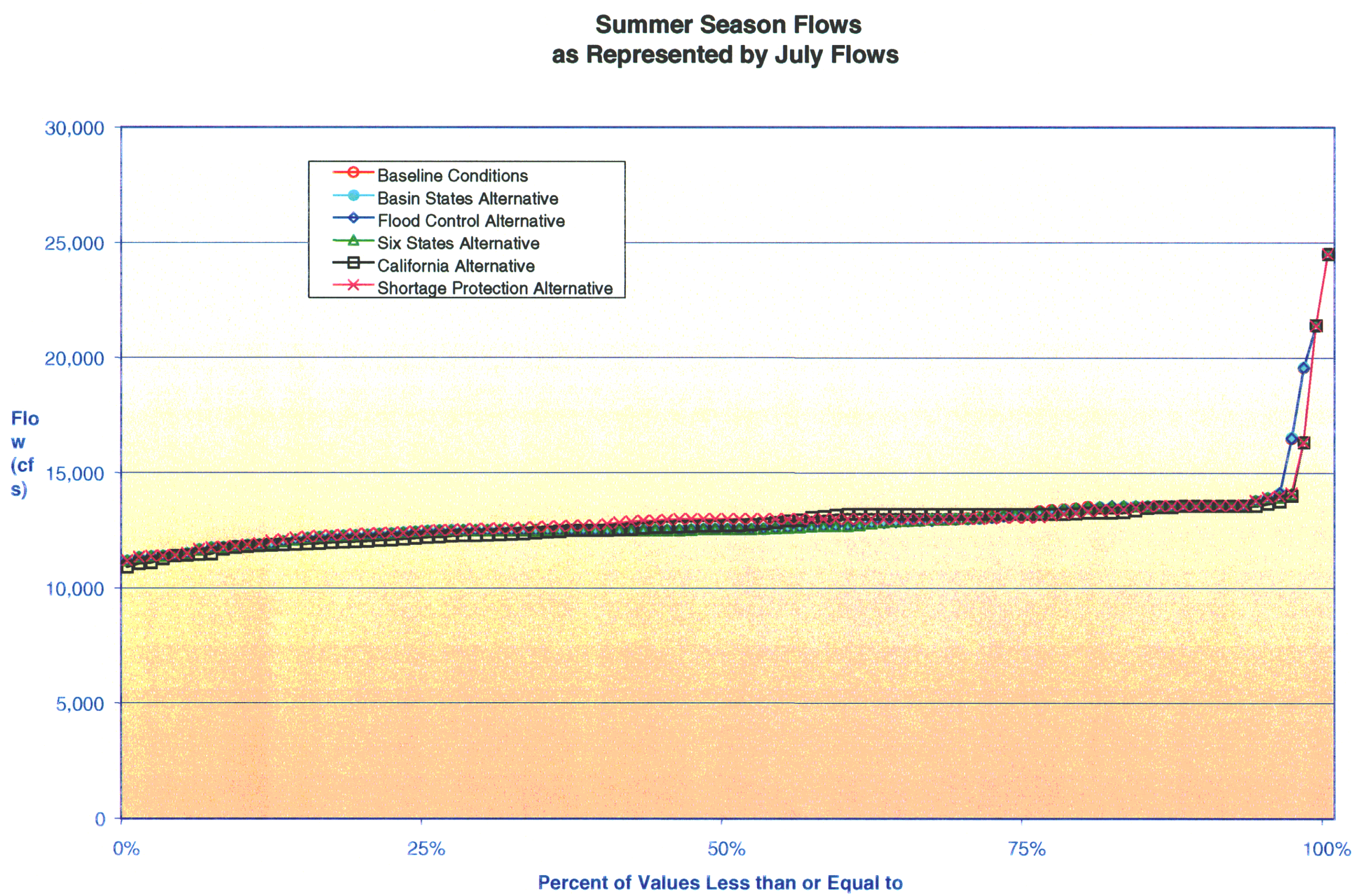
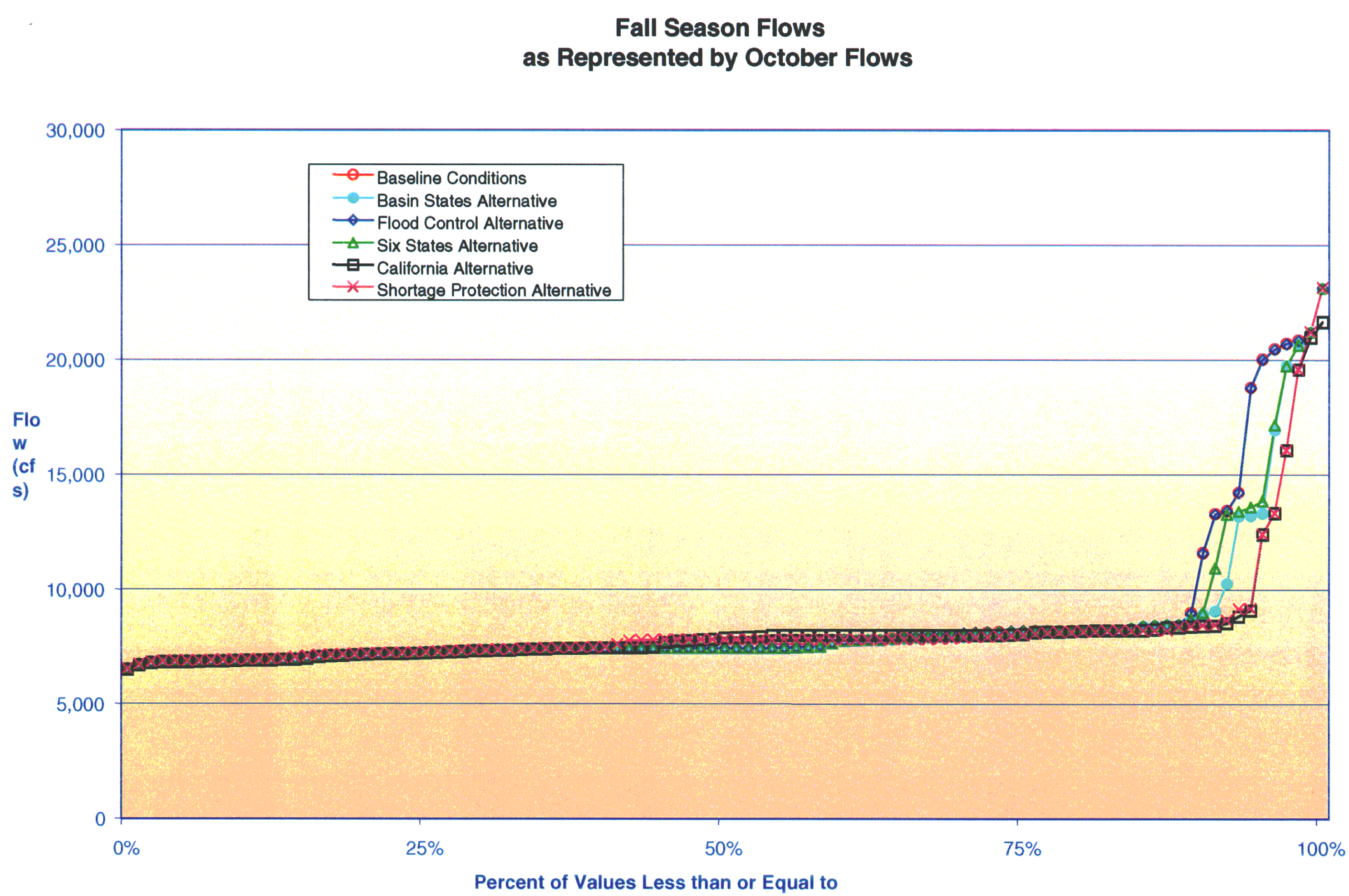


Figure 3.3-23d
Colorado River Seasonal Flows Upstream of Colorado River Indian Reservation
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016



3.3.4.5.3 River Flows Between Palo Verde Diversion Dam and Imperial Dam

The flow of the Colorado River between Palo Verde Diversion Dam and Imperial Dam is normally set at the amount needed to meet the United States diversion requirements downstream of the Palo Verde Diversion plus deliveries to Mexico. The river location that was modeled for this reach of the river is located immediately downstream of the Palo Verde Diversion Dam.

As discussed in Section 3.3.4.5.2, the proposed California water interstate transfers are included in the simulation of the baseline conditions and surplus alternatives.

The 90th, 50th, and 10th percentile annual flow volumes for this reach are shown in Figure 3.3-24. As shown by the 50th percentile values, annual flow volumes in this reach can be expected to be greater for the California and Shortage Protection alternatives than for the baseline conditions for the first few years of the 15-year interim surplus criteria period. This is a result of more frequent surplus deliveries. The largest increases from baseline conditions occur under the California Alternative and are approximately eight percent during the years 2002 through 2007. After 2007, the annual flow volumes are identical to the baseline conditions. Annual flow volumes under the Shortage Protection Alternative are approximately five percent during the years 2002 through 2011. After 2011, the annual flow volumes are identical to the baseline conditions. Results for the Flood Control, Six States, and Basin States alternatives are identical to those under the baseline conditions for the entire period (2002 through 2050).

At the 10th percentile level, the California Alternative has the same relative difference (eight percent) for the years 2002 and 2003, while the Shortage Protection Alternative exhibits the same relative difference (five percent) for the years 2002 through 2005. All other results are identical to those observed for the 50th percentile values.

At the 90th percentile level, all surplus alternatives (except for the Flood Control Alternative) show annual flow volumes less than or equal to the flows under the baseline conditions. This is the result of more frequent surplus deliveries, which tend to lower Lake Mead reservoir levels. With lower reservoir levels, the frequency of flood control events (which contribute most of the flows at the 90th percentile level) is decreased, which in turn decreases the annual flow volume for a given percentile. The California and Shortage Protection alternatives exhibit the largest decreases, ranging from approximately 17 percent less than baseline conditions in 2006 to four percent less by 2023. Results for the Six States and Basin States alternatives are similar to each other, ranging from approximately 11 percent less than baseline conditions in 2016 to four percent less by 2023.

In Figure 3.3-25, the cumulative distribution of annual flow volumes is shown for year 2006. This is the year of the largest differences at the 90th percentile level as shown in Figure 3.3-24. Although the annual flow volumes decrease for all surplus alternatives (except Flood Control Alternative) at a fixed percentile (i.e. at the 90th percentile) as compared to baseline, the range of annual flow volumes are the same for baseline conditions and the surplus alternatives. The frequency that a flow of a specific magnitude will occur, however, is lower under the surplus alternatives (except for the Flood Control Alternative) as shown in Figure 3.3-25.

Figures 3.3-26 (a-d) present comparisons of the representative seasonal flows under baseline conditions and the surplus alternatives for 2016. As expected, the largest flows occur in the spring and summer seasons for baseline conditions and all alternatives due to downstream irrigation demands. For flows that are due primarily to flood control releases from Lake Mead (flows in the 90th – 100th percentile range), the range of mean monthly flows is not changed by the different surplus alternatives, since these magnitudes are dictated by the flood control regulations. These flows occur, however, less often for the surplus alternatives (except the Flood Control Alternative). This effect is less pronounced in July, when most flood control releases have ceased.

The differences in flows not due to flood control releases are similar for all alternatives and baseline conditions. A numerical comparison are the 70th percentile values is shown in Table 3.3-15. The differences in mean monthly flows for the California Alternative compared to baseline conditions are approximately 10 percent in the winter, seven percent in the spring, six percent in the summer, and eight percent in the fall. For the Basin States Alternative, the mean monthly flows are identical to those under baseline conditions for all seasons.

Table 3.3-15
Comparison of Mean Monthly Flow (cfs) – Baseline Conditions and Surplus Alternatives
Colorado River Downstream of Palo Verde Diversion Dam (River Mile = 133.8)
70th Percentile Values for Year 2016

Season	Mean Monthly Flows (cfs) for Year 2016 at the 70th Percentile					
	Baseline	Basin States	Flood Control	Six States	California	Shortage Protection
Winter	3516	3516	3516	3516	3865	3760
Spring	9888	9888	9888	9888	10608	10392
Summer	10729	10729	10729	10729	11426	11217
Fall	7191	7191	7191	7191	7749	7582

Figure 3.3-24
Colorado River Downstream Palo Verde Diversion Dam Annual Flow Volume (af)
Comparison of Surplus Alternatives to Baseline Conditions
90th, 50th and 10th Percentile Values

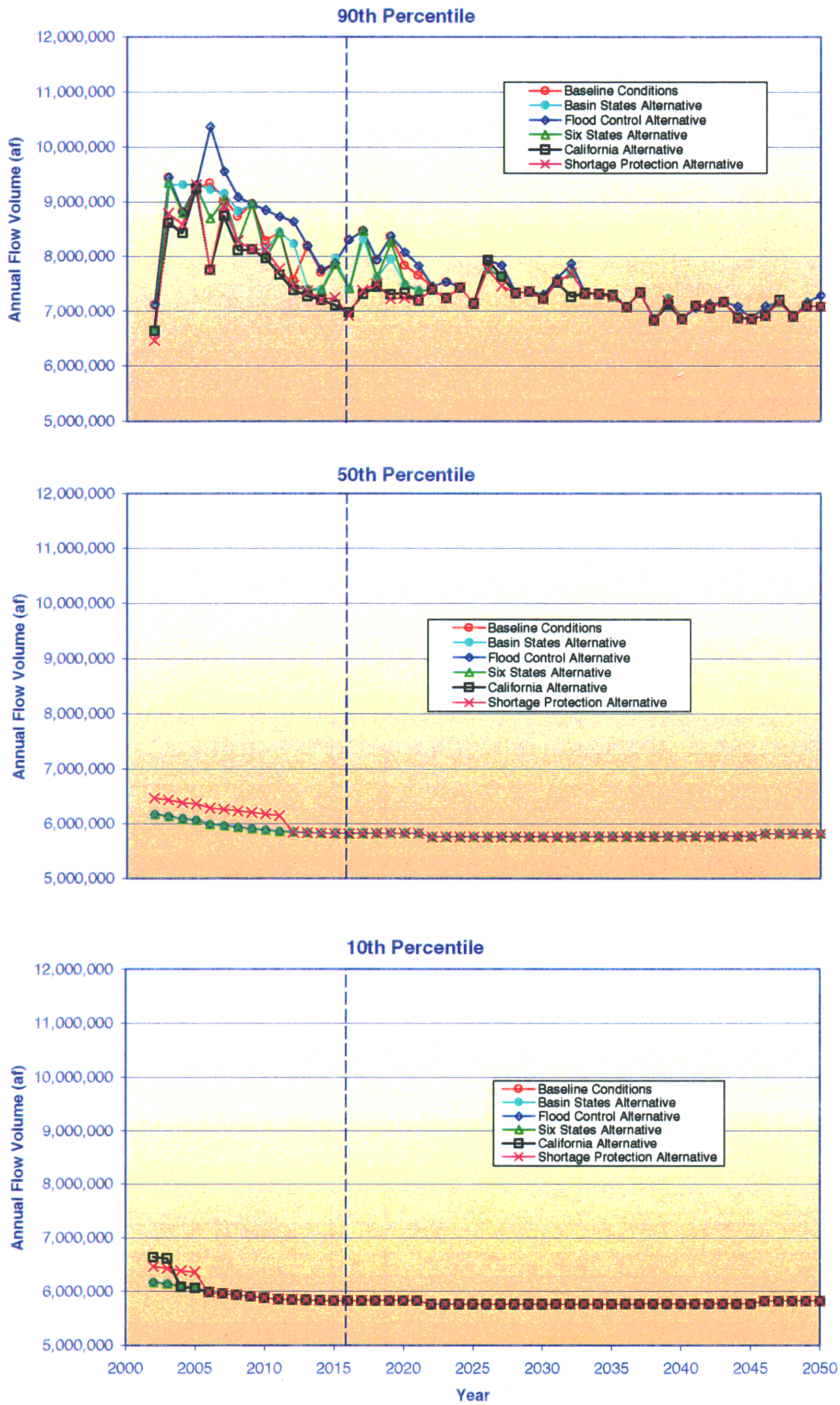


Figure 3.3-25
Colorado River Annual Flow Volumes Downstream of Palo Verde Irrigation Diversion
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2006

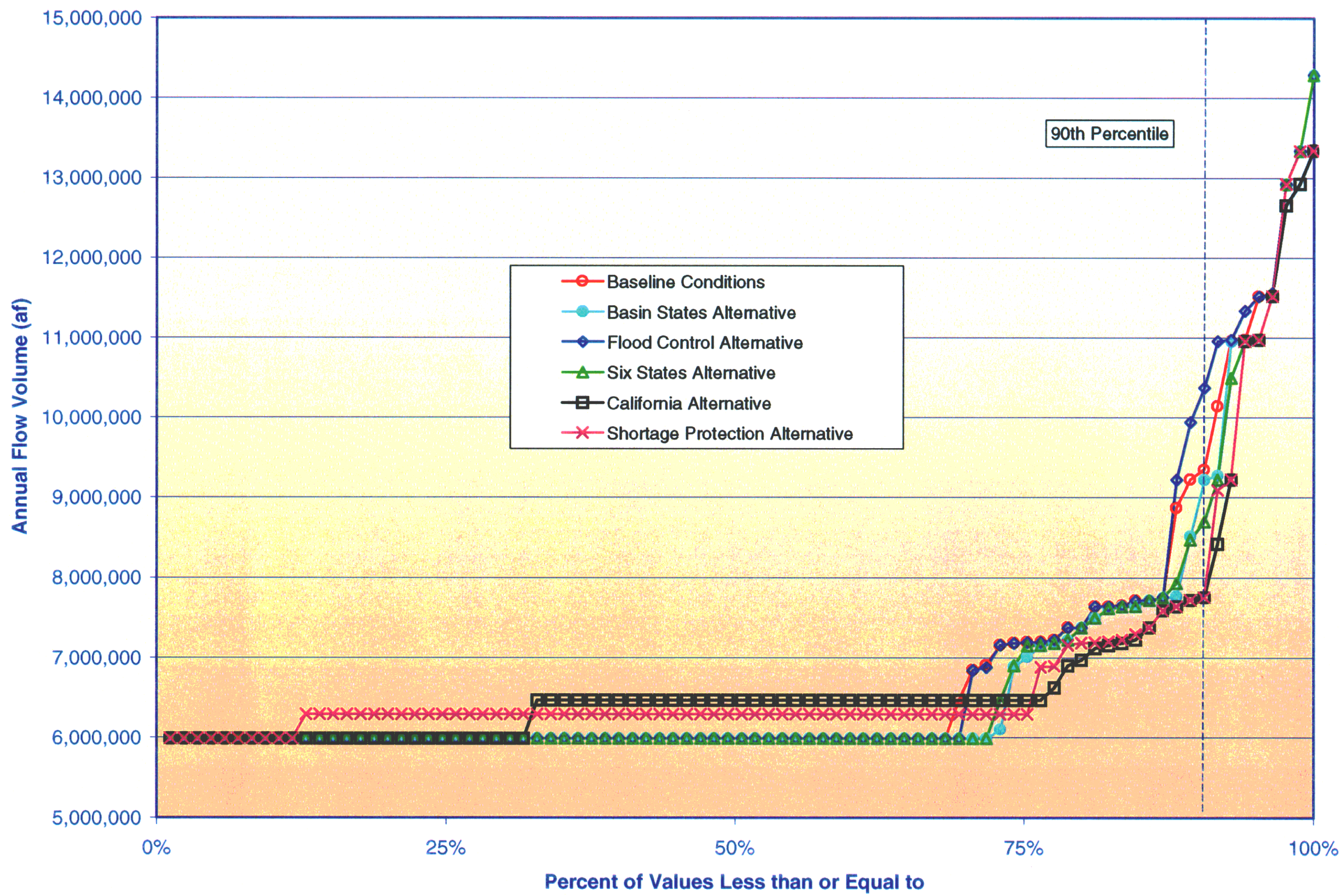


Figure 3.3-26a
Colorado River Seasonal Flows Downstream of Palo Verde Diversion Division
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

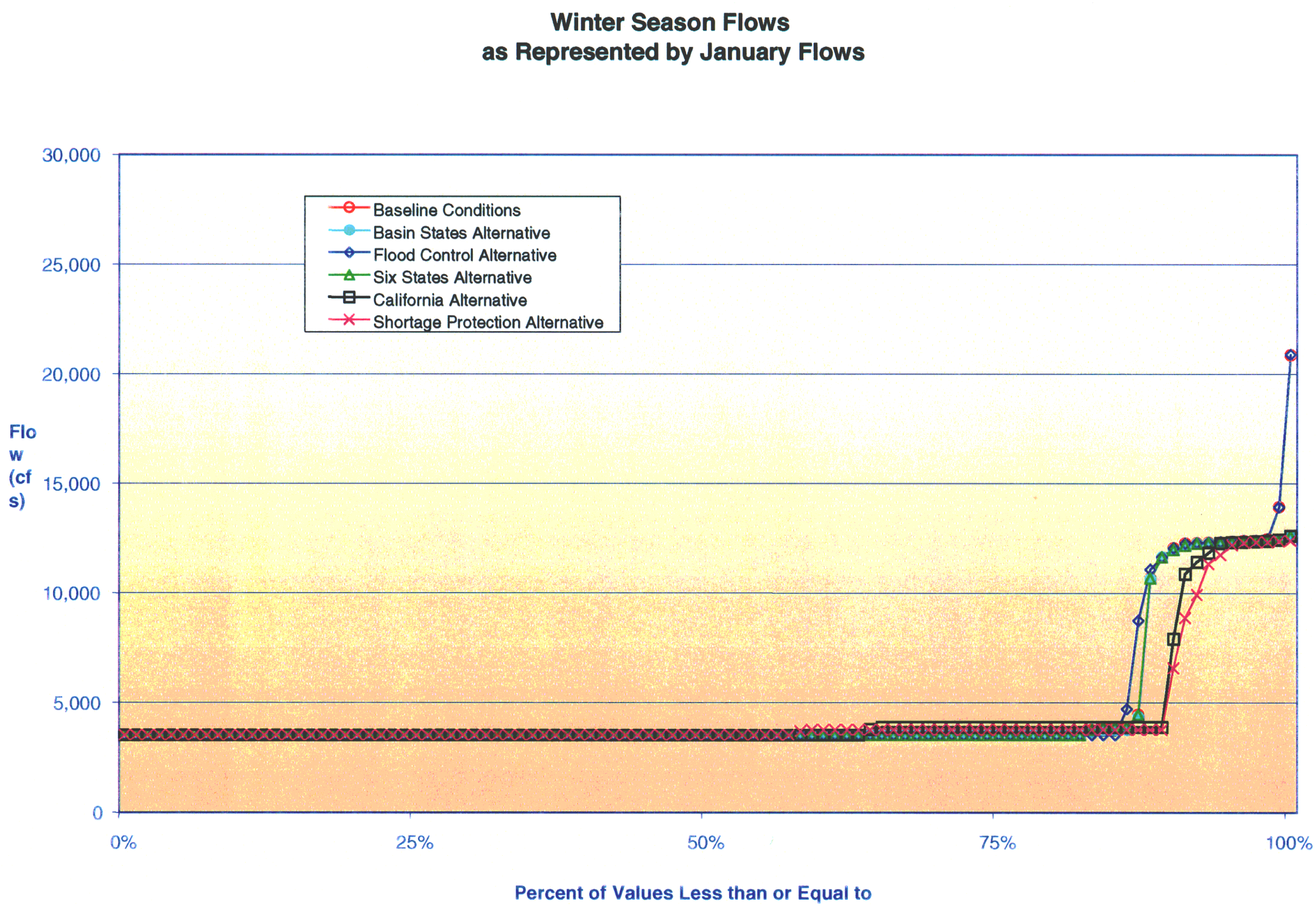


Figure 3.3-26b
Colorado River Seasonal Flows Downstream of Palo Verde Diversion Division
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

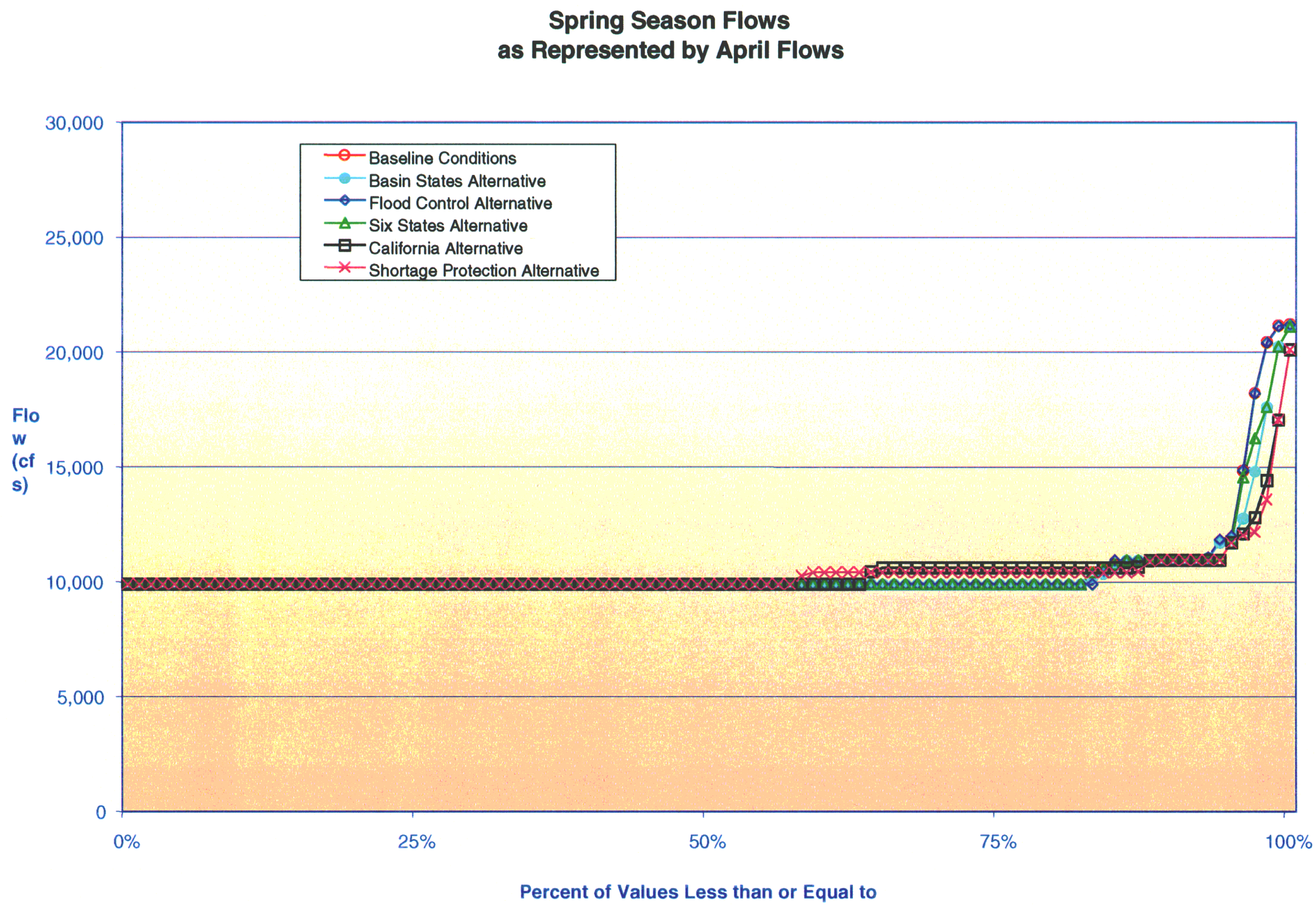


Figure 3.3-26c
Colorado River Seasonal Flows Downstream of Palo Verde Diversion Division
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

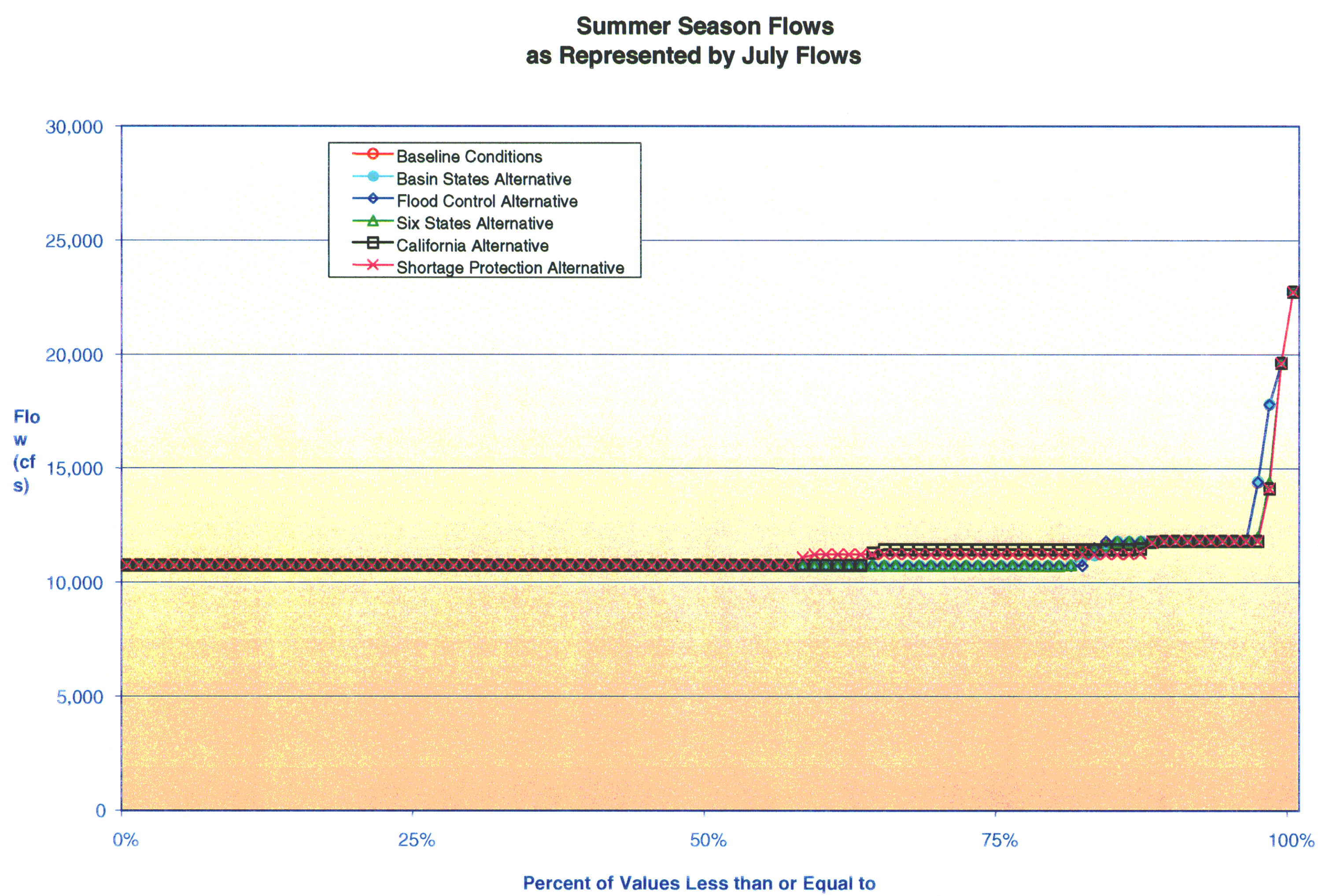
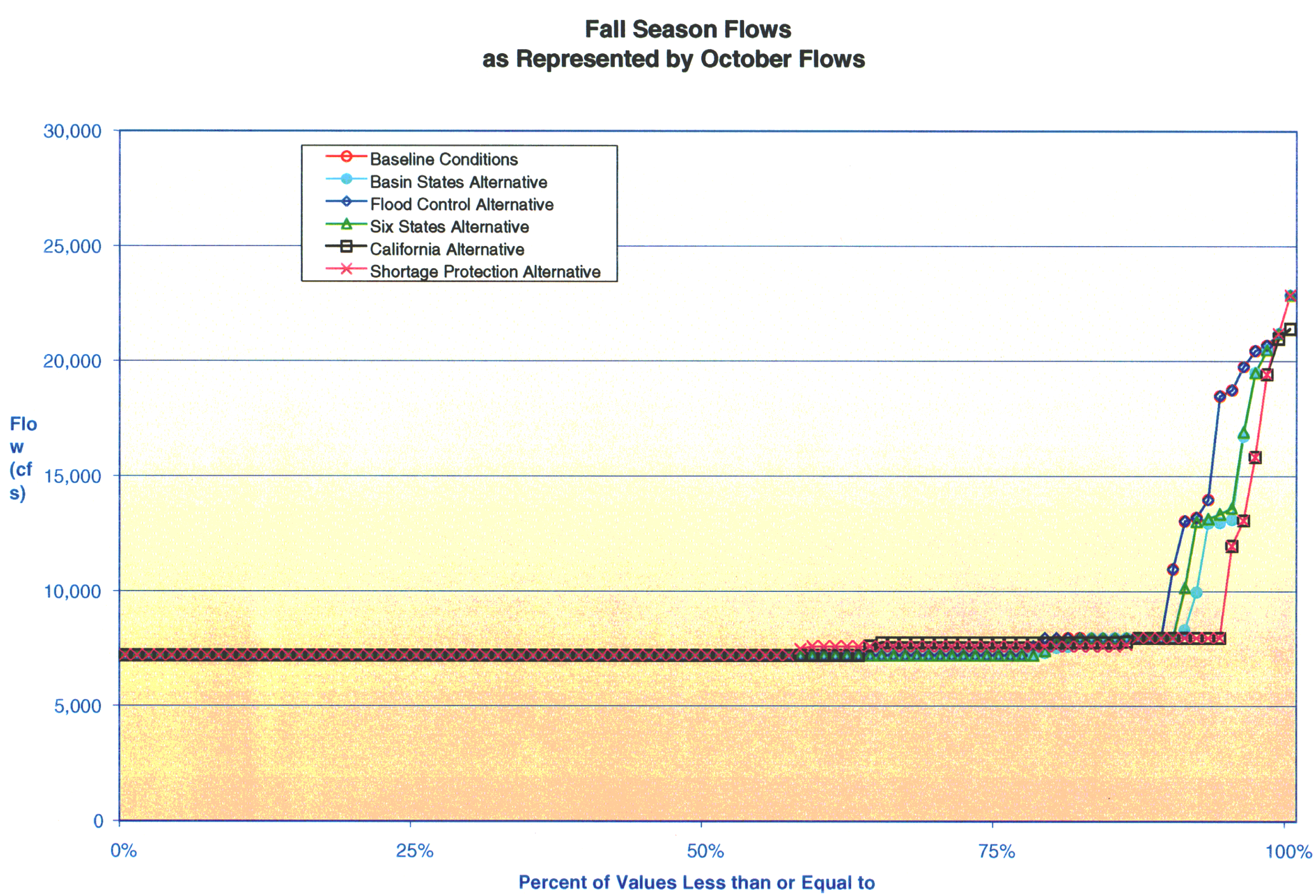


Figure 3.3-26d
Colorado River Seasonal Flows Downstream of Palo Verde Diversion Division
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016



3.3.4.5.4 River Flows Between Imperial Dam and Morelos Dam

The flows in the Colorado River below Imperial Dam are primarily comprised of the water delivered to Mexico in accordance with the Treaty. Mexico's principal diversion is at Morelos Dam, which is located, approximately nine miles southwest of Yuma, Arizona. Mexico owns, operates, and maintains Morelos Dam.

The reach of river between Morelos Dam and the SIB is commonly referred to by Reclamation as the Limitrophe Division. Reclamation's authority in this division is limited to maintaining the bankline road, the levee, various drains to the river, and the U.S. Bypass drain that carries agricultural drainage water to the Cienega de Santa Clara in Mexico. Under International Treaty the United States Section of the IBWC is obligated to maintain the river channel within this division. Reclamation provides assistance to the IBWC, when requested, for maintenance needs in this reach of the river.

Minute 242 (Minutes are defined as decisions of IBWC and signed by the Mexican and United States commissioners) of IBWC and the Mexican Water Treaty of 1944 provide requirements for deliveries at the NIB and SIB near Yuma and San Luis, Arizona, respectively. Up to 140,000 af annually of agricultural drainage water can be delivered to Mexico at the SIB. The remaining 1,360,000 af of water is to be delivered to Mexico at the NIB annually and diverted at Morelos Dam to the Mexicali Valley. For several years after the United States Bypass Drain was completed in 1978, the Colorado River Channel downstream of Morelos Dam was normally dry. Flows below Morelos Dam now occur only when water in excess of Mexico's requirement arrive at the NIB.

Much of the NIB water is diverted at Imperial Dam into the All-American Canal (AAC) where it is returned to the bed of the Colorado River through Siphon Drop and Pilot Knob Powerplants. A portion of the NIB deliveries remains in the river, passing through Imperial and Laguna Dams to Morelos Dam.

Water in excess of Mexico's water order at the NIB is normally passed through Morelos Dam, through the Limitrophe Division, and into the original Colorado River channel downstream. Water in excess of Mexico's water order occurs primarily when flood releases are made from Lake Mead. Excess water arriving at the NIB may also result from flooding on the Gila River, and from operational activities upstream (i.e., cancelled water orders in the United States, maintenance activities, etc.).

In December of each year, Mexico provides to the United States an advance monthly water order for the following calendar year. Normally, this water order can only be changed by providing the United States with written notice, 30 days in advance and each monthly water order can be increased or decreased by no more than 20 percent of the original monthly water order. The Treaty further stipulates that Mexico's total water order must be no less than 900 cfs and no more than 5500 cfs during the months of January, February, October, November and December. During the remainder of the year, Mexico's water order must be no less than 1500 cfs and no more than 5500 cfs. Daily water orders are usually not allowed to increase or decrease by more than 500 cfs.

As discussed in Section 3.3.3.3, the model accounts for the all deliveries to Mexico diversions at the NIB (Morelos Dam). Flows that are modeled downstream of Morelos Dam represent mean monthly flows that are excess flows in the Colorado River due to Lake Mead flood control releases. These excess flows may reach the Colorado River Delta, although Mexico has the authority to divert them for other uses. Such decisions by Mexico are not modeled. The excess flows are over and above Mexico's normal 1.5 mafy water entitlement, plus the 200,000 afy for surplus deliveries.

The 90th, 50th, and 10th percentile annual flow volumes for this reach are shown in Figure 3.3-27. Since these flows are dependent solely upon infrequent flood control releases, no flows are observed at either the 10th or 50th percentiles. At the 90th percentile level, all surplus alternatives (except for the Flood Control Alternative) show annual flow volumes less than or equal to the flows under the baseline conditions. This is the result of more frequent surplus deliveries, which tend to lower Lake Mead reservoir levels. With lower reservoir levels, the frequency of flood control events is decreased, which in turn decreases the annual flow volume for a given percentile. The California and Shortage Protection alternatives exhibit the largest decreases, ranging from approximately 70 percent less than baseline conditions in 2016 to 12 percent less by 2023. Results for the Six States and Basin States alternatives are similar to each other, ranging from approximately 47 percent less than baseline conditions in 2013 to 12 percent less by 2023.

In Figure 3.3-28, the cumulative distribution of annual flow volumes is shown for year 2006. This is the year of the largest differences at the 90th percentile level as shown in Figure 3.3-27. Although the annual flow volumes decrease for all surplus alternatives (except Flood Control Alternative) at a fixed percentile (i.e. at the 90th percentile) as compared to baseline, the range of annual flow volumes are the same for baseline conditions and the surplus alternatives. The frequency that a flow of a specific magnitude will occur, however, is lower under the surplus alternatives (except for the Flood Control Alternative) as shown in Figure 3.3-28.

Additional analysis of annual flow volumes in this reach is presented in Section 3-16.

Figure 3.3-27
Colorado River Below Mexico Diversion at Morelos Dam Annual Flow Volume (af)
Comparison of Surplus Alternatives to Baseline Conditions
90th, 50th and 10th Percentile Values

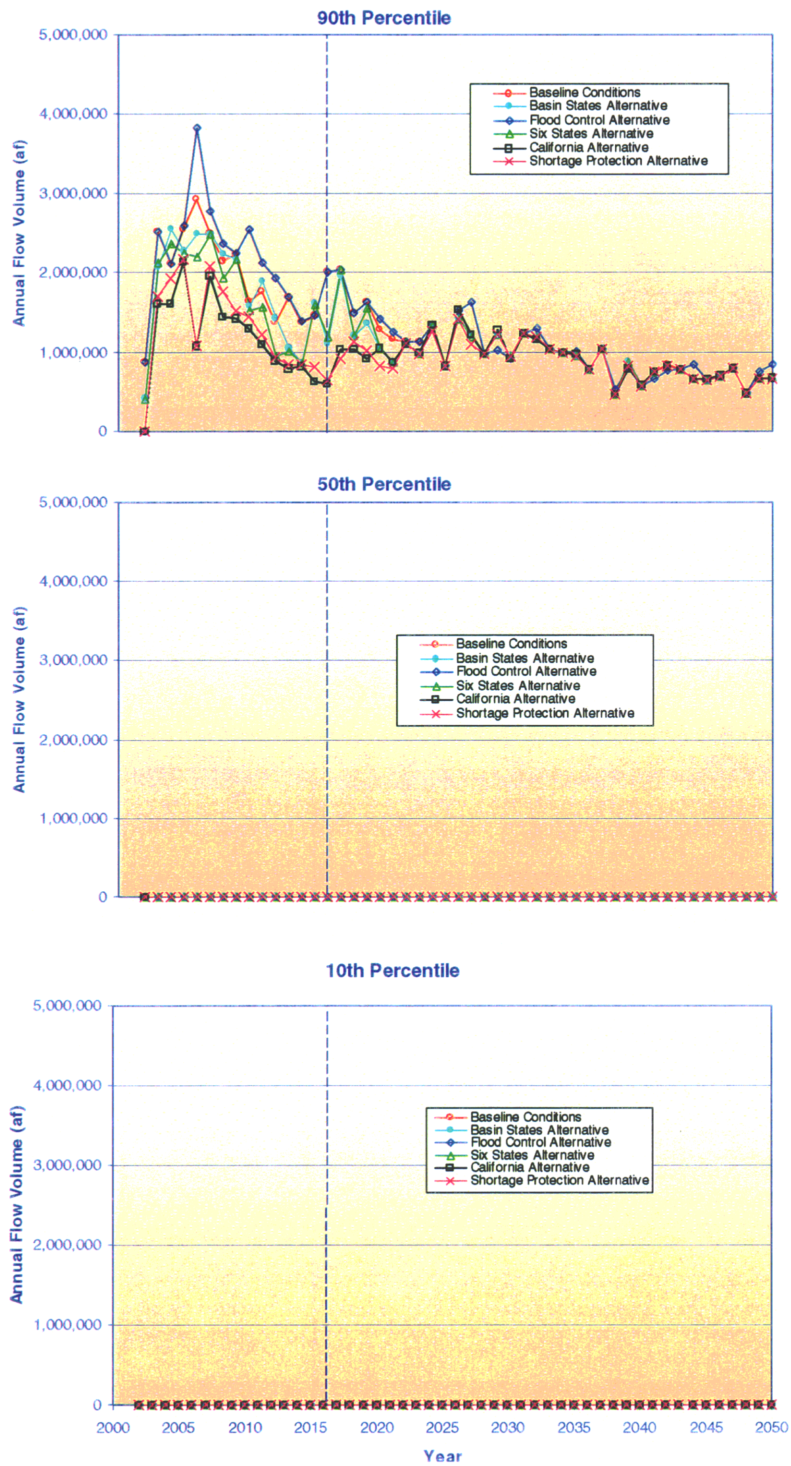
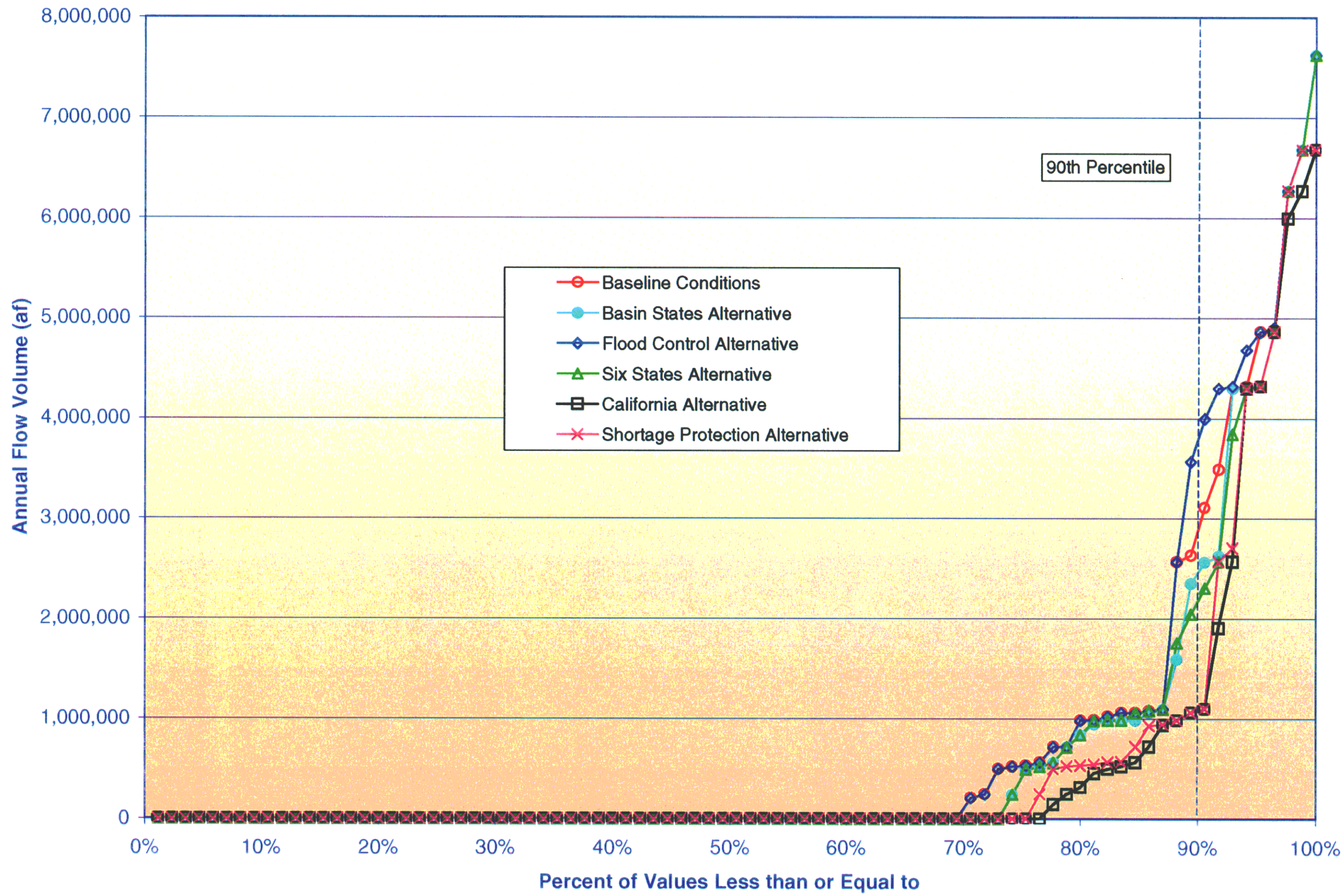


Figure 3.3-28
Colorado River Annual Flow Volumes Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2006



Figures 3.3-29 (a-d) present comparisons of the representative seasonal flows under baseline conditions and the surplus alternatives for 2016. As expected, the only differences are seen for flows that are due to flood control releases from Lake Mead (flows in the 90th – 100th percentile range). As seen in the figures, the range of mean monthly flows is not changed by the different surplus alternatives, since these magnitudes are dictated by the flood control regulations. These flows occur, however, less often for the surplus alternatives (except the Flood Control Alternative). This effect is less pronounced in July, when most flood control releases have ceased.

A numerical comparison of the 90th percentile values is shown in Table 3.3-16. The differences in mean monthly flows for the California Alternative compared to baseline conditions are approximately 51 percent in the winter, zero percent in the , zero percent in the summer, and 100 percent in the fall. For the Basin States alternative, the differences (compared to baseline conditions) in mean monthly flows are approximately one percent in the winter, zero percent in the spring, and zero percent in the summer and 100 percent in the fall seasons. The large fluctuating differences are due to the infrequent nature of these flows and are indicative of the decreased frequency of occurrence due to the interim surplus criteria.

Table 3.3-16
Comparison of Mean Monthly Flow Data – Baseline Conditions and Surplus Alternatives
Colorado River Downstream of Morelos Dam (River Mile = 23.1)
90th Percentile Values (cfs) for Year 2016

Season	Mean Monthly Flows (cfs) for Year 2016 at the 70th Percentile					
	Baseline	Basin States	Flood Control	Six States	California	Shortage Protection
Winter	8125	8052	8125	8052	3983	2706
Spring	0	0	0	0	0	0
Summer	0	0	0	0	0	0
Fall	3007	0	3007	0	0	0

Figure 3.3-29a
Colorado River Seasonal Flows Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

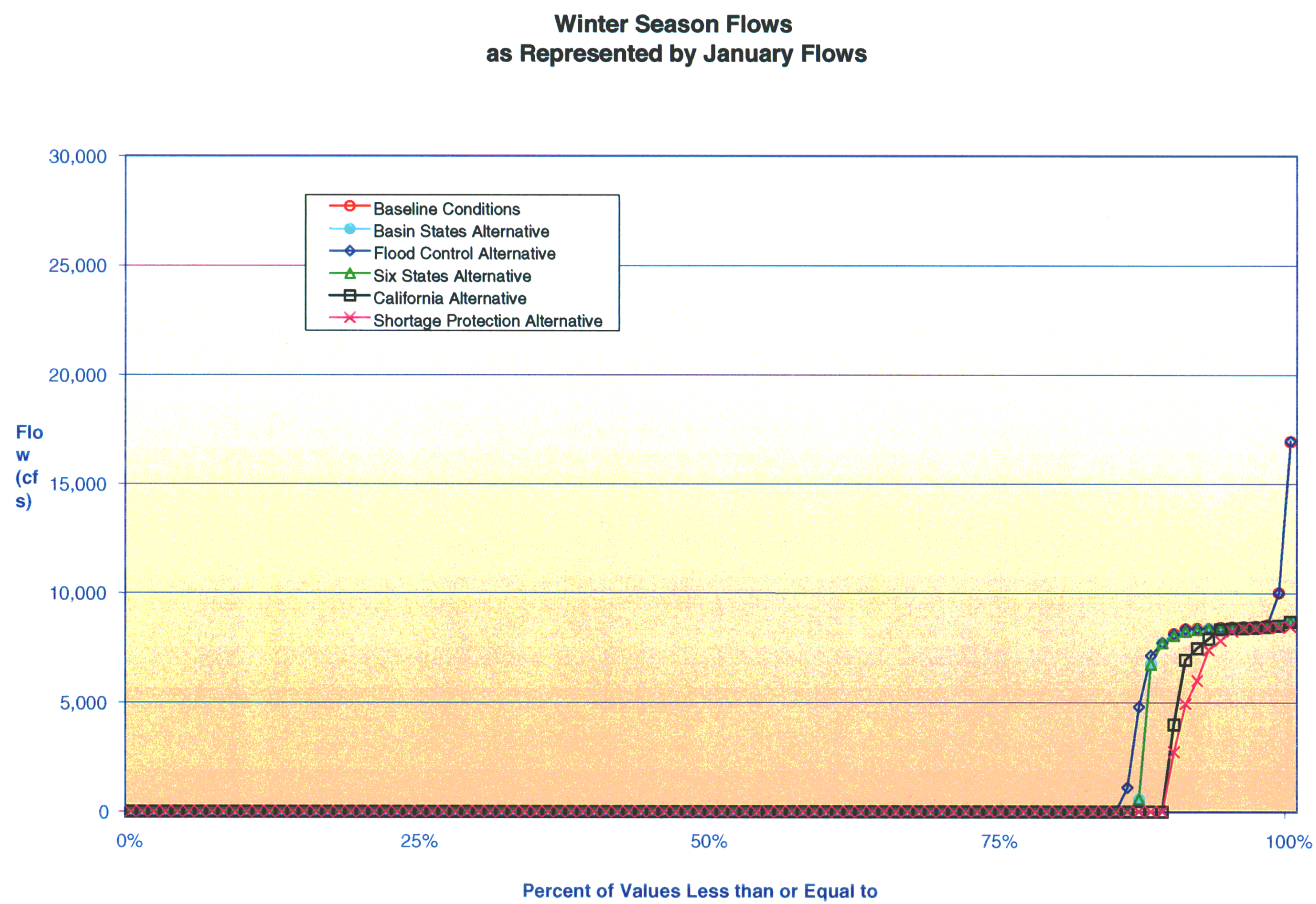


Figure 3.3-29b
Colorado River Seasonal Flows Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

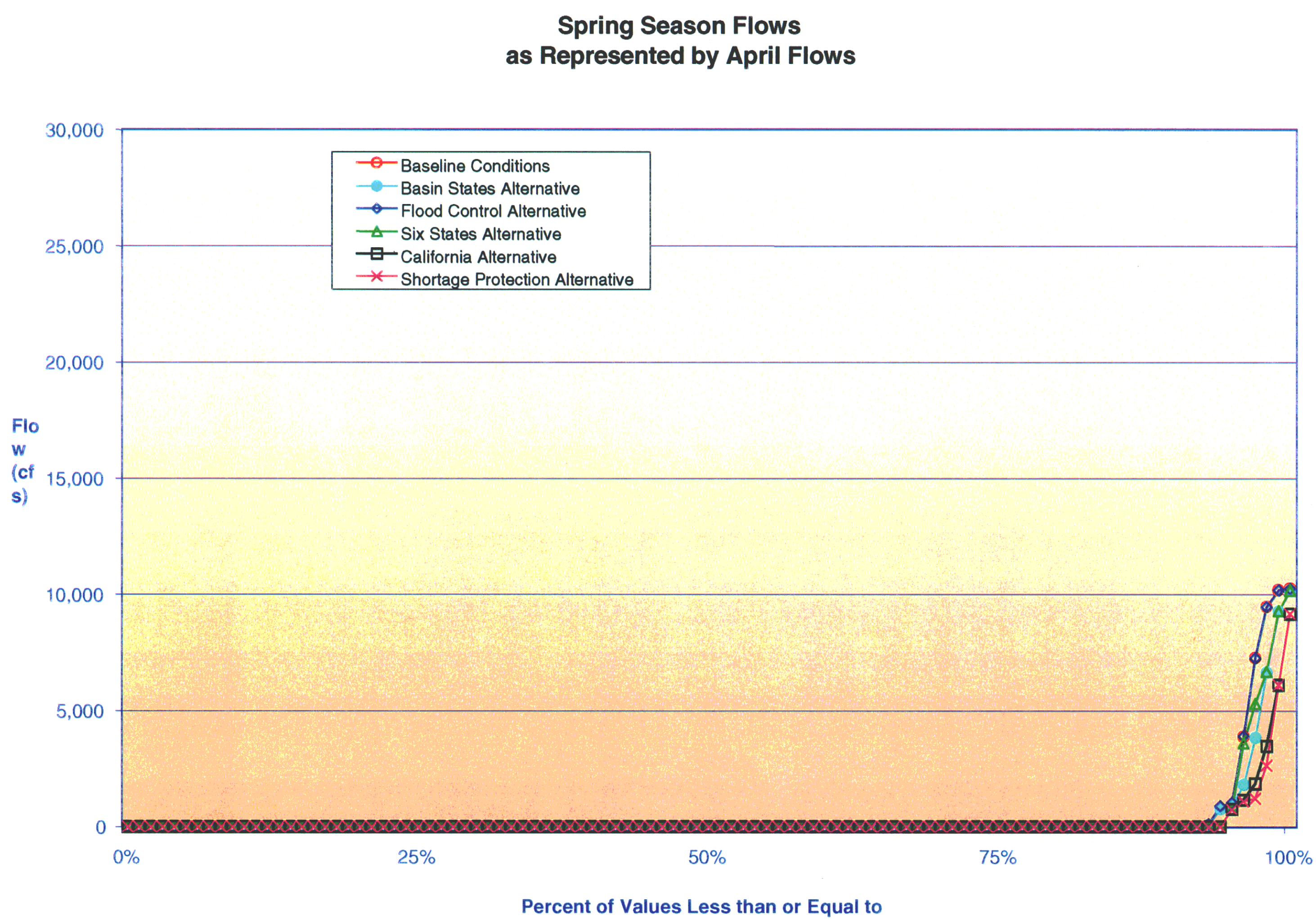


Figure 3.3-29c
Colorado River Seasonal Flows Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

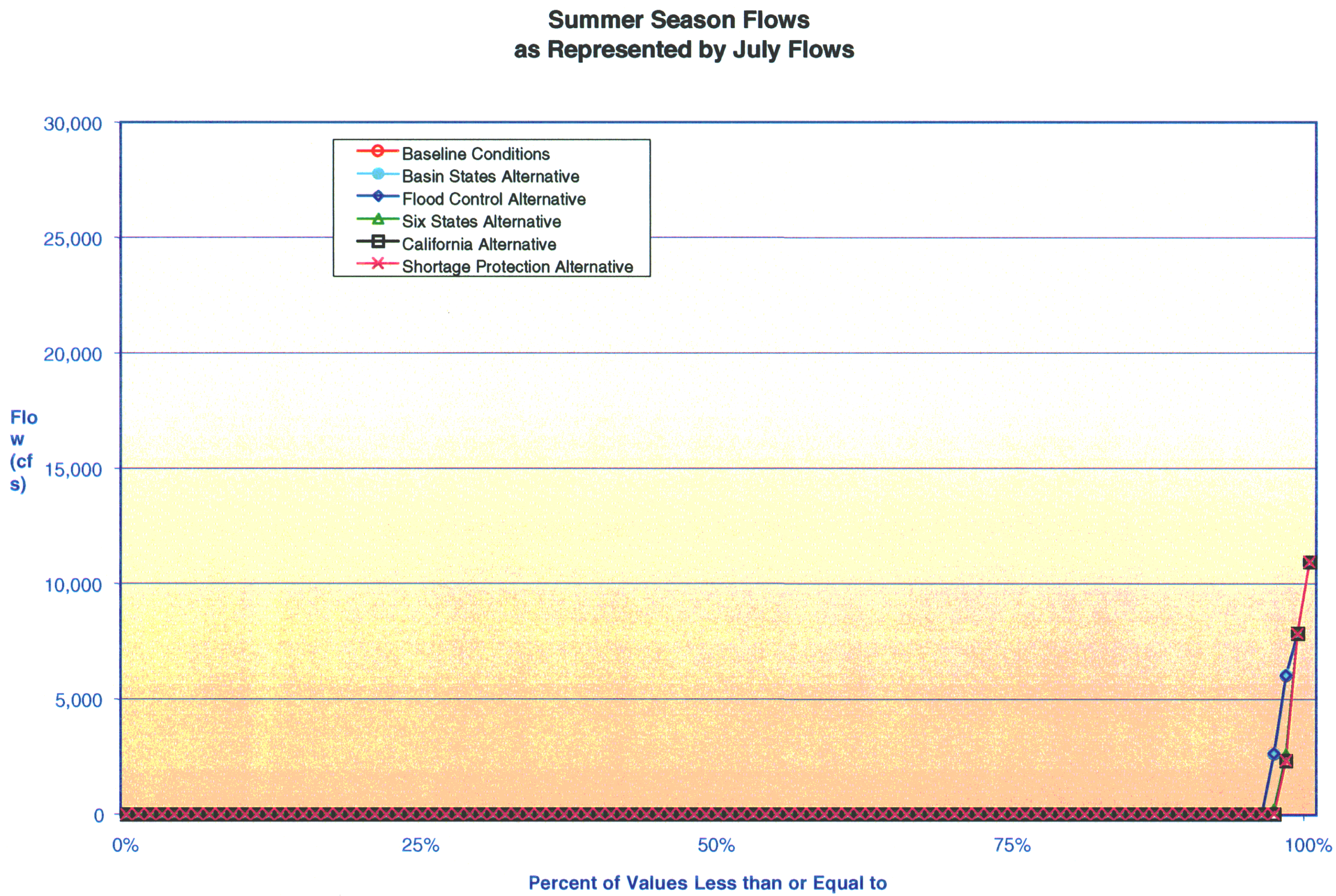
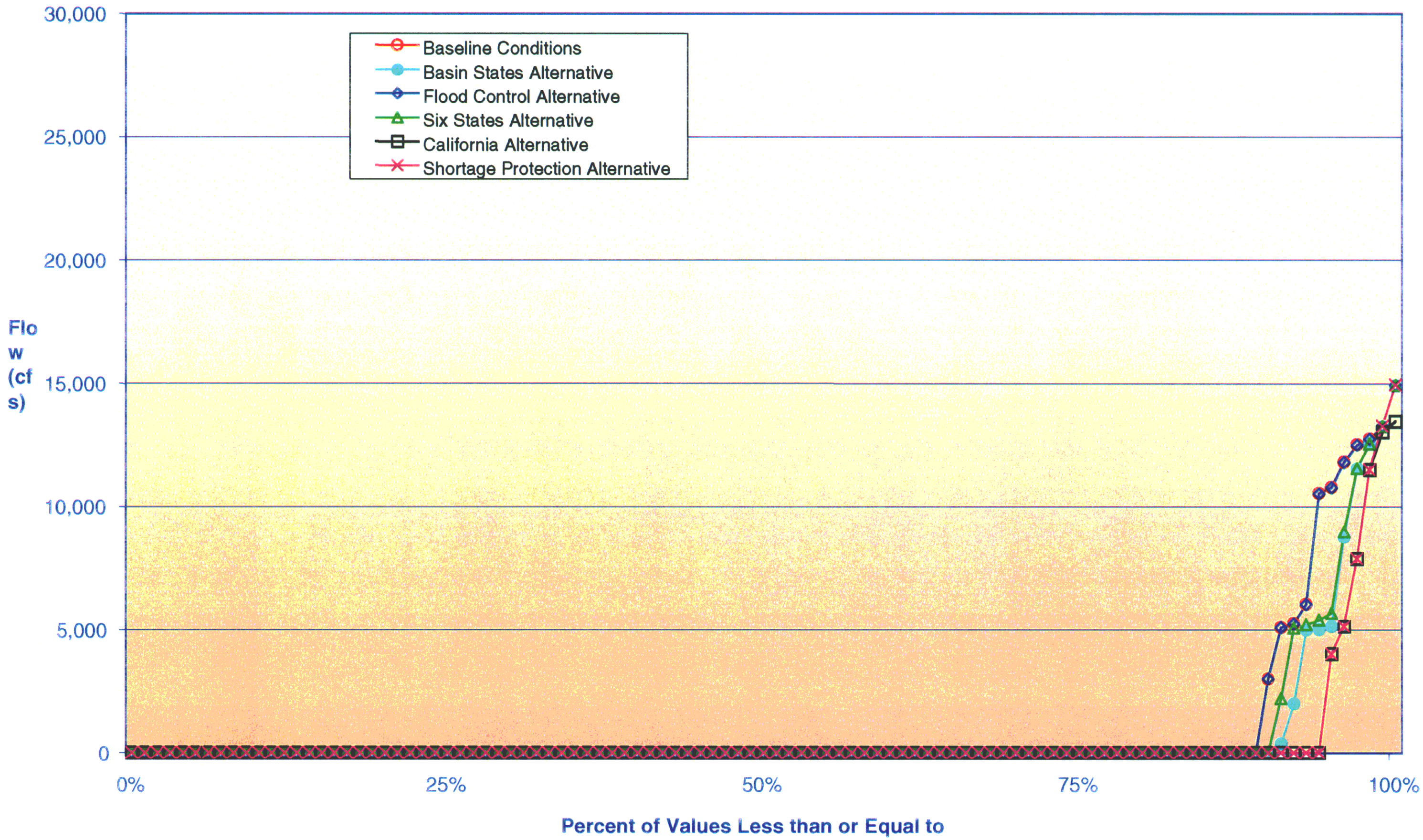


Figure 3.3-29d
Colorado River Seasonal Flows Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

Fall Season Flows
as Represented by October Flows



3.4 WATER SUPPLY

3.4.1 INTRODUCTION

This section discusses the water supply available to the Lower Division states and Mexico under baseline conditions and the interim surplus criteria alternatives. It provides an evaluation of the effectiveness of meeting the water delivery objectives previously articulated by the Lower Division states and notes the states' contingency plans in the event of shortages. Water supply deliveries are the deliveries of Colorado River water by Reclamation 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 1.3.4.1.

3.4.2 METHODOLOGY

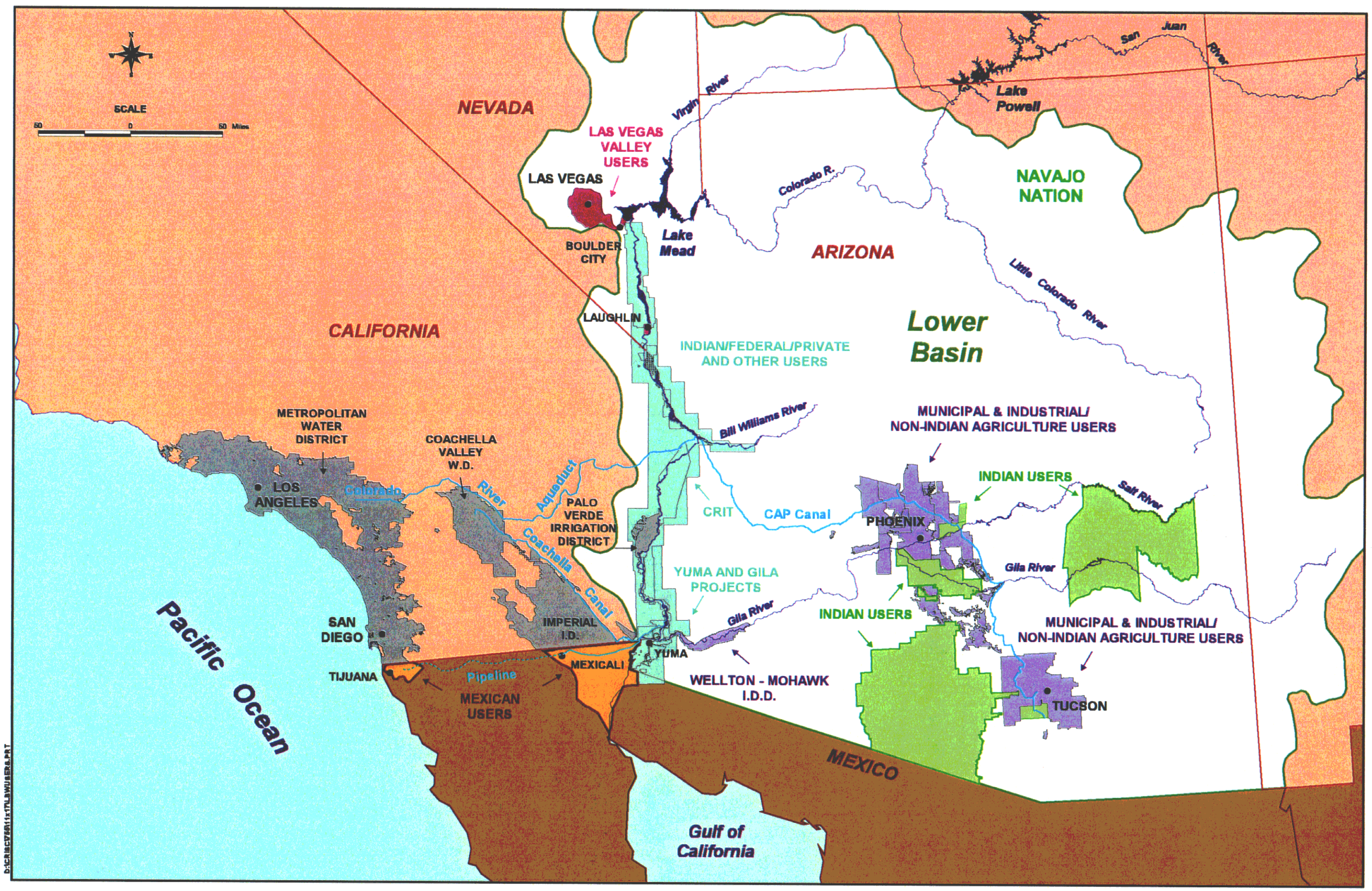
The model was used to produce estimates of future water supply deliveries for the Lower Division states and Mexico under the modeled hydrologic conditions. The modeled water demands of the Lower Division states reflect demand projections provided by the water users as described in Section 3.3.3. A copy of the demand schedules used to model the Lower Division states' depletions is included in Attachment H. The demand schedule used to model the Upper Division states' depletions is included in Attachment K.

The output from each model run included monthly and annual diversions, return flows and depletions for the Colorado River water users in af. The water supply data was analyzed using statistical methods and focused upon the comparison of the model results of the surplus alternatives to baseline conditions. See Section 3.3 for a further explanation of the modeling process.

3.4.3 AFFECTED ENVIRONMENT

The affected environment for water supply consists of the Colorado River from Lake Powell to the SIB, including the mainstream reservoirs. Geographically, the affected environment is bounded by the reservoir shorelines at maximum reservoir levels and the 100-year flood plain of the affected intervening sections of the Colorado River. This zone includes all the diversion points for water users in the Lower Division states and Mexico. Map 3.4-1 presents the water service areas in the Colorado River Lower Basin.

Map 3.4-1
Colorado River Water Service Areas in the Lower Basin



3.4.3.1 WATER USE PROJECTION PROCESS

Three Colorado River water supply conditions are recognized in the operation of the river system: surplus, normal and shortage conditions, as discussed in Section 1.3.4.1. The Basin States provided Reclamation with revised estimates of projected water use under each of the three water supply conditions for use in the modeling for this FEIS. Copies of the depletion schedules used to model the Upper and Lower Division states' demands are presented in Attachments K and H, respectively. Second level shortage amounts are computed within the model as described in Section 3.3.3.4. The states' requests are distributed among the major diversion points along the river system. The projections for normal water supply conditions reflect each state's water supply apportionment from the Colorado River.

3.4.3.2 STATE OF ARIZONA

The portions of Arizona in the Lower Basin that depend on Colorado River mainstream water consist of the following areas:

- The lower Colorado River from Lake Mead to the SIB;
- The Gila River Valley upstream from Yuma, Arizona; and
- A large area in the central part of the state served by facilities of the CAP.

Under the BCPA and the Decree, Arizona receives on annual apportionment of 2.8 maf from the Lower Division states' total of 7.5 maf.

In addition, Arizona can also use up to 50,000 afy of water pumped from Lake Powell under the State's Upper Basin apportionment. Numerous districts and other entities that divert and distribute the water administer the contractual arrangements for the use of Colorado River water in Arizona. The Central Arizona Water Conservation District (CAWCD) administers the CAP water diversions. The Director of the Arizona Department of Water Resources has state statutory authority to represent the state in Colorado River water supply matters.

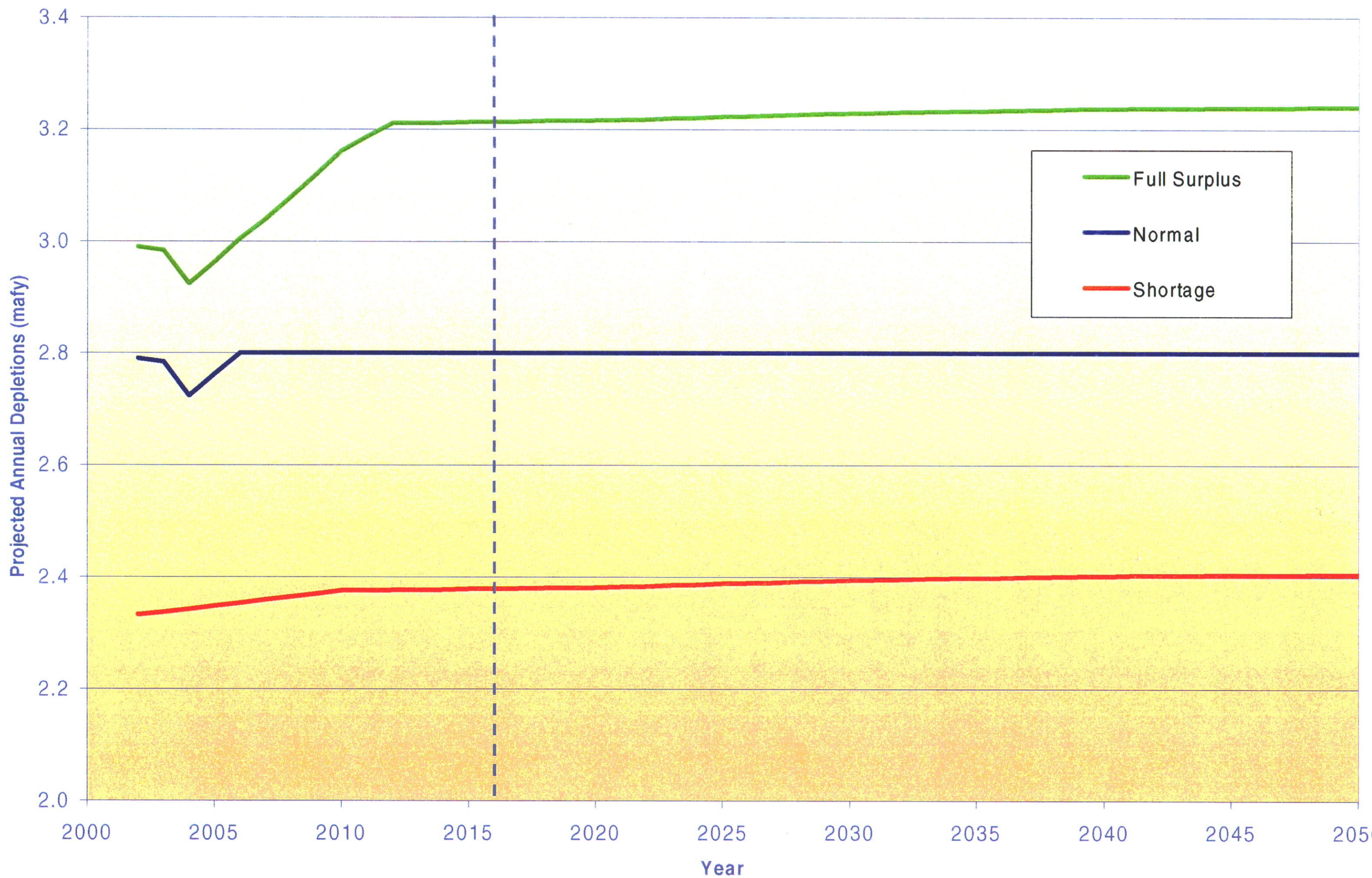
Arizona established the Arizona Water Banking Authority (AWBA) in 1996. The state legislation that authorized the AWBA states that it was created: 1) to increase Arizona's use of Colorado River water by delivering though the CAP system and storing water that otherwise would be unused by Arizona; 2) to ensure an adequate water supply to CAP municipal and industrial (M&I) users in times of shortages or disruptions of the CAP system; 3) to meet water management plan objectives of the Arizona state groundwater code; 4) to assist in settling Indian water rights claims; and 5) to provide an opportunity for authorized agencies in California and Nevada to store unused Colorado River water in Arizona for future use.

Arizona has numerous users of Colorado River water. The largest diversion of water is the CAP that delivers water to contractors in the central part of the state. CAP's diversion is located at Lake Havasu. The next three largest diversions are those of the Colorado River Indian Reservation at Headgate Rock Dam and the Gila and Yuma Projects, whose diversions are located at Imperial Dam. The remaining diversions serve irrigated areas and community development along the river corridor, including lands of the Fort Mojave Indian Reservation, water used by federal agencies in Arizona, the cities of Bullhead, Lake Havasu and Parker, Mojave Valley Irrigation District and Cibola Irrigation District. A portion of the water from the river corridor is also diverted by wells located along the river.

The CAP and other fourth priority Arizona users that contracted for Colorado River water after September 30, 1968, have the lowest priority. The exceptions are lower priority contractors that contracted for unused normal year entitlement and surplus year supplies when available. Included in the CAP category are Bullhead City, Lake Havasu City, Mojave Valley Irrigation District and others. For the most part, the non-CAP contracts total 164,652 afy. The non-CAP users include present perfected rights or other rights that predate the BCPA and users that contracted before September 30, 1968.

Under shortage conditions, initial shortages in the United States would be shared between Nevada and Arizona on a four and 96 percent basis, respectively. Within Arizona, if any use of water was occurring under contracts for unused entitlement, that use would be the first eliminated under shortage conditions. Any remaining reduction in Arizona would be shared prorata among the CAP and the non-CAP holders of fourth priority entitlements. More severe shortages would result in holders of higher priority entitlements having to incur reduction in their water use. For this FEIS, the analysis of Arizona's water supply under baseline conditions and the interim surplus criteria alternatives has been limited to an analysis of the effects of water availability on total Arizona diversions. Figure 3.4-1 presents a graphical illustration of Arizona's normal, full surplus and first level shortage condition depletion schedules that were used as input for the model. These data are presented in tabular form in Attachment H.

Figure 3.4-1
Arizona Projected Colorado River Water Demand Schedules
(Full Surplus, Normal and Shortage Water Supply Conditions)



Arizona's consumptive use of Colorado River water, including that used for groundwater banking, reached its normal year entitlement of 2.8 maf in 1997. However, its consumptive use since then has been less than this amount.

As shown on Figure 3.4-1, Arizona's normal year depletion schedule is projected to reach 2.8 maf in 2006, and remains at that level thereafter. For the modeling, Arizona's unused apportionment in 2002 through 2005 was distributed to MWD (73 percent) and SNWA (27 percent). The CAP's projected normal year depletions are approximately 1.458 maf in 2002 and gradually decrease to 1.395 maf by 2050, which represent approximately one-half of the state's total normal demand. The demands of Arizona's non-CAP users meanwhile increase towards their full apportionment amount as time progresses making up the balance of Arizona's normal 2.8 maf apportionment.

The state's projected full surplus depletions increase from 2.99 maf in 2002 to approximately 3.24 maf in 2050. The projected CAP surplus condition demand rises steadily from 1.658 maf to approximately 1.835 maf in 2012. Thereafter, the CAP surplus condition depletion schedule remains flat at approximately 1.835 maf. First level shortage condition depletions for Arizona increases from 2.332 maf in 2002 to 2.405 maf by 2050.

The modeled Colorado River water deliveries under the baseline conditions and surplus alternatives assumed that all Arizona shortages would be assigned to the CAP, as discussed in Section 3.3.3.4. Although it is recognized that under the current Arizona priority framework there would be some sharing of Arizona shortages between the CAP and users at the same priority, modeling at this level of detail was not necessary to analyze deliveries on a statewide basis.

Arizona's basic strategy for meeting short-term shortages in CAP M&I supply centers on reduced uses for recharge, reduced agricultural deliveries and an increased use of groundwater. In addition to naturally occurring groundwater, Arizona has established a groundwater bank and it is currently actively storing CAP water that is excess to its current needs for future withdrawal. As discussed above, the AWBA administers the groundwater bank. Groundwater banking is occurring with the intent of providing a source for withdrawal during periods when the amount of Colorado River water available for diversion under the CAP priority is curtailed by shortage conditions. Additionally, CAWCD has stored a substantial amount of CAP water in central Arizona.

It is projected that CAP water will be used for groundwater recharge until about 2040 under normal and surplus conditions. This use will be terminated first in case of shortage. For other interim and long term contract users, agriculture has the lowest priority. Therefore, irrigation users will be reduced before CAP M&I or Indian users in case of shortage conditions. Most irrigation users have rights to pump groundwater as a replacement supply. The increased use of the groundwater supplies and the management of the groundwater basins are expected to be consistent with the state's groundwater management goals.

When CAP diversions are limited to 1.0 maf during first-level shortage conditions, the impact before year 2020 would be to both groundwater recharge and agricultural users. After 2020, CAP M&I users would also be impacted by shortage conditions.

3.4.3.3 State of California

The Colorado River supplies about 14 percent of the water used in California by agriculture, industry, commercial businesses and residential customers. All of the Colorado River water used by California is used in the southern California region. Colorado River water is by far the most important source of water for southern California, accounting for over 60 percent of its water supply. During the last several years, the Colorado River has supplied up to 5.2 maf of the 8.4 maf of water used annually in southern California.

Under the BCPA and the Decree, 7.5 maf of Colorado River water is apportioned for consumptive use in the Lower Division states (California, Nevada and Arizona). In 1964, a United States Supreme Court decree established California's normal apportionment of 4.4 maf from within the Lower Division states' 7.5 maf apportionment. The 1979 and 1984 Supplemental Decrees also awarded present perfected water rights to Indian reservations along the Colorado River. The 1964 Decree granted California, Arizona and Nevada respectively 50 percent, 46 percent, and four percent shares of any surplus water the Secretary determines to be available for use by the Lower Division states.

In California, a priority system for the principal parties that claimed rights to Colorado River water was established by the *California Seven-Party Agreement of August 31, 1931.* The priority system allows water apportioned but unused by a senior priority holder to cascade down to the next lower priority. The *Seven-Party Agreement* limits a priority holder's use of this water to beneficial use exclusively on lands within the priority holder's service area. The water transfers that are being proposed to be implemented under California's *Colorado River Water Use Plan* will work within the framework of the *Seven-Party Agreement* and within the framework of the agreements that are executed to carry out those transfers.

Agriculture and present perfected rights have highest priority to about 90 percent of California's entitlement. The balance goes to the MWD, which provides wholesale water service to most of the communities within the southern California coastal plain. California's largest agricultural water agencies that rely on Colorado River water include the IID, Palo Verde Irrigation District (PVID) and the Coachella Valley Water District (CVWD).

Three major structures divert water from the Colorado River to California. Parker Dam impounds Lake Havasu, which supplies water for MWD's Colorado River Aqueduct on the California side of the state line and for the Central Arizona Project on the Arizona side of the state line. Palo Verde Diversion Dam supplies water to PVID's canal system. Imperial Dam diverts water to the All American Canal on the California side of the state line and to the Gila Gravity Main Canal on the Arizona side of the state line. The AAC is used to deliver water to the Yuma Project, IID and the CVWD.

California has relied on the Secretary's release of unused Nevada and Arizona Colorado River apportionments in accordance with Article II(B)(6) of the Decree for more than three decades. In recent years, Nevada and Arizona depletions have approached their apportionment amounts as a result of the completion of the CAP and rapid population growth in these states. Additionally, Arizona has started to bank its water (such as by groundwater storage) to protect against future shortages. As a result, there is currently not enough Nevada and Arizona unused apportionment to meet California's demand. Since 1996, California has received as much as 800,000 af above its annual 4.4 maf normal apportionment due to determinations by the Secretary of surplus conditions on the Colorado River through the AOP process.

The California Department of Water Resources projects that over the next several decades, California's overall demand for water will continue to increase. Urban demand is expected to outweigh projected declines in agricultural demand. For example, the Department's 1993 California Water Plan projected that urban water demand will increase by 60 percent from 1990 to 2020. However, California's ability to access Colorado River water beyond its normal apportionment may be limited for the following two reasons:

- Since Arizona and Nevada will be using their normal apportionment's, California's access to any substantial amount of water above its normal apportionment will depend on surplus determinations by the Secretary on a year-by-year basis. Under current Colorado River system management practices, such determinations are not certain, as they depend on conditions which change each year—namely snowpack runoff and reservoir storage.
- Even with a surplus determination, California's access is limited by the capacity of its delivery systems. Currently, the existing delivery system to urban users—the Colorado River Aqueduct—is operating at near capacity (approximately 1.3 maf per year).

If the amount of Colorado River water available for use in California was limited to the 4.4 maf normal apportionment, the immediate impact would fall mainly on the MWD because much of the allocation to California above normal apportionment now goes to urban users serviced by MWD. MWD (or its customers) would have to look to: 1) other California users of Colorado River water, namely the agriculture agencies, or 2) other sources—such as northern California water supplies—for about 700,000 af of the approximate two maf of MWD's normal annual water deliveries, which ranged between 1.5 maf and 2.6 maf during the 1990s.

California faces other issues that may impact the quantity or quality of the supply of Colorado River water to certain users. In particular, listing of additional endangered bird and fish species could reduce the amount of water available for non-environmental purposes. Also, Colorado River salinity control projects could impact the quantity and quality of future Colorado River water. Both the type of crops produced (high market value crops generally require water that is low in salinity) and the quality of southern California drinking water could change.

The Colorado River Board of California developed a plan for California to live within its normal apportionment of 4.4 maf. The Board's draft plan was previously referred to as the California 4.4 Plan (dated August 11, 1997) and addressed various water supply management issues that are focused on changes in the use, supply or transfer of Colorado River water. The draft plan was updated, renamed and re-released in May 2000 as the *California Colorado River Water Use Plan* (CA Plan). The CA Plan relies first on a variety of intrastate measures that either conserve water or increase water supplies. The plan also relies on measures that would make extra water available to California. (A discussion of the Colorado River Board's CA Plan and the various water supply and water resources management measures contemplated therein are presented in Section 1.4.1.)

California's use of Colorado River water reached a high of 5.4 maf in 1974 and has varied from 4.5 to 5.2 maf per year over the past 10 years. Limiting California to 4.4 maf per year would reduce California's annual water supply by approximately 800,000 afy. All or most of this reduction will be borne by MWD. While the water supply analysis under the FEIS is focused on the total California depletions, the assumption is made that the surplus deliveries that may become available would be managed and distributed by and between the California users in accordance with the proposed provisions of the CA Plan, the corresponding "Quantification Agreement" and associated cooperative programs. Most of these cooperative programs are between MWD or one of its member agencies and the agricultural water agencies. Under these programs, MWD will be able to use its basic Colorado River water apportionment plus water made available under water conservation and groundwater storage programs. These programs include the following:

- **Coachella Groundwater Storage Program** - Cooperative program with the Desert Water Agency and the CVWD that exchanges their State Water Project (SWP) entitlements for MWD's Colorado River water and provides storage of Colorado River water for future extraction by these two agencies.

- **Water Conservation Program with Imperial Irrigation District** - MWD and the IID entered into a water conservation agreement in December 1988. The agreement called for IID to implement various projects to conserve water including improving its water distribution system and on-farm management of water.

- **Test Land Fallowing Program in the Palo Verde Valley** - MWD and the PVID implemented a two-year test land-fallowing program from August 1, 1992 through July 31, 1994.

- **Demonstration Project on Underground Storage of Colorado River Water in Central Arizona** - Under a cooperative program with the CAP, MWD has placed 89,000 af and the SNWA has placed 50,000 af of unused Colorado River water in underground storage (groundwater banking) in central Arizona.

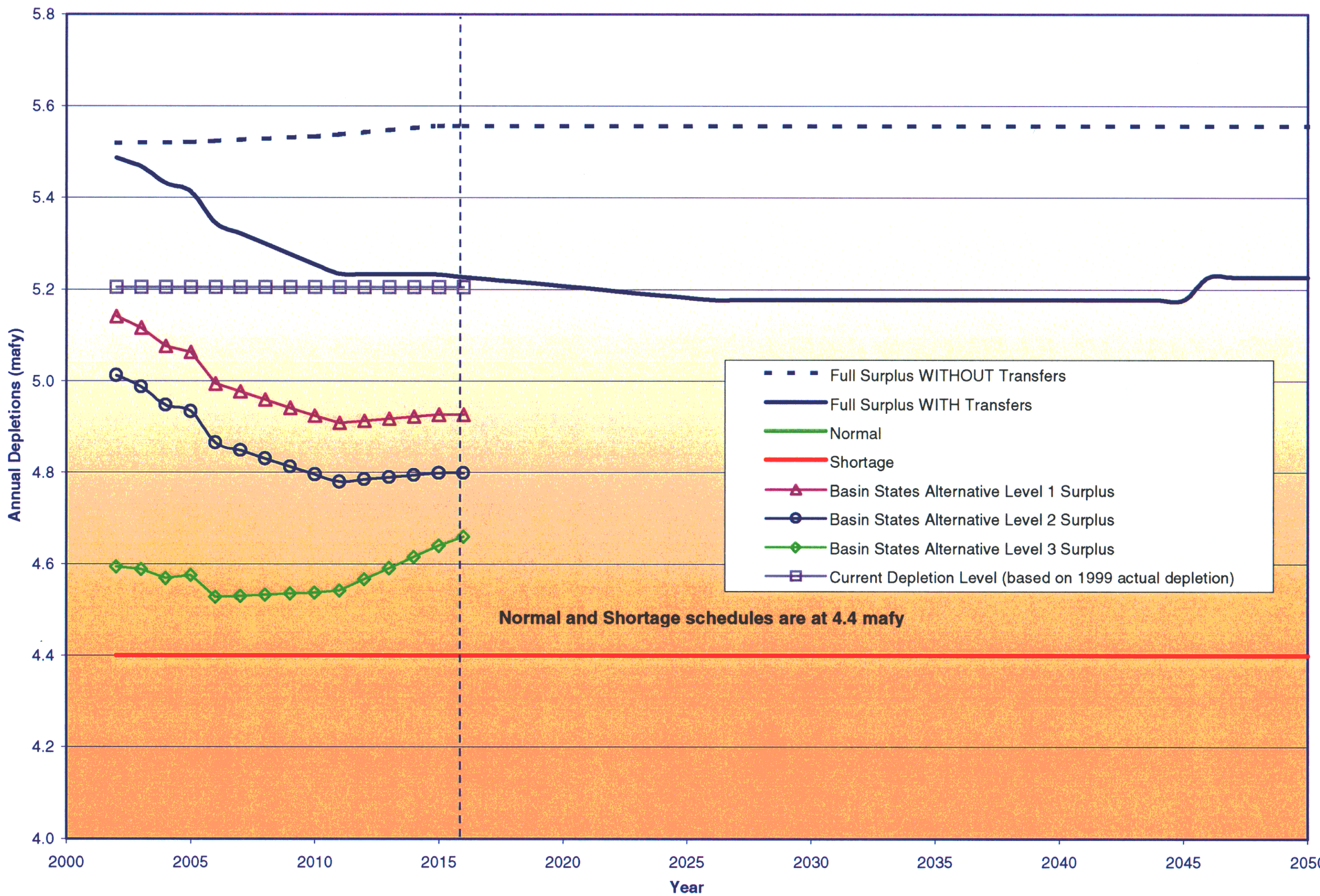
- **Agricultural-to-Urban Intrastate Water Transfers –** The SDCWA and IID have negotiated an agreement by which IID will transfer (sell) agricultural water conserved through various conservation and efficiency programs to SDCWA for urban use – where demand is growing. The agreement contemplates transfer of up to 200,000 afy. A number of bills have been introduced in the California Senate that attempt to address this and other similar intrastate water transfers, including SB 1011 (Costa), SB 1082 (Kelley), SB 1335 (Polanco) and AB 554 (Papan). To date, the legislature has enacted only SB 1082 which would facilitate a transfer of water between the IID and the SDCWA.

Figure 3.4-2 presents a graphical illustration of California's full surplus, normal and first level shortage demand schedules that were used as input to the model. Two full surplus depletion schedules are shown (with and without transfers). The sensitivity analysis that evaluated a baseline condition without intrastate transfers is provided in Attachment L. These two surplus schedules consider the fact that California anticipates a continued need for surplus water, when available, in order to implement the conjunctive use programs (e.g., groundwater banking) that will assist California in reducing its projected Colorado River depletion toward its normal apportionment of 4.4 mafy.

However, California's full surplus schedule that considers the proposed intrastate water transfers is substantially less than the full surplus schedule without the transfers over time. This reflects the additional cooperative programs that would increase the amount of water transferred from agricultural agencies to MWD. Therefore, as a result of the Quantification Agreement, the cooperative programs, and the proposed increased intrastate transfers, the full surplus depletion schedules for California are reduced while at the same time, allowing MWD to continue to meet its users' needs.

As illustrated by the graph, the Basin States Alternative provides an opportunity to manage the surplus deliveries coincident with the management of Lake Mead water levels while at the same time, providing a structure whereby total deliveries to California are reduced. These reductions are significant when compared to California's current depletion level of 5.2 mafy, also shown on Figure 3.4-2. Both California's normal and Level 1 shortage condition water depletion schedules are at 4.4 maf throughout the period of analysis.

Figure 3.4-2
California Projected Colorado River Water Demand Schedules
(Full Surplus, Normal and Shortage Water Supply Conditions)



3.4.3.4 STATE OF NEVADA

The portion of Nevada that depends on Colorado River water is limited to southern Nevada, primarily the Las Vegas Valley and the Laughlin area further south. The Colorado River Commission and SNWA manages Nevada's Colorado River water supply. The SNWA coordinates the distribution and use of the water by its member agencies whose systems provide retail distribution.

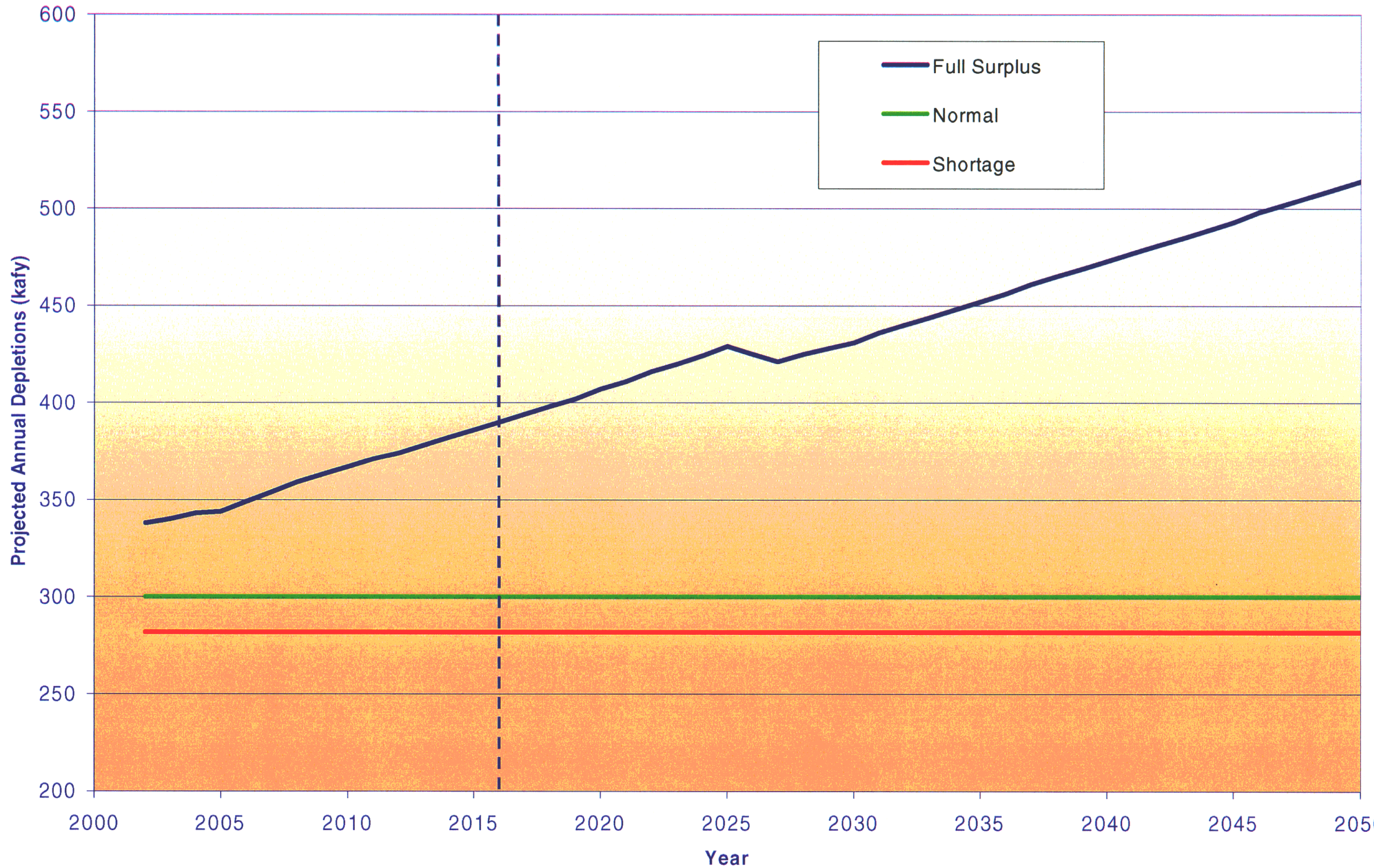
Nevada has five principal points of diversion for Colorado River water. The largest of these is the Las Vegas Valley that pumps water from Lake Mead at Saddle Island (on the west shore of the lake's Boulder Basin) through facilities of SNWA. The water is pumped at two adjacent pumping plants. The Lake Mead minimum water surface elevations for each intake are 1050 feet msl and 1000 feet msl, respectively. The pumped water is treated before being distributed to the Las Vegas Valley and to Boulder City water distribution systems. Three other diversion points are downstream of Davis Dam. They serve the community of Laughlin, Southern California Edison's coal fired Mohave Generating Station and uses on that portion of the Fort Mojave Indian Reservation lying in Nevada. The fifth diversion consists of water used by federal agencies in Nevada, primarily the National Park Service and its concessionaires at various points on lakes Mead and Mohave.

Nevada's current Colorado River water demand is on the threshold of reaching its Colorado River normal water apportionment under the BCPA and the Decree of 300,000 afy. SNWA depletions represent approximately 90 percent of this amount. Figure 3.4-3 presents a graphical illustration of the full surplus, normal and first level shortage demand schedules for Nevada that were used as input to the model.

Nevada's water demand projections for full surplus years rise steadily from a current value of approximately 338,000 af to approximately 514,000 af in 50 years, the end of the period of analysis for this FEIS. Projected depletions under shortage conditions are approximately 282,000 afy over the period of analysis, reflecting the fact that Nevada's reduction in consumptive use of Colorado River water is four percent of the total shortage during shortage years.

SNWA's Integrated Resource Plan calls for optimizing both the use of Colorado River water and the use of the Las Vegas Valley shallow aquifer before developing water from additional sources, including the lower Virgin River and Muddy River. The SNWA has been supporting groundwater recharge in the Las Vegas Valley through facilities of member agencies. The artificial recharge of Colorado River water into the Las Vegas Valley groundwater basin is intended to help meet summer peak demands, provide an interim future water supply and stabilize declining groundwater tables. Water agencies in the valley will be able to withdraw water to meet temporary shortfalls in supply. However, such withdrawals would be coupled with the opportunity for replenishment of the aquifer.

Figure 3.4-3
Nevada Projected Colorado River Water Demand Schedules
(Full Surplus, Normal and Shortage Water Supply Conditions)



Nevada also proposes to bank water in Arizona through arrangements with the AWBA using available groundwater storage capacity as described above in the discussion of alternate supplies for Arizona.

3.4.3.5 Upper Basin States

The depletions for the Upper Basin states were developed and submitted by the Upper Colorado River Commission (Commission) to Reclamation in December 1999. These depletions were then modified in coordination with the Commission to include updated Indian Tribe depletions provided by Keller-Bliessner Engineering, acting on behalf of the Indian Tribes with Colorado River water rights (see Attachment Q). Figure 3.3-4 shows that the Upper Basin depletions are approximately at 4.273 maf in 2002 and increase gradually to approximately 5.325 maf by 2050. These depletions do not include the evaporation losses that occur within the Upper Basin and that are estimated to be approximately 574,000 afy. The Upper Division depletion schedule that includes the estimated evaporation losses are presented in tabular form in Attachment K. The modeled depletions as shown on Figure 3.3-4 and presented in Attachment K are consistent with the Upper Division states' apportionment of Colorado River water.

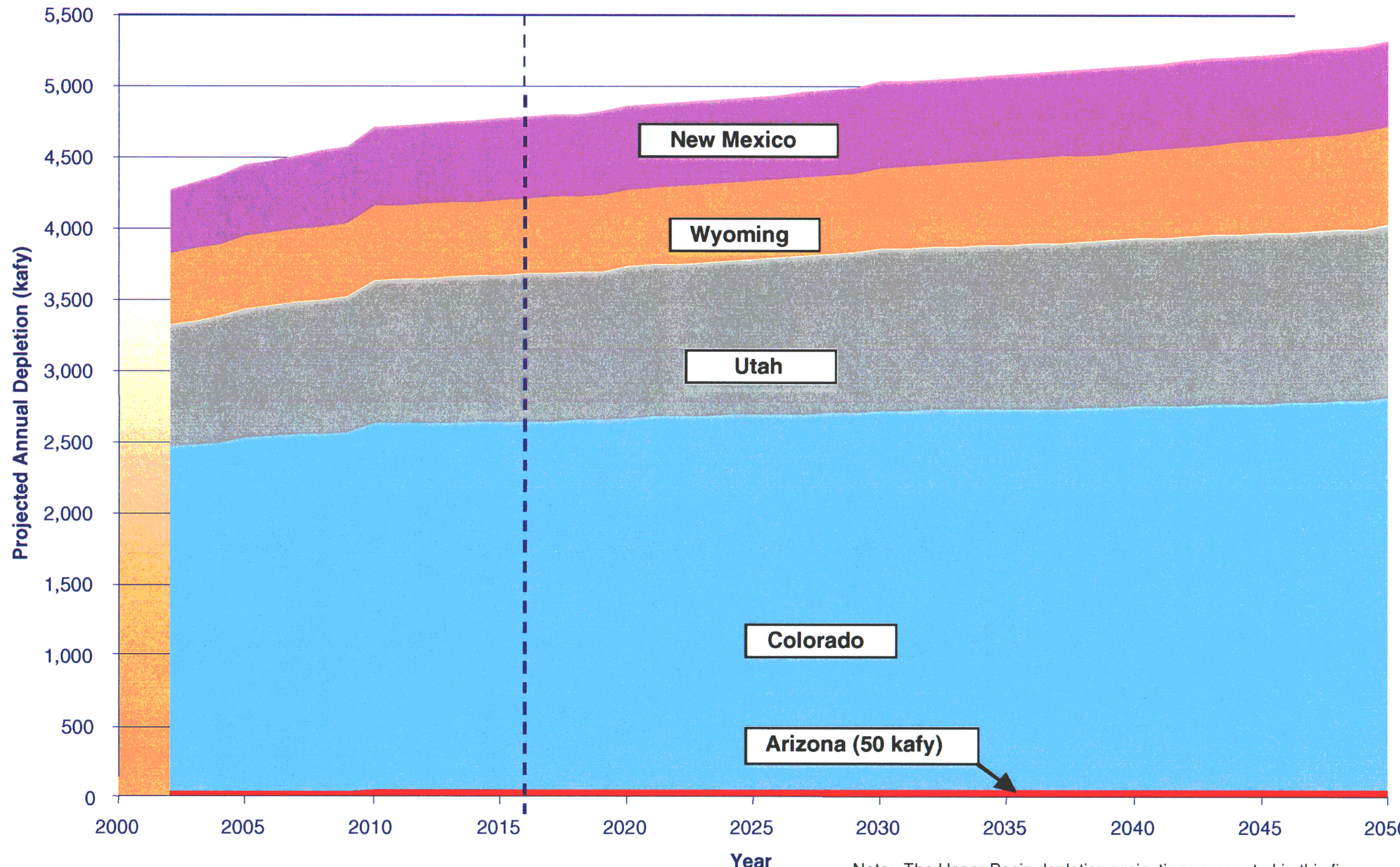
3.4.3.6 Mexico

As discussed earlier in Section 1.3.2.2.3, Mexico has a Treaty entitlement to Colorado River water. This entitlement is set forth in Article 10 of the Treaty 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 af (1,850,234,000 cubic meters) to be delivered in accordance with the provisions of Article 15 of this Treaty.

Figure 3.4-4
Upper Basin Depletion Projections
(Based on 1998 Depletion Schedule)



Note: The Upper Basin depletion projections presented in this figure do not include the evaporation losses that are estimated to be approximately 574,000 afy.

(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 af (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 af (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 af (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 af (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 acre-feet (1,677,545,000 cubic meters) annually upstream of Morelos Dam and approximately 140,000 acre-feet (172,689,000 cubic meters) annually on the land boundary at San Luis and in the limitrophe section of the Colorado River downstream from Morelos Dam. It should be noted that while a portion of Mexico's 1.5 maf annual apportionment is actually delivered below Morelos Dam, the entire delivery to Mexico was modeled at Morelos Dam. This basic assumption, while different than actual practice, served to simplify and facilitate the analysis of water deliveries to Mexico under the baseline conditions and surplus alternatives.

3.4.4 ENVIRONMENTAL CONSEQUENCES

The following discussion is based on the results of analysis of water supply data generated by the model. The data evaluated consisted principally of data relating to the amount of water available for consumptive use in the Lower Division states under baseline conditions and the surplus alternatives during the 50-year period of analysis. Because differences between alternatives are at times small in relation to the quantities and time periods, it was necessary to compare the data in precise terms. However, it should be noted that the analysis is based on assumptions of water supply and operation conditions, as described earlier in Section 3.3, and that the results described below represent approximations of probable future conditions that become increasingly uncertain over time.

The time period for the analysis is 2002 through 2050. The analysis is based on depletion schedules for those years provided by the states and Tribes. Protection was provided for the water level of Lake Mead at elevation 1083 feet msl. As discussed earlier in Section 3.3, the elevation of 1083 feet msl is assumed to be the lower elevation at which the Hoover Powerplant can produce power efficiently.

The results are portrayed graphically in two ways. As discussed earlier in Section 3.3, the modeling process involved making 85 separate runs (traces) which were then examined for the range of water supply available in a given year under baseline conditions and the alternatives. One way that these results can be portrayed graphically is to plot the 90th percentile values (meaning that 90 percent of the values produced by the model were less than shown), the 50th percentile values (the median value) and the 10th percentile values (that 10 percent of the values produced by the model were less than shown). Plots of the maximum and minimum depletion values produced by the model for any given year were added to this "90-50-10" array. The plots for the annual depletions for the Lower Division states and Mexico under baseline conditions are presented in this section. The plots that depict the annual depletions under each of the five surplus alternatives are included in Attachment O.

A second way that the results are portrayed is derived by first ranking all the values for the entire interim surplus criteria period (2002 through 2016) and the subsequent period (2017 through 2050). The depletion values can then be plotted versus the percent of values that are greater than or equal to. This type of plot provides a cumulative distribution of the respective state's depletion and allows for a generalized comparison of the water supply available under baseline conditions and the surplus alternatives, for each period of time.

An important modeling assumption needs to be restated to provide a better understanding of the model results for the alternatives. The interim surplus criteria used for the Basin States, Flood Control, Six States, California and Shortage Protection alternatives become null and void after year 2016. At year 2017, the operating criteria for these surplus alternatives revert to a process that approximates the baseline conditions (modeled as the 70R surplus strategy). The criteria used to model the baseline conditions is effective throughout the 50-year period of analysis.

3.4.4.1 STATE OF ARIZONA

This section presents the simulated water deliveries to Arizona under the baseline conditions and surplus alternatives. The analysis of Arizona's water supply concentrated on total Arizona water depletions.

3.4.4.1.1 Baseline Conditions

The water deliveries to Arizona are projected to fluctuate throughout the 50-year period of analysis reflecting variations in hydrologic conditions. The 90th, 50th and 10th percentile ranking of modeled water deliveries to Arizona under the baseline conditions are presented in Figure 3.4-5.

With the exception of the first year modeled (2002), the 90th percentile line coincides with Arizona's depletion schedule during full surplus water supply conditions. As indicated by this 90th percentile line, the probability that the baseline conditions would provide Arizona's full surplus depletion schedule is at least 10 percent throughout the 50-year period of analysis.

The 50th percentile line represents the median annual depletion values. This 50th percentile line generally coincides with Arizona's projected depletion schedule under normal water supply conditions through year 2026 (see Figure 3.4-1). After 2026, the median values drop to approximately 2.39 maf and remains at approximately that level for the remainder of the analysis period. As previously noted and as reflected by the graph, Arizona's demands are not anticipated to reach its 2.8 maf entitlement until 2006.

As noted in Section 3.4.3.2, under shortage conditions, Arizona would bear 96 percent of the reduction and Nevada would bear four percent. In Arizona, the reduction would be shared prorata among CAP and non-CAP holders of fourth priority entitlements. To simplify the modeling process, the model sets the CAP's shortage condition deliveries at 1.0 maf when the Lake Mead water level is between elevation 1000 feet msl and the assumed shortage protection line as discussed in Section 3.3.3.4. This modeling assumption kept Arizona's annual deliveries above 2.3 maf until further cuts to the CAP were necessary to maintain the Lake Mead water level above the 1000 feet msl elevation (a Level 2 shortage condition). Under the baseline conditions, deliveries to Arizona below 2.3 maf were not observed to occur during the 15-year interim surplus criteria period. However, deliveries below 2.3 maf were observed during years 2017 to 2050 and occurred less than five percent of the time.

Figure 3.4-5
Arizona Modeled Annual Depletions Under Baseline Conditions
90th, 50th and 10th Percentile Values

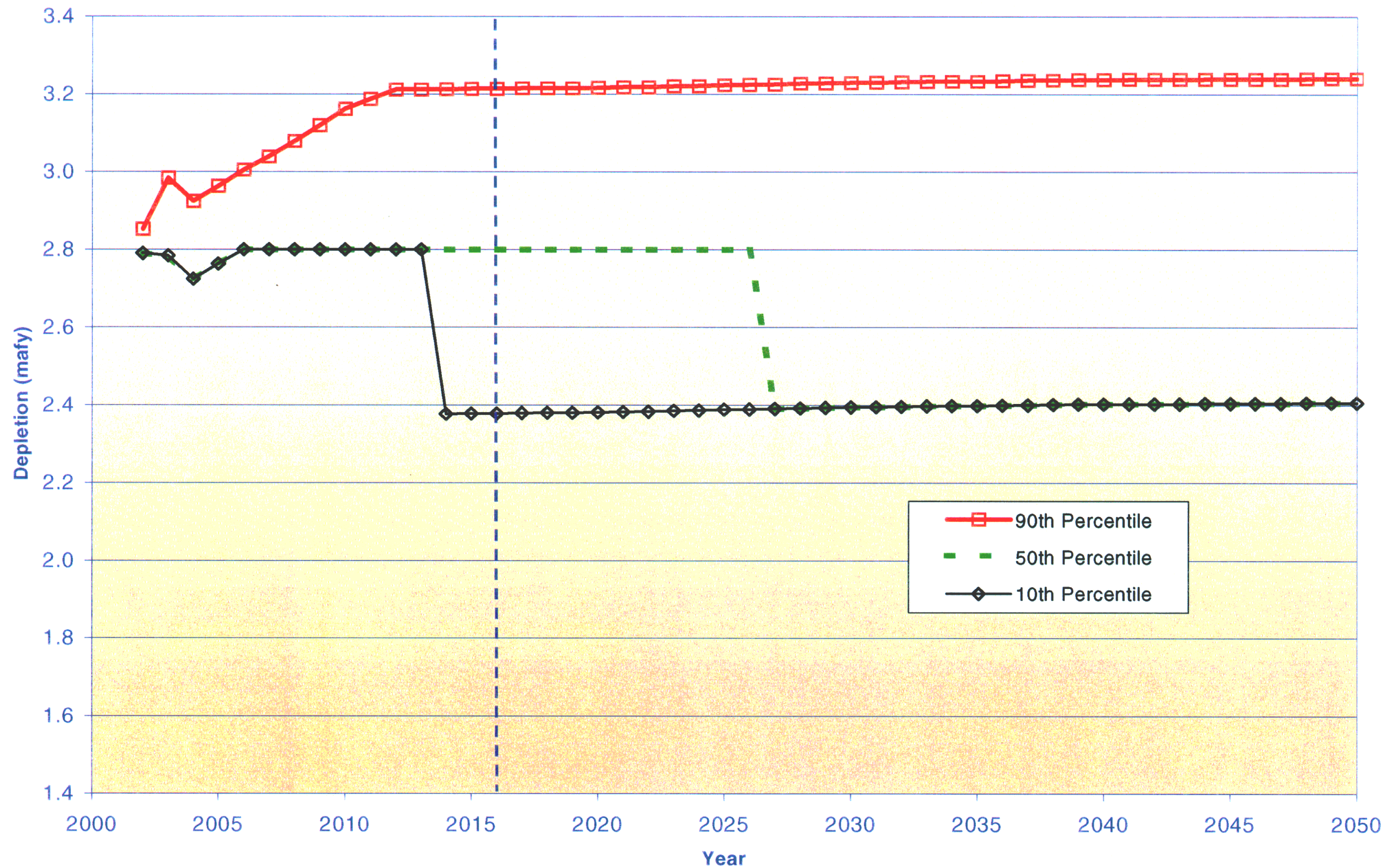


Figure 3.4-6 provides a comparison of the cumulative distribution of Arizona's depletions under the surplus alternatives to those of the baseline conditions during the interim surplus criteria period (years 2002 to 2016). This type of graph is used to represent the frequency that annual deliveries of different magnitudes occur in the respective period. The results presented in Figure 3.4-6 indicate a 96 percent probability that Arizona's depletions would meet its normal depletion schedule during this period under the baseline conditions. The probability that Arizona would receive surplus condition deliveries during this period was approximately 29 percent. The maximum surplus condition depletions under the baseline conditions were 3.213 maf during this period. The probability that Arizona would receive shortage condition deliveries was less than four percent. The minimum shortage condition depletion was 2.375 maf.

Figure 3.4-7 provides a comparison of the cumulative distribution of the water deliveries to Arizona under the surplus alternatives to those of the baseline conditions for the 34-year period (years 2017 to 2050) that would follow the interim surplus criteria period. The results presented in Figure 3.4-7 indicate a 50 percent probability that water deliveries to Arizona would meet its normal depletion schedule during this period under the baseline conditions. The probability that Arizona would receive surplus condition deliveries during this same period under the baseline conditions was approximately 21 percent. The maximum surplus condition depletions under the baseline conditions were 3.24 maf during this period. The probability that Arizona would receive shortage conditions deliveries was approximately 50 percent. The minimum shortage condition depletion was 1.596 maf, representing second level shortage conditions that occurred less than five percent of the time during this period.

Figure 3.4-6
Arizona Modeled Depletions
Comparison of Surplus Alternatives to Baseline Conditions
Years 2002 to 2016

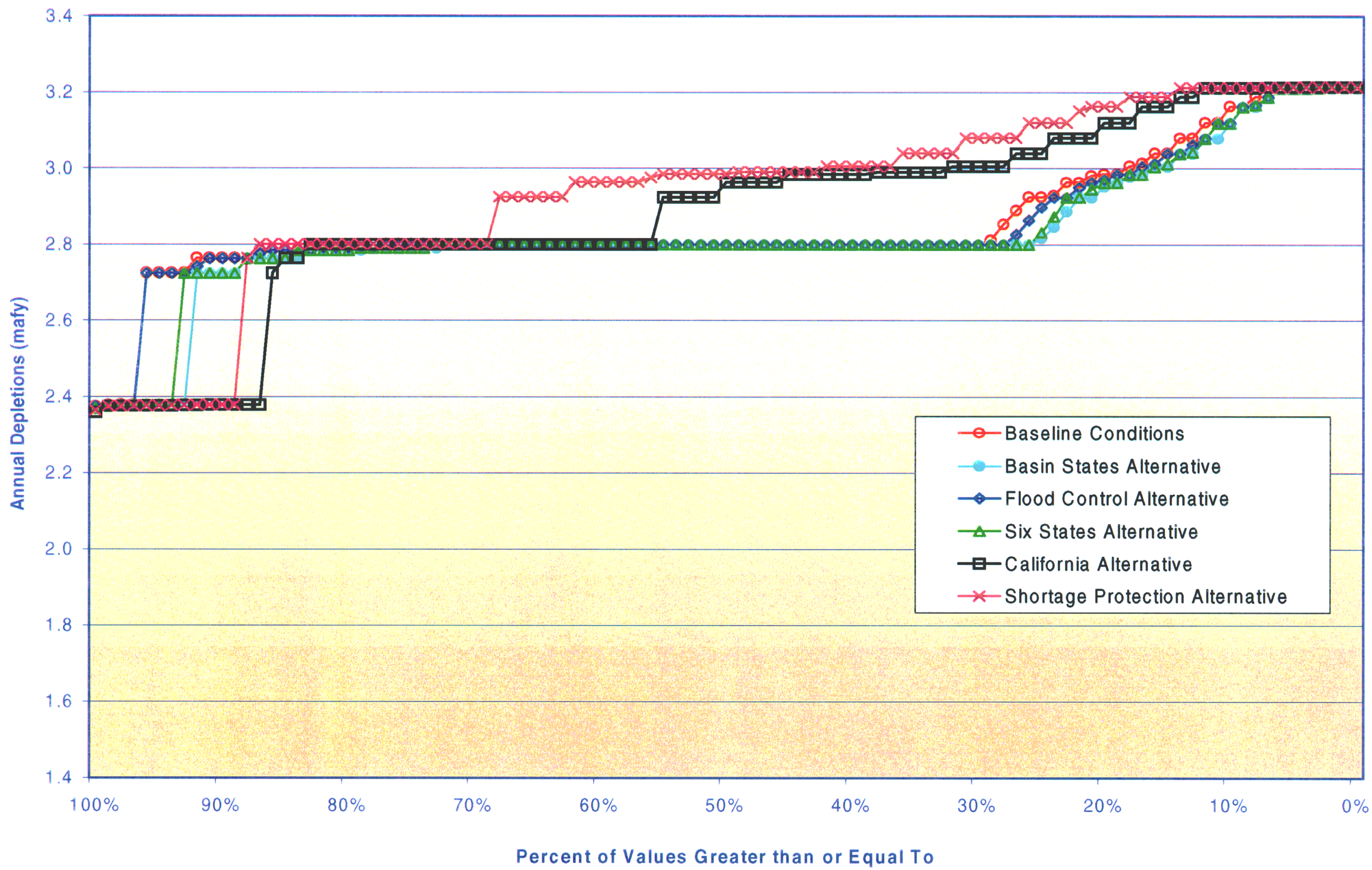
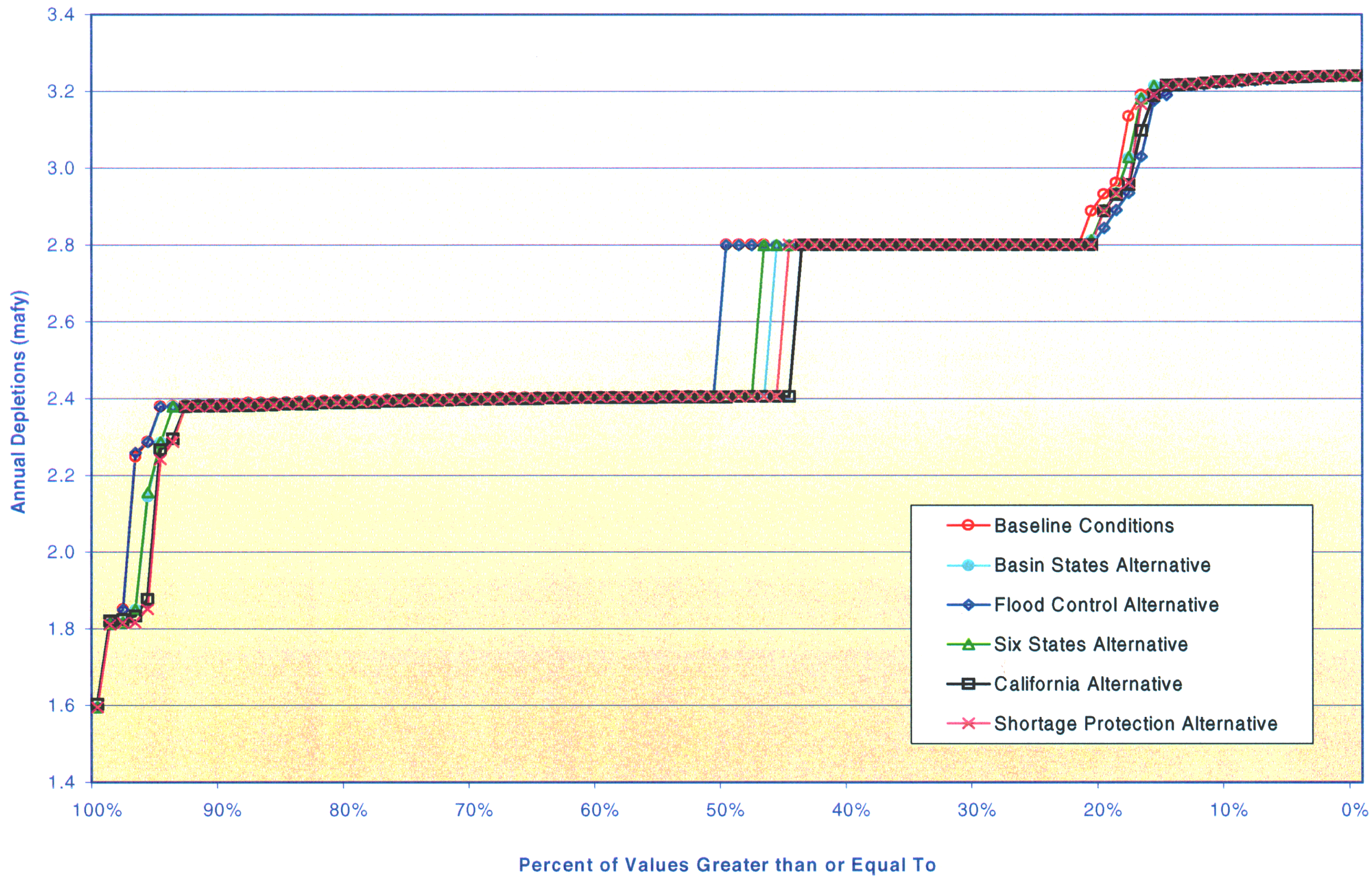


Figure 3.4-7
Arizona Modeled Depletions
Comparison of Surplus Alternatives to Baseline Conditions
Years 2017 to 2050



3.4.4.1.2 Comparison of Surplus Alternatives to Baseline Conditions

Figure 3.3-8 provides a comparison of the 90th, 50th and 10th percentile values for Arizona's modeled depletions under the baseline conditions to those of the surplus alternatives. As noted in Figure 3.4-8, there is little difference in the 90th percentile lines resulting from the surplus alternatives to those of the baseline conditions. The 90th percentile lines generally coincide with Arizona's surplus depletion schedule.

The 50th percentile lines for the baseline conditions, Basin States, Flood Control and Six States alternatives are essentially the same during the interim surplus criteria period and coincide with Arizona's normal depletion schedule. The 50th percentile lines for the California and Shortage Protection alternatives are identical to each other during the initial eight years and coincide with Arizona's surplus depletion schedule. The 50th percentile line for the Flood Control Alternative continues to coincide with the normal depletion schedule through year 2011. After 2011, the 50th percentile lines for the baseline conditions and all surplus alternatives are the same until 2023. Thereafter, the median values for the baseline conditions and surplus alternatives begin to fall due to increasing probability of the Level 1 shortages.

The 10th percentile lines for the baseline conditions and the surplus alternatives are essentially at or above Arizona's normal depletion schedule through year 2009. In 2010, the California and Shortage Protection alternatives drop to the Level 1 shortage depletion values followed by the Basin States and Six States alternatives and finally in year 2013, the baseline conditions and Flood Control alternatives. Thereafter, the 10th percentile lines for the baseline conditions and the surplus alternatives remain at this level through 2050.

Figures 3.4-6 and 3.4-7 presented comparisons of the cumulative distribution of Arizona's depletions under the surplus alternatives to those of the baseline conditions during the interim surplus criteria period (years 2002 to 2016) and the 34-year period that follows the interim surplus criteria (years 2017 to 2050), respectively. These graphs best illustrate the frequency that different amounts of annual Arizona water deliveries occur over these time frames. Table 3.4-1 provides a summary of the comparison for these two periods.

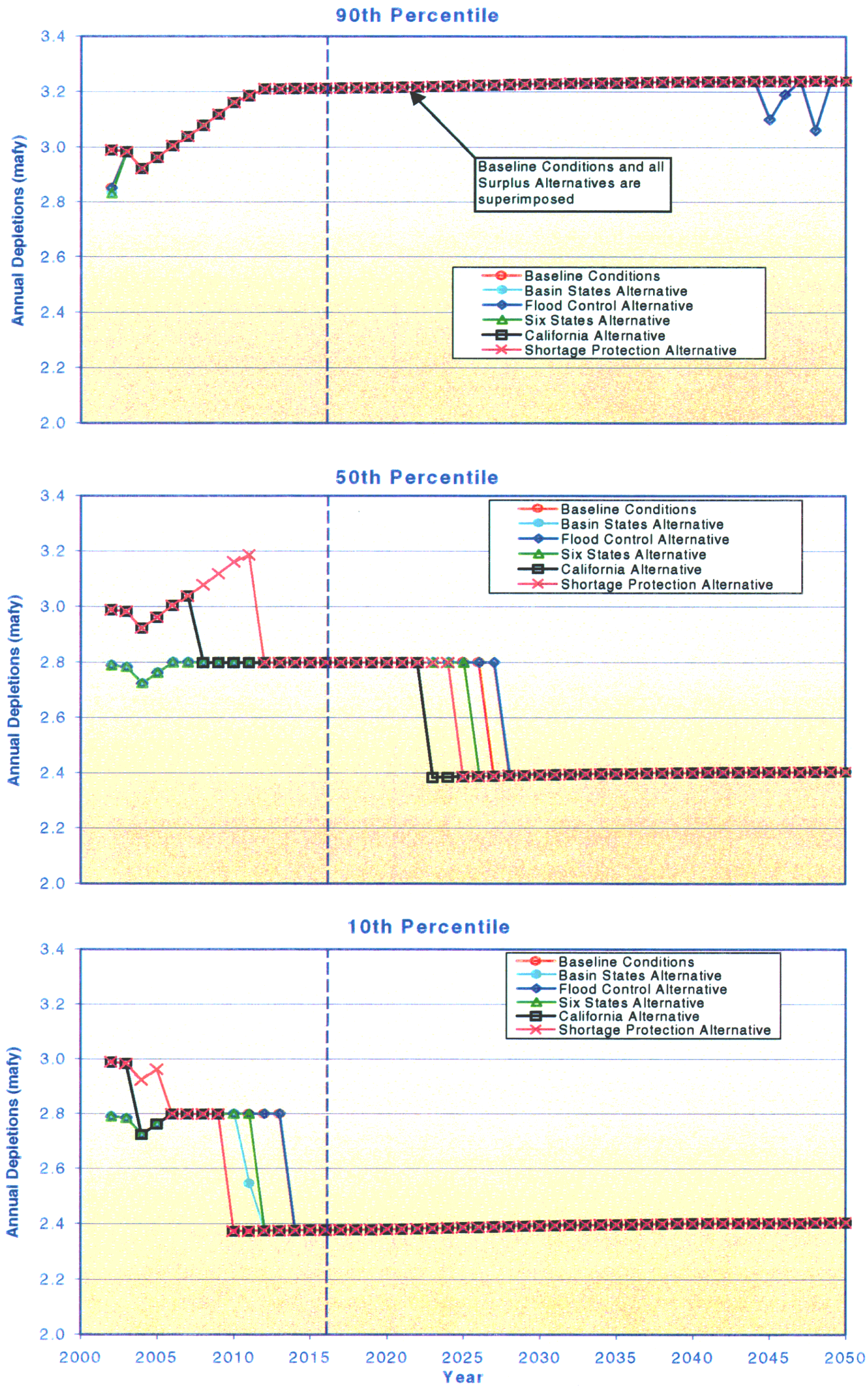
Table 3.4-1
Summary of Arizona Modeled Annual Depletions
Comparison of Surplus Alternatives to Baseline Conditions

Alternative/Conditions	Years 2002 to 2016			Years 2017 to 2050		
	Normal*	Surplus	Shortage	Normal*	Surplus	Shortage
Baseline Conditions	> 96%	29%	< 4%	50%	21%	50%
Basin States	> 92%	25%	< 8%	> 46%	> 21%	< 54%
Flood Control	>96%	27%	< 4%	50%	20%	50%
Six States	> 93%	25%	< 7%	> 47%	21%	< 53%
California	> 86%	55%	< 14%	> 44%	20%	< 56%
Shortage Protection	> 88%	68%	< 12%	> 45%	20%	< 55%

*The values under normal represent the total percentage of time that depletions would be at or above the normal depletion conditions.

The percentage values presented under the column heading labeled "Normal" in Table 3.4-1 represent the total percentage of time that depletions under the noted conditions would be at or above the normal depletion schedule amount. The values presented under the column labeled "Surplus" represent the total percentage of time that depletions under the noted conditions exceed the normal depletion schedule amount. The values presented under the column labeled "Shortage" represent the total percentage of time that depletions under the noted conditions would be below the normal depletion schedule amount.

Figure 3.4-8
Arizona Modeled Annual Depletions
Comparison of Surplus Alternatives to Baseline Conditions
90th, 50th and 10th Percentile Values



3.4.4.2 STATE OF CALIFORNIA

This section presents the simulated water de.liveries to California under the baseline conditions and surplus alternatives. The analysis of California's water supply concentrated on total California water depletions. The underlying assumptions for California's depletions under the baseline conditions include: 1) California's normal annual depletion is 4.4 maf; 2) intrastate water transfers are included in the baseline conditions and all alternatives; and 3) surplus deliveries are made during flood control operations and under 70R criteria. The underlying assumption for California's depletions are that several transfers and exchanges will be carried out over a number of years. The transfers and exchanges proposed under California's Colorado River Water Use Plan will result in water transfers between MWD and the agricultural agencies, in particular IID and CVWD. The normal schedules for MWD, IID and CVWD with and without transfers as provided by California are tabulated in Attachment H.

3.4.4.2.1 Baseline Conditions

The water deliveries to California are projected to fluctuate throughout the 50-year period of analysis reflecting variations in hydrologic conditions. The 90th, 50th and 10th percentile rankings of modeled water deliveries to California under the baseline conditions are presented in Figure 3.4-9.

The 90th percentile line generally coincides with California's depletion schedule during full surplus water supply conditions. As indicated by this 90th percentile line, the probability that the baseline conditions would provide California's full surplus depletion amount is at least 10 percent throughout the 50-year period of analysis.

From 2002 through 2050, under baseline conditions, the 50th percentile line for California coincides with its normal depletion schedule.

Annual water deliveries to California never fall below the apportionment of 4.4 maf available for use in California during a normal year. Therefore, no Level 2 shortage condition deliveries to California were observed.

Figure 3.4-9
California Modeled Annual Depletions Under Baseline Conditions
90th, 50th and 10th Percentile Values

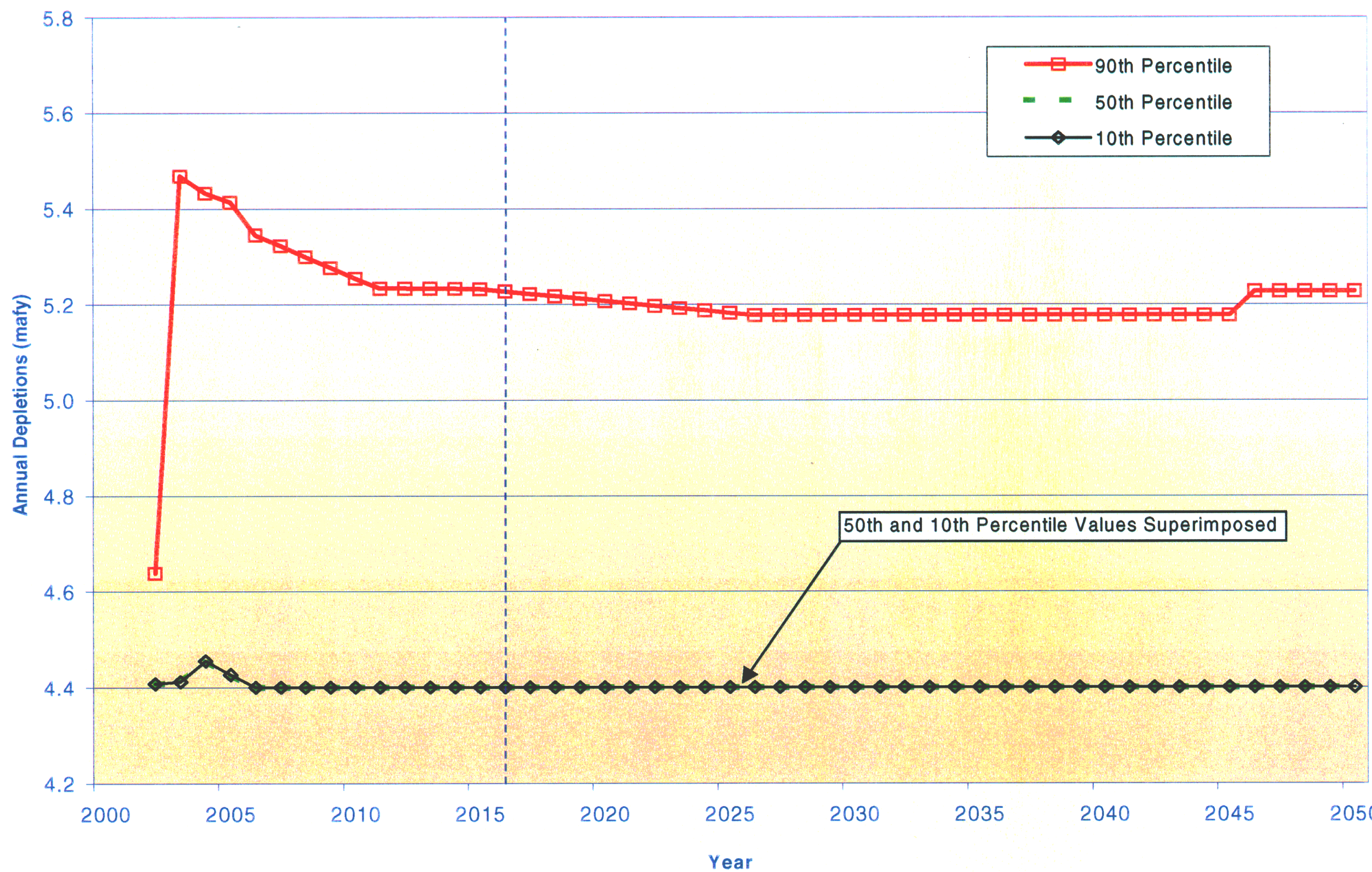


Figure 3.4-10 provides a comparison of the cumulative distribution of California's depletions under the surplus alternatives to those of the baseline conditions during the interim surplus criteria period (years 2002 to 2016). These graphs are best used to represent the frequency that different magnitude annual water deliveries to California occur in the respective period. The results presented in Figure 3.4-10 indicate a 100 percent probability that California's depletions would meet its normal depletion schedule during this period under the baseline conditions. The probability that California would receive surplus condition deliveries (any amount greater than 4.4 mafy) during this period under baseline conditions was approximately 47 percent. The maximum surplus condition depletions observed under the baseline conditions were 5.468 maf during this period.

Figure 3.4-11 provides a comparison of the cumulative distribution of the water deliveries to California under the surplus alternatives to those of the baseline conditions for the 34-year period (years 2017 to 2050) that follows the interim surplus criteria period. The results presented in Figure 3.4-11 indicate a 100 percent probability that water deliveries to California would meet its normal depletion schedule during this period under the baseline conditions. The probability that California would receive surplus condition deliveries during this same period under the baseline conditions was approximately 21 percent. The maximum surplus condition depletions under the baseline conditions were 5.227 maf during this period. During this period, California did not receive shortage condition deliveries.

Figure 3.4-10
California Modeled Depletions
Comparison of Surplus Alternatives to Baseline Conditions
Years 2002 to 2016

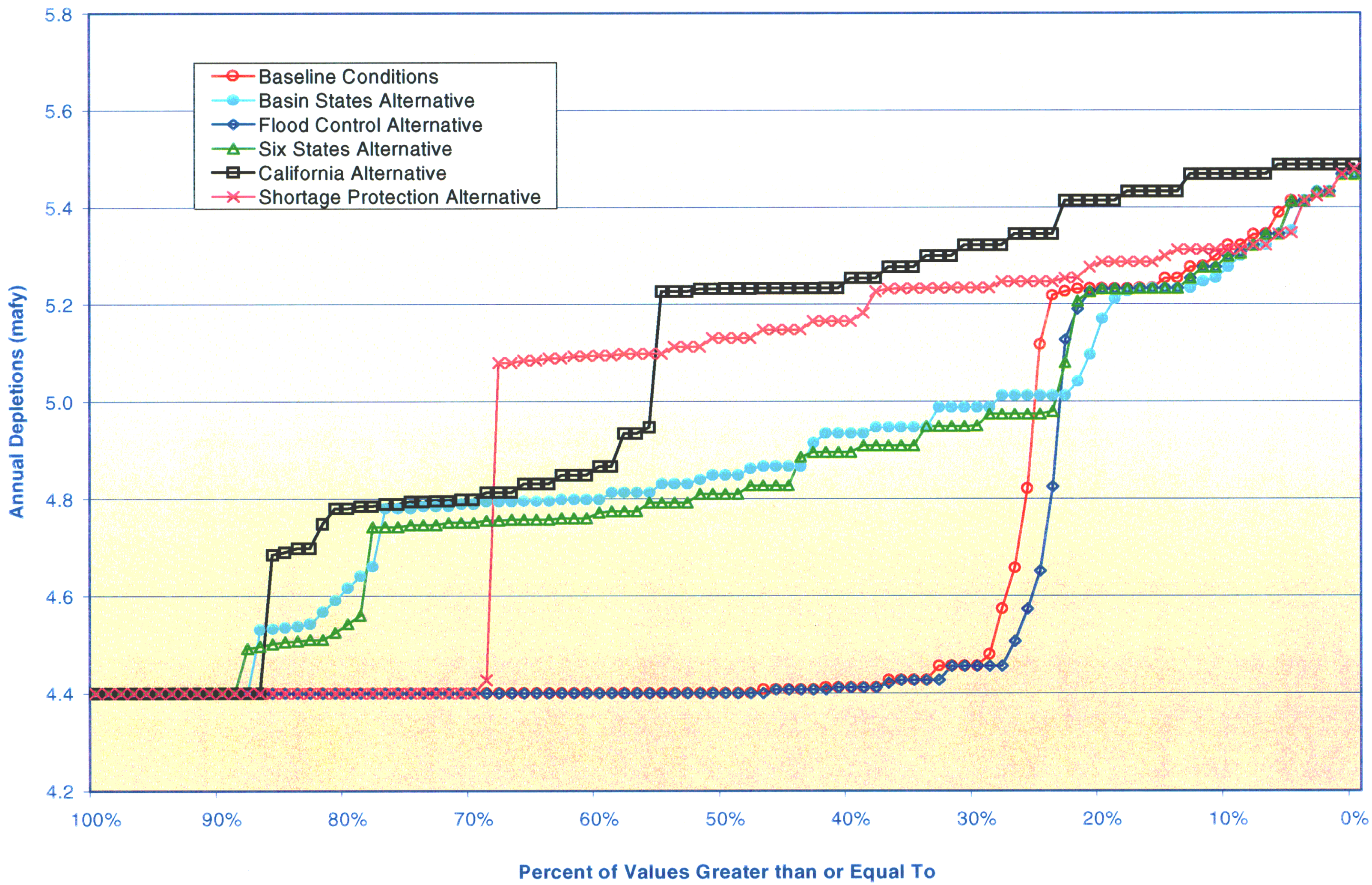
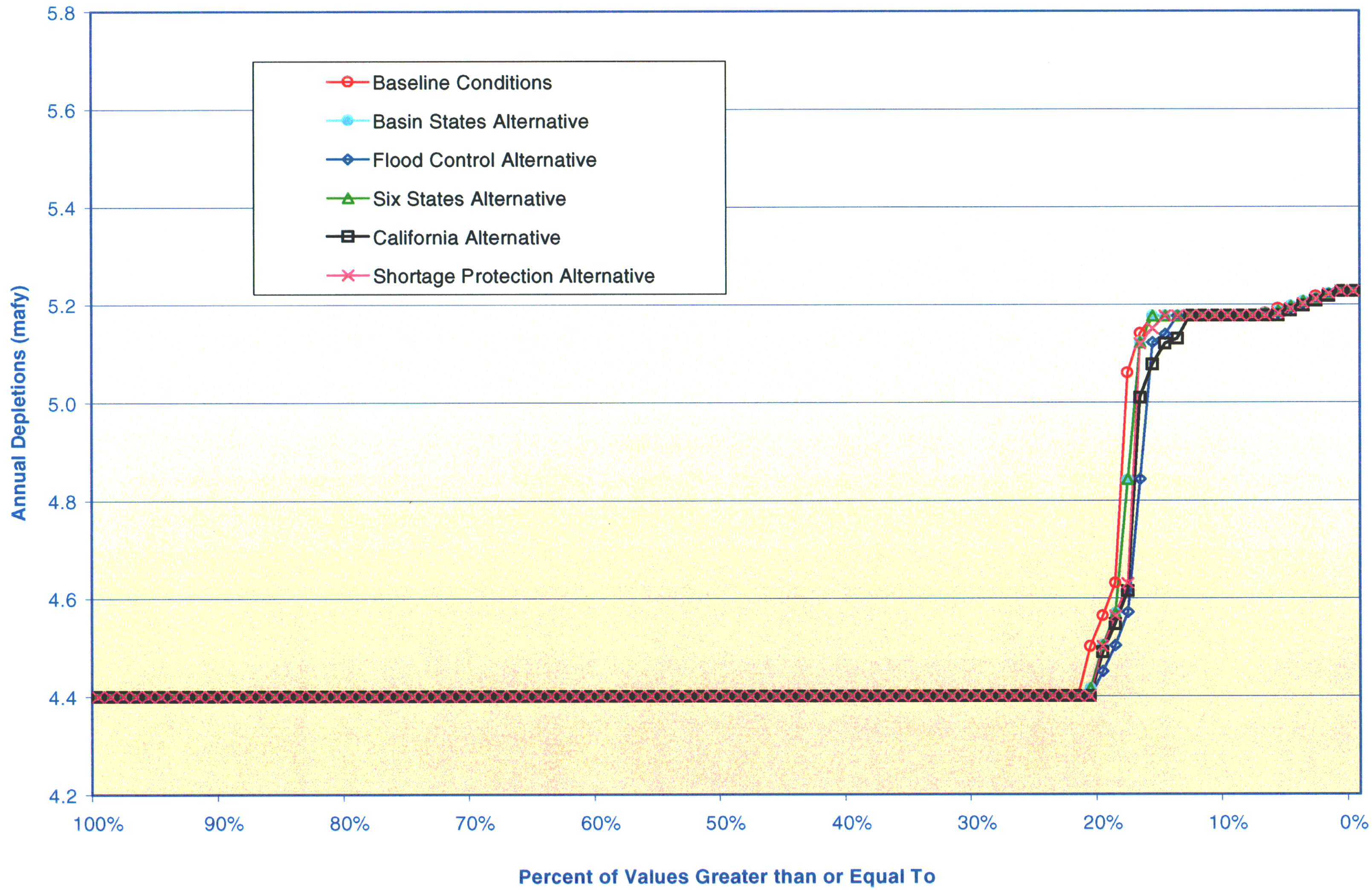


Figure 3.4-11
California Modeled Depletions
Comparison of Surplus Alternatives to Baseline Conditions
Years 2017 to 2050

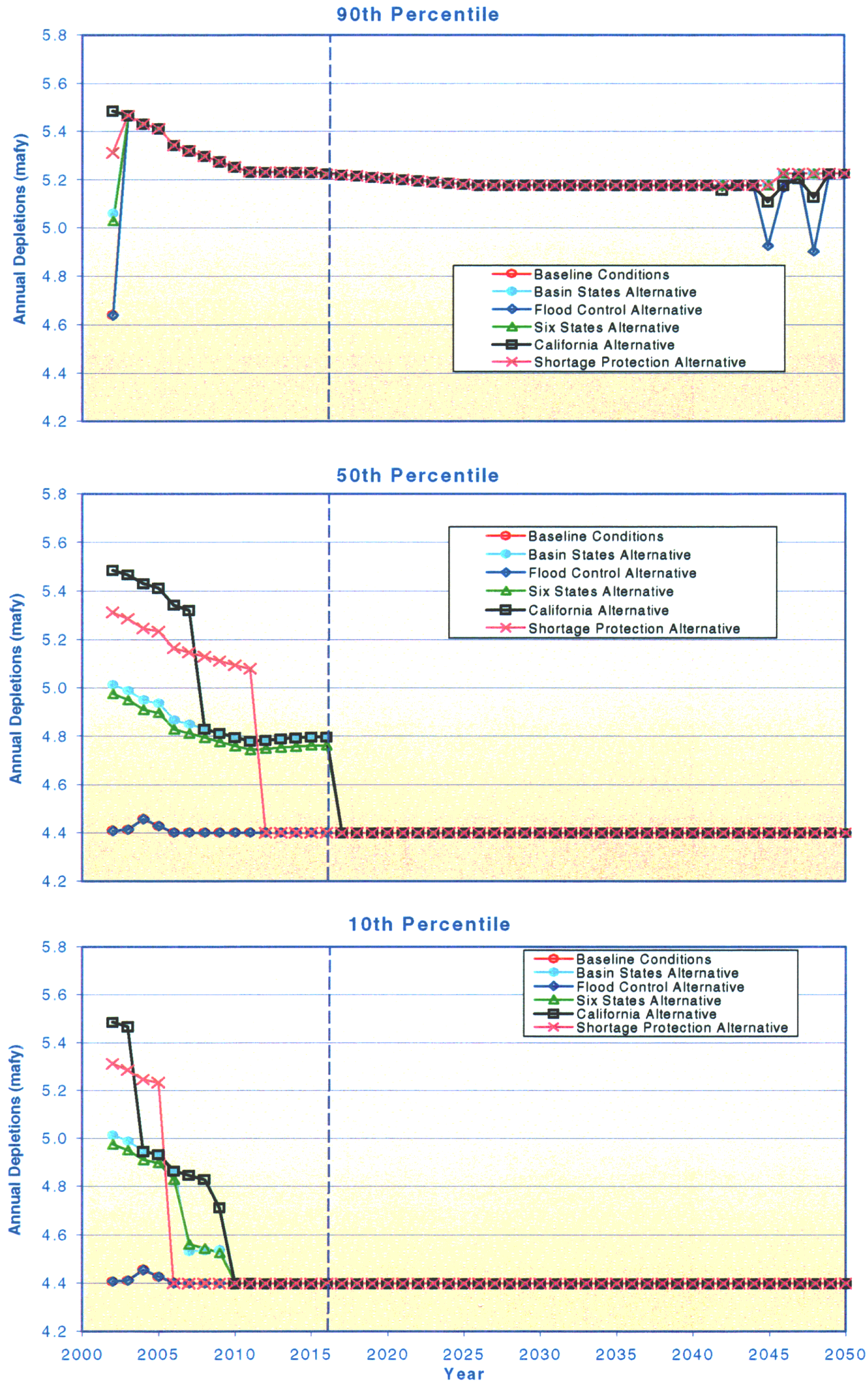


3.4.4.2.2 Comparison of Surplus Alternatives to Baseline Conditions

Figure 3.4-12 provides a comparison of the 90th, 50th and 10th percentile values for California's depletions under the surplus alternatives to those of the baseline conditions.

As noted in Figure 3.4-12, there is little difference in the 90th percentile values resulting from the surplus alternatives to those of the baseline conditions. The exceptions to this are in year one and years 2045 to 2050 where the 90th percentile values are less than the full surplus amounts and indicating the occurrence of frequent limited surplus conditions. The 90th percentile lines generally coincide with California's surplus depletion schedule.

Figure 3.4-12
California Modeled Annual Depletions
Comparison of Surplus Alternatives to Baseline Conditions
90th, 50th and 10th Percentile Values



The 50th percentile lines for the Basin States, Six States, California, and Shortage Protection alternatives are above California's normal depletion schedule during all or most of the 15-year interim surplus criteria, indicating a high probability of surplus conditions under these alternatives. The 50th percentile lines for the baseline conditions and Flood Control Alternative generally coincide with California's normal depletion schedule throughout the 50-year period of analysis. Beyond 2016, the 50th percentile lines for all of the surplus alternatives also coincide with California's normal depletion schedule.

The 10th percentile lines for the baseline conditions and the Flood Control Alternative coincide with California's normal depletion schedule throughout the 50-year period of analysis. The 10th percentile values for the Basin States, Six States, California, and Shortage Protective alternatives are essentially above the normal depletion schedule through year 2009 (2005 for the Shortage Protection Alternative). The 10th percentile lines for the baseline conditions and the surplus alternatives converge after 2009.

Figures 3.4-10 and 3.4-11 presented comparisons of the cumulative distribution of California's depletions under the surplus alternatives to those of the baseline conditions during the interim surplus criteria period (years 2002 to 2016) and the 34-year period that would follow the interim surplus criteria (years 2017 to 2050), respectively. Table 3.4-2 provides a tabular summary and comparison for these two periods.

Table 3.4-2
Summary of California Modeled Annual Depletions
Comparison of Surplus Alternatives to Baseline Conditions

Alternative/Conditions	Years 2002 to 2016			Years 2017 to 2050		
	Normal*	Surplus	Shortage	Normal*	Surplus	Shortage
Baseline Conditions	100%	47%	0%	100%	21%	0%
Basin States	100%	87%	0%	100%	21%	0%
Flood Control	100%	46%	0%	100%	20%	0%
Six States	100%	69%	0%	100%	21%	0%
California	100%	86%	0%	100%	20%	0%
Shortage Protection	100%	69%	0%	100%	20%	0%

The percentage values presented under the column heading labeled "Normal" in Table 3.4-2 represent the total percentage of time that depletions under the noted conditions would be at or above the normal depletion schedule amount. The values presented under the column labeled "Surplus" represent the total percentage of time that depletions under the noted conditions exceed the normal depletion schedule amount. The values presented under the column labeled "Shortage" represent the total percentage of time that depletions under the noted conditions would be below the normal depletion schedule amount.

3.4.4.3 STATE OF NEVADA

This section presents the simulated water deliveries to Nevada under the baseline conditions and surplus alternatives. The analysis of Nevada's water supply concentrated on total Nevada water depletions.

3.4.4.3.1 Baseline Conditions

The water deliveries to Nevada are projected to fluctuate throughout the 50-year period of analysis reflecting variations in hydrologic conditions. The 90th, 50th and 10th percentile ranking of modeled water deliveries to Nevada under the baseline conditions is presented in Figure 3.4-13. The 90th percentile line generally coincides with Nevada's depletion schedule during full surplus water supply conditions. As indicated by this 90th percentile line, the probability that the baseline conditions would provide Nevada's full surplus depletion amount is at least 10 percent throughout the 50-year period of analysis.

The 50th percentile line generally coincides with Nevada's normal depletion schedule under baseline conditions through year 2026. Thereafter, the 50th percentile line drops to and coincides with Nevada's Level 1 shortage depletion schedule.

As noted in Section 3.4.3, the SNWA and CAP essentially take all the reductions in water deliveries during shortage conditions (for modeling purposes). The model sets the SNWA's shortage condition delivery reductions to four percent of the total shortage condition delivery reduction amount when the Lake Mead water level is between elevation 1000 feet msl and the assumed shortage protection line as discussed in Section 3.3.3.4. This modeling assumption kept Nevada' annual delivery above 280 kaf until further cuts to the SNWA and CAP were necessary to maintain the Lake Mead water level above the 1000 feet msl elevation, a level 2 shortage condition. Under the baseline conditions, deliveries to Nevada below 280 kaf occurred less than four percent of the time during the 15-year interim surplus criteria period.

Under the baseline conditions, the 10th percentile line remains at or above Nevada's normal depletion schedule until 2013. Beyond 2013, the 10th percentile line drops to Nevada's Level 1 shortage condition depletion schedule.

Figure 3.4-13
Nevada Modeled Annual Depletions Under Baseline Conditions
90th, 50th and 10th Percentile Values

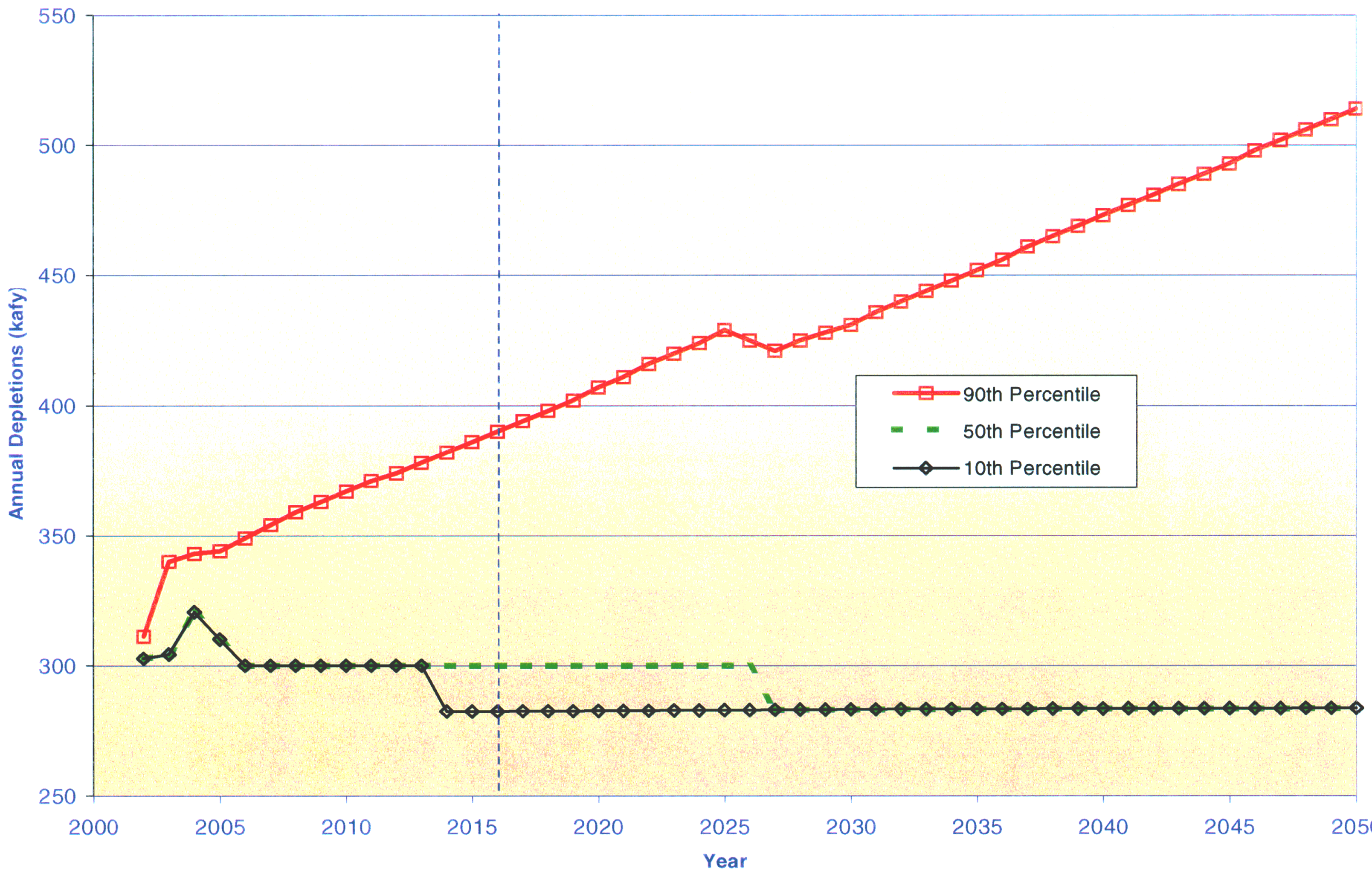


Figure 3.4-14 provides a comparison of the cumulative distribution of Nevada's depletions under the surplus alternatives to those of the baseline conditions during the interim surplus criteria period (years 2002 to 2016). This graph is best used to represent the frequency that different magnitude water deliveries to Nevada occurred during the 15-year interim surplus criteria period. The results presented in Figure 3.4-14 indicate a 96 percent probability that water deliveries to Nevada would meet or exceed its normal depletion schedule during this period under the baseline conditions. The probability that Nevada would receive surplus condition deliveries under the baseline conditions during this period was approximately 47 percent. The maximum surplus condition depletions under the baseline conditions were 390 kaf during this period. The probability that Nevada would receive shortage condition deliveries under baseline conditions was less than four percent. The minimum shortage condition depletion was 282.3 kaf.

Figure 3.4-14
Nevada Modeled Depletions
Comparison of Surplus Alternatives to Baseline Conditions
Years 2002 to 2016

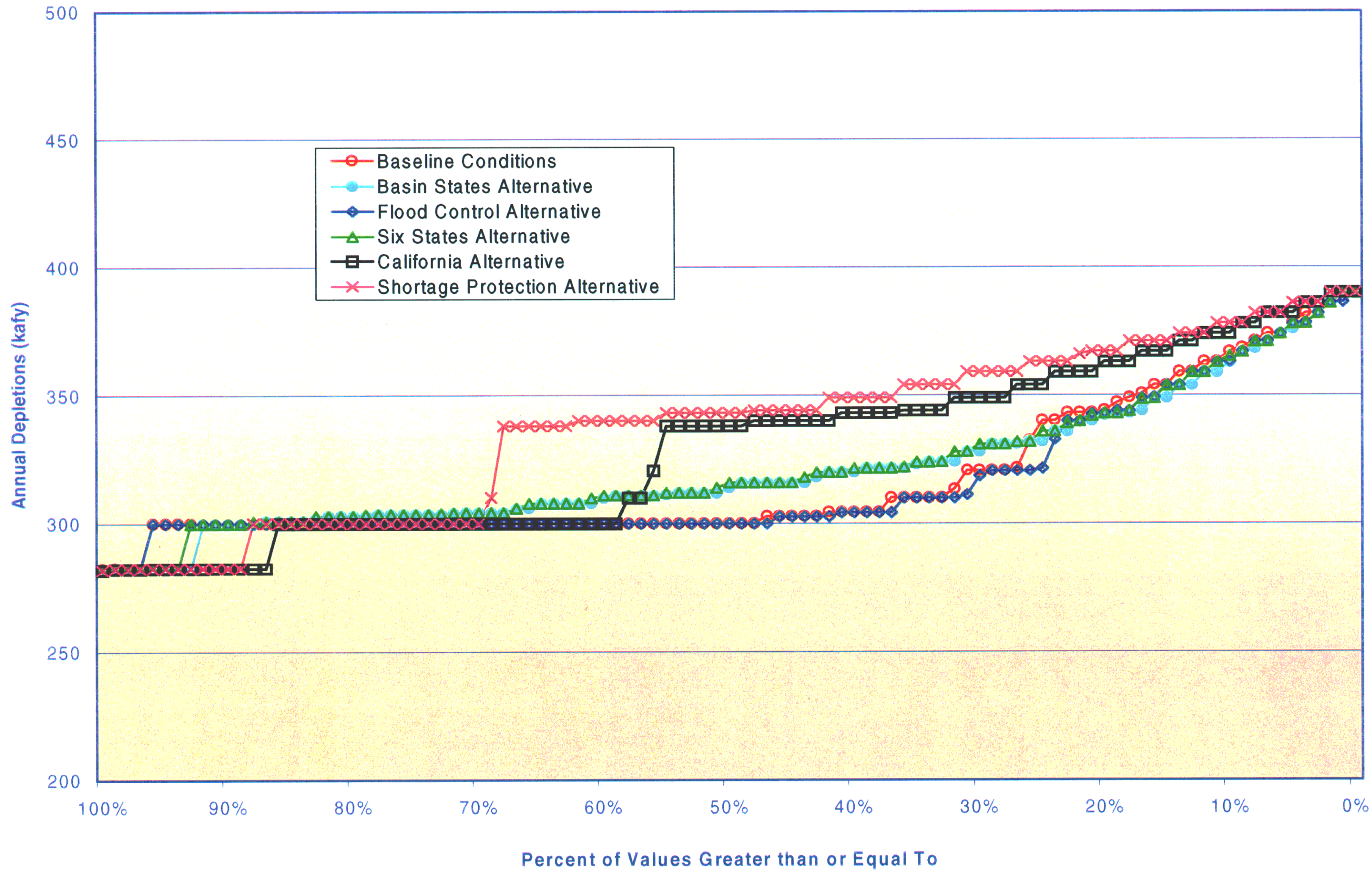


Figure 3.4-15 provides a comparison of the cumulative distribution of the water deliveries to Nevada under the surplus alternatives to those of the baseline conditions for the 34-year period (years 2017 to 2050) that would follow the interim surplus criteria period. The results presented in Figure 3.4-15 indicate a 50 percent probability that water deliveries to Nevada would meet or exceed its normal depletion schedule during this period under the baseline conditions. The probability that Nevada would receive surplus condition deliveries during this same period under the baseline conditions was approximately 21 percent. The maximum surplus condition depletions under the baseline conditions were 514 kaf during this period. The probability that Nevada would receive shortage condition deliveries was approximately 50 percent. The minimum shortage condition depletion during this period was 249.8 kaf.

3.4.4.3.2 Comparison of Surplus Alternatives to Baseline Conditions

Figure 3.4-16 provides a comparison of the 90th, 50th and 10th percentile values for Nevada's depletions under the baseline conditions to those of the surplus alternatives.

As noted in Figure 3.4-16, there is little difference in the 90th percentile values generally resulting from the surplus alternatives where compared to those of the baseline conditions. The 90th percentile linescoincide with Nevada's surplus depletion schedule.

The 50th percentile lines for the baseline conditions generally stay at or above Nevada's normal depletion schedule through year 2022. From 2022 through 2027, the 10th percentile values for the baseline conditions and surplus alternatives drop to and remain at a level equal to Nevada's Level 1 shortage depletion schedule.

Figure 3.4-15
Nevada Modeled Depletions
Comparison of Surplus Alternatives to Baseline Conditions
Years 2017 to 2050

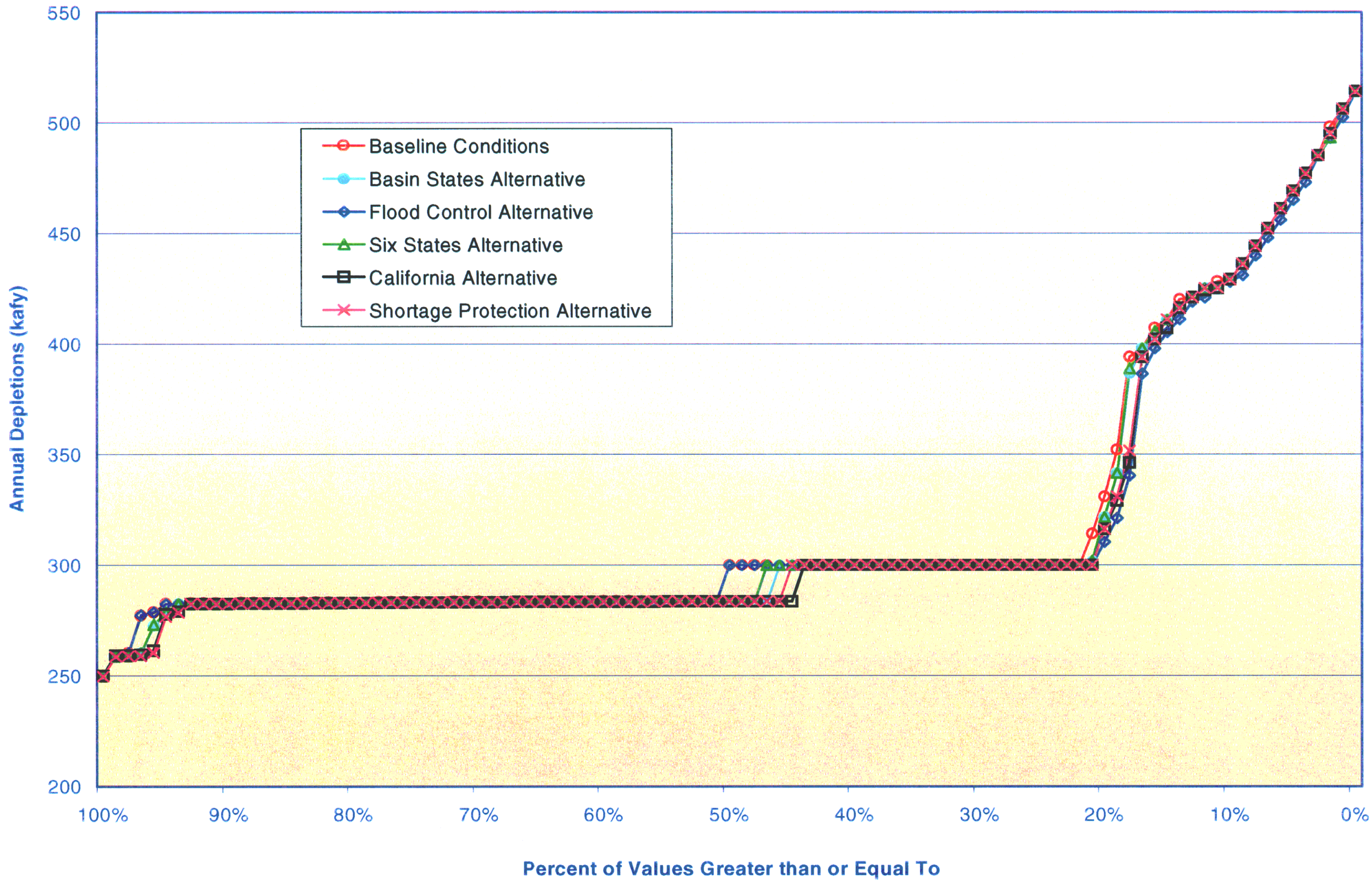
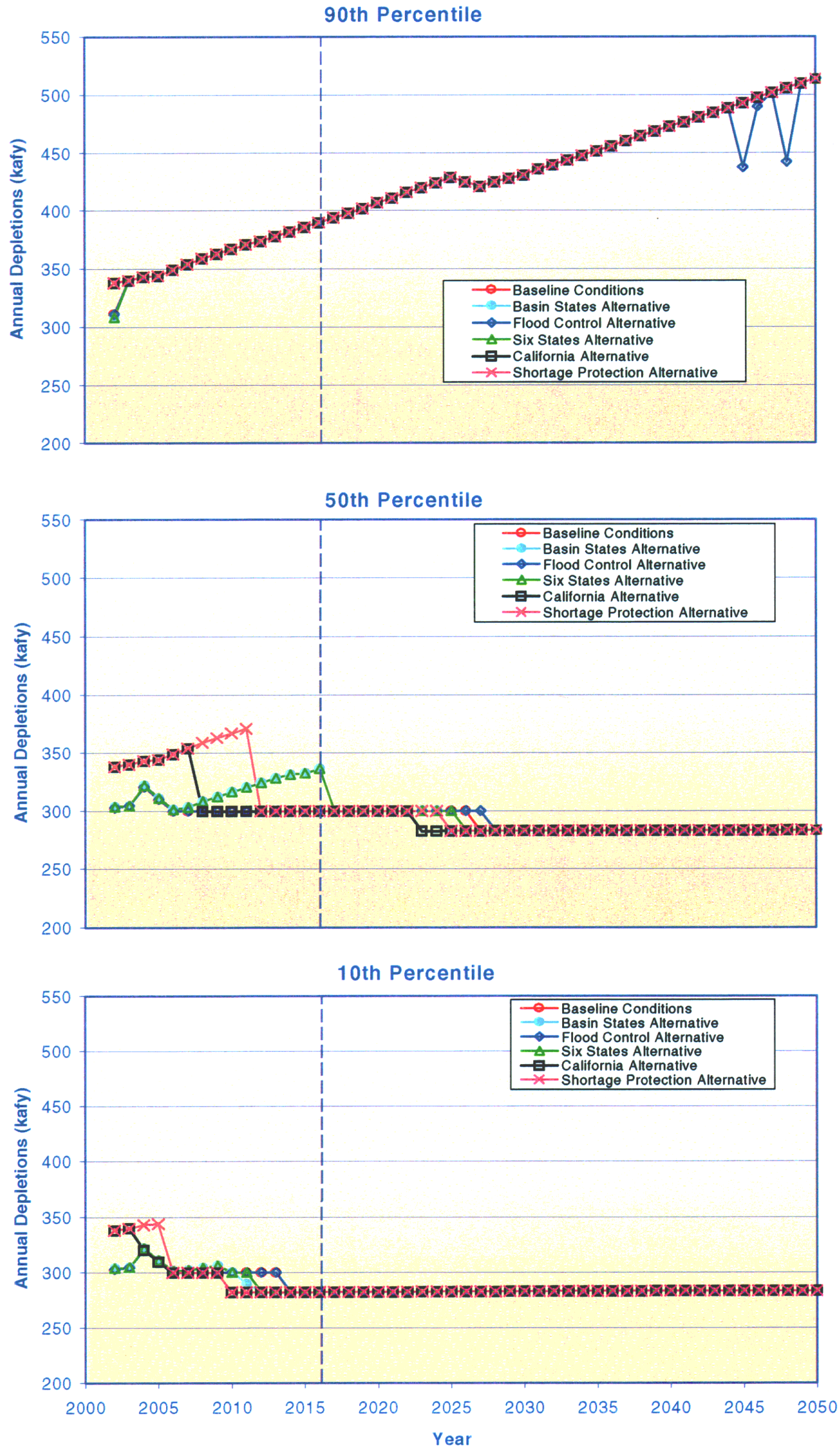


Figure 3.4-16
Nevada Modeled Annual Depletions
Comparison of Surplus Alternatives to Baseline Conditions
90th, 50th and 10th Percentile Values



The 10th percentile lines for the baseline conditions and surplus alternatives generally stay at or above Nevada's Level 1 shortage depletion schedule through year 2009. Between years 2009 through 2013, the 10th percentile lines for the baseline conditions and surplus alternatives drop to and remain at a level equal to Nevada's Level 1 shortage depletion schedule.

Figures 3.4-14 and 3.4-15 presented comparisons of the cumulative distribution of Nevada's depletions under the surplus alternatives to those of the baseline conditions during the interim surplus criteria period (years 2002 to 2016) and the 34-year period that would follow the interim surplus criteria (years 2017 to 2050), respectively. These graphs represent the frequency that different magnitude annual deliveries to Nevada occurred under each respective period. Table 3.4-3 provides a tabular summary of the comparison for these two periods.

Table 3.4-3
Summary of Nevada Modeled Annual Depletions
Comparison of Surplus Alternatives to Baseline Conditions

Alternative/Conditions	Years 2002 to 2016			Years 2017 to 2050		
	Normal	Surplus	Shortage	Normal	Surplus	Shortage
Baseline Conditions	> 96%	47%	< 4%	50%	21%	50%
Basin States	> 92%	87%	< 8%	> 46%	21%	< 54%
Flood Control	> 96%	91%	< 4%	50%	20%	50%
Six States	> 93%	88%	< 7%	> 47%	27%	< 53%
California	> 86%	58%	< 14%	> 44%	21%	< 56%
Shortage Protection	> 88%	11%	< 12%	> 46%	20%	< 54%

*The values under normal represent the total percentage of time that depletions would be at or above the normal depletion conditions.

The percentage values presented under the column heading labeled "Normal" in Table 3.4-3 represent the total percentage of time that depletions under the noted conditions would be at or above the normal depletion schedule amount. The values presented under the column labeled "Surplus" represent the total percentage of time that depletions under the noted conditions exceed the normal depletion schedule amount. The values presented under the column labeled "Shortage" represent the total percentage of time that depletions under the noted conditions would be below the normal depletion schedule amount.

3.4.4.4 UPPER BASIN STATES

There are no specific criteria in the *Law of the River* for surplus or shortage condition water deliveries to users within the Upper Basin states. The normal depletion schedule of the Upper Basin states would be met under most water supply conditions. The exceptions are potential reductions to certain Upper Basin users whose diversions are located upstream of Lake Powell. For these users, the potential reductions would be attributed to dry hydrologic conditions and inadequate regulating reservoir storage capacity upstream of their diversions.

The proposed interim surplus criteria were determined to have no effect on water deliveries to the Upper Basin states, including the Upper Basin Tribes. Therefore, detailed analyses were not necessary for the Upper Basin states' water supply.

3.4.4.5 MEXICO

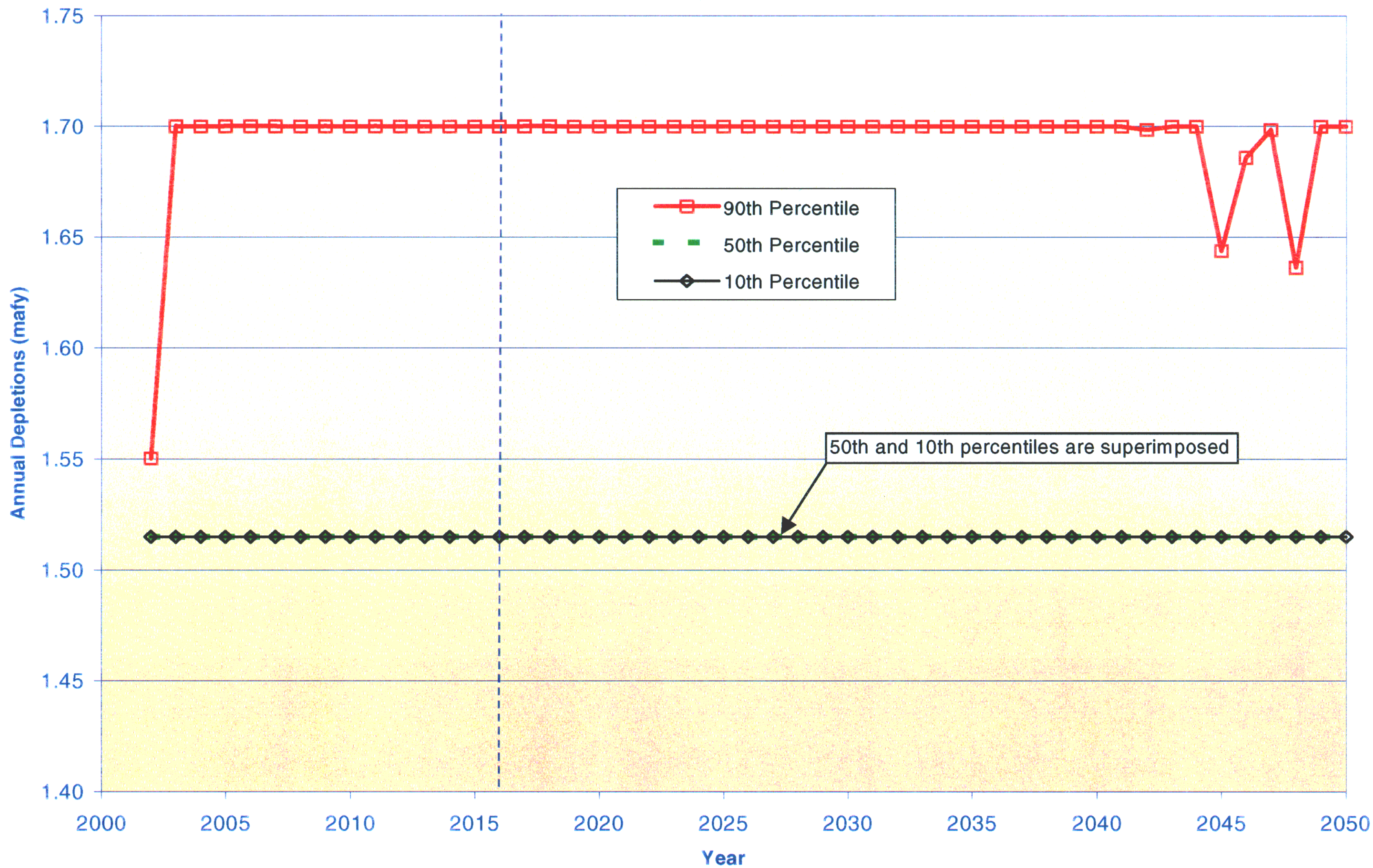
This section presents the simulated water deliveries to Mexico under the baseline conditions and surplus alternatives. As discussed previously, Mexico's normal depletion schedule is modeled as 1.515 maf. An additional 15,000 af is included to account for typical scheduling errors and water that is ordered by the Lower Basin users but that is not diverted. Surplus deliveries to Mexico of up to 200 kaf are delivered under baseline conditions and the surplus alternatives only when Lake Mead makes flood control releases. Shortage deliveries to Mexico would only occur if the CAP were cut to zero and further cuts to MWD and Mexico were necessary to keep the Lake Mead water elevation above 1000 feet msl. This condition was not observed under the baseline conditions or the surplus alternatives.

3.4.4.5.1 Baseline Conditions

The water deliveries to Mexico are projected to be at or above Mexico's normal delivery schedule throughout the 50-year period of analysis. The 90th, 50th and 10th percentile ranking of modeled water deliveries to Mexico under the baseline conditions are presented in Figure 3.4-17.

The 90th percentile line generally coincides with Mexico's depletion schedule during surplus water supply conditions throughout the 50-year period of analysis. The exception to these are the years between 2045 to 2050 when 90th percentile values drop to levels slightly below the full surplus schedule amounts. As indicated by this 90th percentile line, the probability that the baseline conditions would provide Mexico's surplus depletion amount is at least 10 percent throughout the 50-year period of analysis.

Figure 3.4-17
Mexico Modeled Annual Depletions Under Baseline Conditions
90th, 50th and 10th Percentile Values



Under baseline conditions, the 50th and 10th percentile lines coincide with Mexico's normal depletion schedule. Again, it is noted that the depletion amount depicted by both the 50th and 10th percentile lines is equal to 1.515 maf. The 15,000 af above the 1.5 maf Mexico apportionment was added to the model to account for typical scheduling errors and water that is ordered by the Lower Basin users but that is not diverted. Also, it should be noted that the modeled water deliveries to Mexico never dropped below Mexico's normal depletion schedule.

Figure 3.4-18 provides a comparison of the cumulative distribution of Mexico's depletions under the surplus alternatives to those of the baseline conditions during the interim surplus criteria period (years 2002 to 2016). Again, this type of graph is used to represent the frequency that annual deliveries of different magnitudes occur in the respective period. The results presented in Figure 3.4-18 indicate a 100 percent probability that Mexico's depletions would meet or exceed its normal depletion schedule during this period under the baseline conditions. The probability that Mexico would receive surplus condition deliveries during this period was approximately 26 percent under baseline conditions. The maximum surplus condition depletion under the baseline conditions was 1.7 maf during this period.

Figure 3.4-19 provides a comparison of the cumulative distribution of the water deliveries to Mexico under the surplus alternatives to those of the baseline conditions for the 34-year period (years 2017 to 2050) that would follow the interim surplus criteria period. The results presented in Figure 3.4-19 also indicate a 100 percent probability that water deliveries to Mexico would meet its normal depletion schedule during this period under the baseline conditions. The probability that Mexico would receive surplus condition deliveries during this same period under the baseline conditions was approximately 19 percent. The maximum surplus condition depletion under the baseline conditions was also 1.7 maf during this period.

Figure 3.4-18
Mexico Modeled Depletions
Comparison of Surplus Alternatives to Baseline Conditions
Years 2002 to 2016

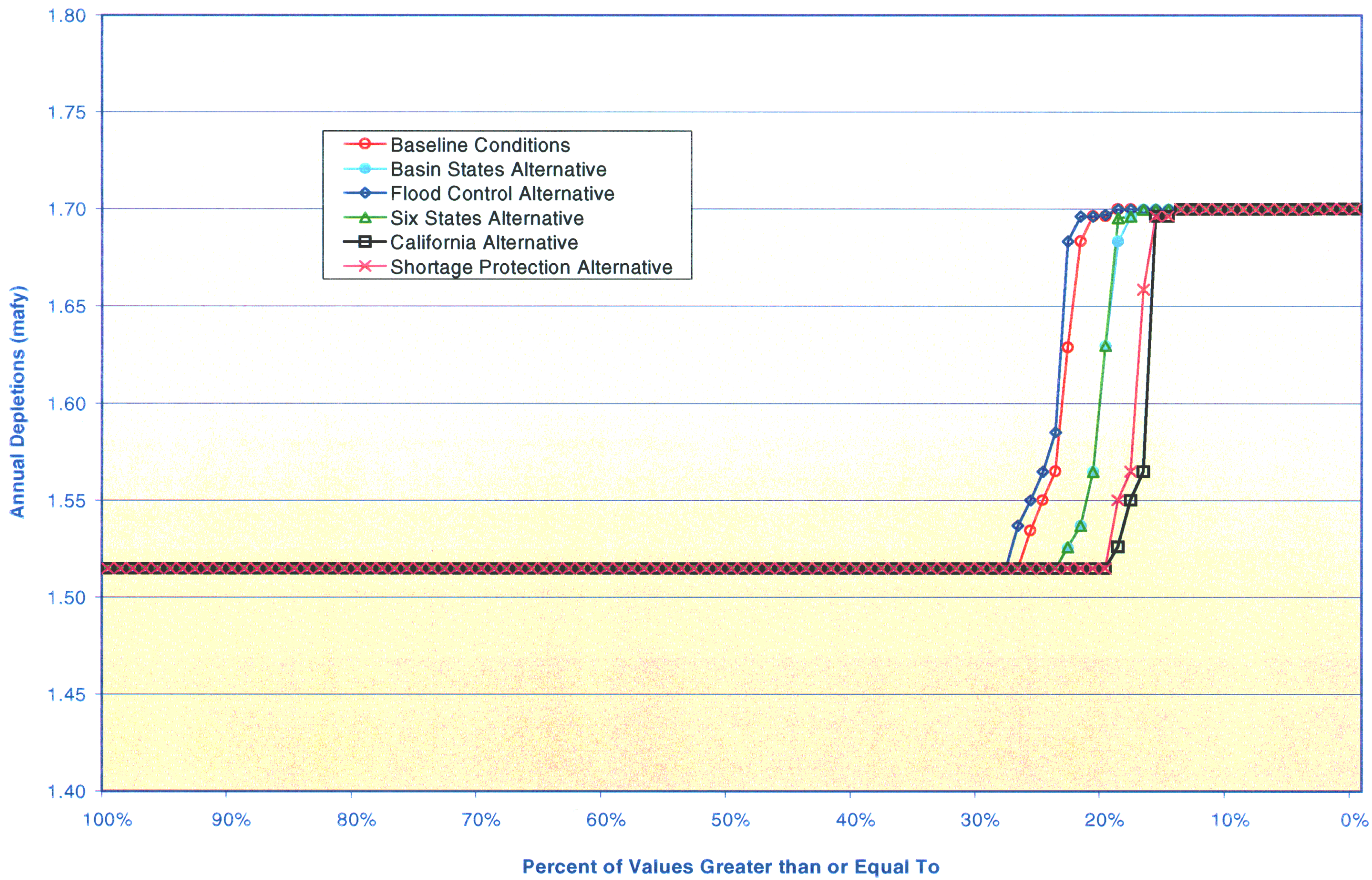
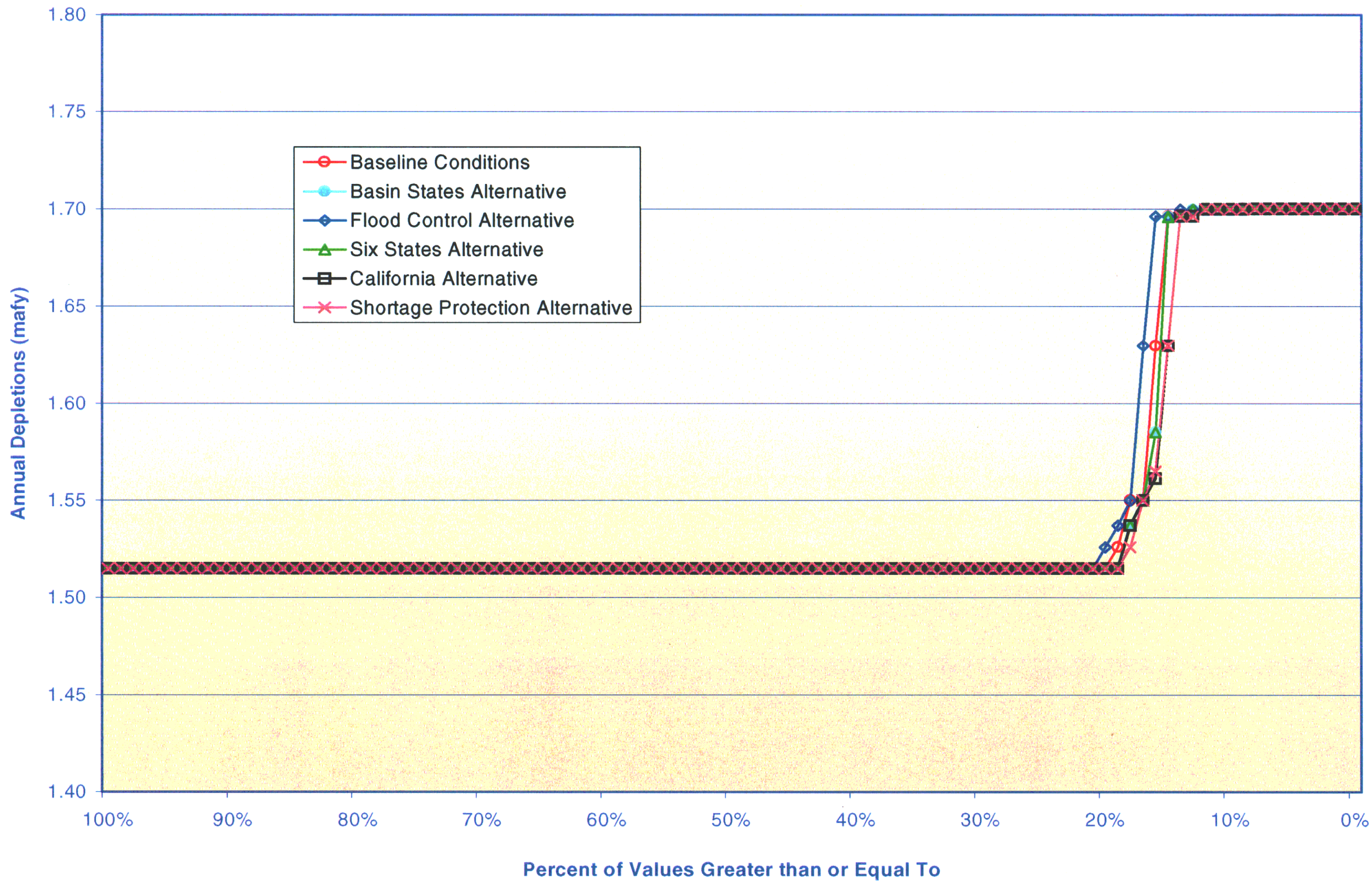


Figure 3.4-19
Mexico Modeled Depletions
Comparison of Surplus Alternatives to Baseline Conditions
Years 2017 to 2050



3.4.4.5.2 Comparison of Surplus Alternatives to Baseline Conditions

Figure 3.4-20 provides a comparison of the 90th, 50th and 10th percentile values for Mexico's depletions under the surplus alternatives to those of the baseline conditions.

As noted in Figure 3.4-20, there is essentially no difference in the 90th percentile lines resulting from the surplus alternatives when compared to those of the baseline conditions. The 90th percentile lines generally coincide with Mexico's surplus depletion schedule.

The 50th and percentile lines for all the surplus alternatives and the baseline conditions coincide with Mexico's normal depletion schedule. Again, water deliveries to Mexico were not observed to fall below Mexico's 1.5 maf apportionment.

Figures 3.4-18 and 3.4-19 presented comparisons of the cumulative distribution of Mexico's depletions under the surplus alternatives to those of the baseline conditions during the interim surplus criteria period for years 2002 to 2016 and the 34-year period that follows the interim surplus criteria (years 2017 to 2050), respectively. Table 3.4-4 provides a tabular summary of the comparison for these two periods.

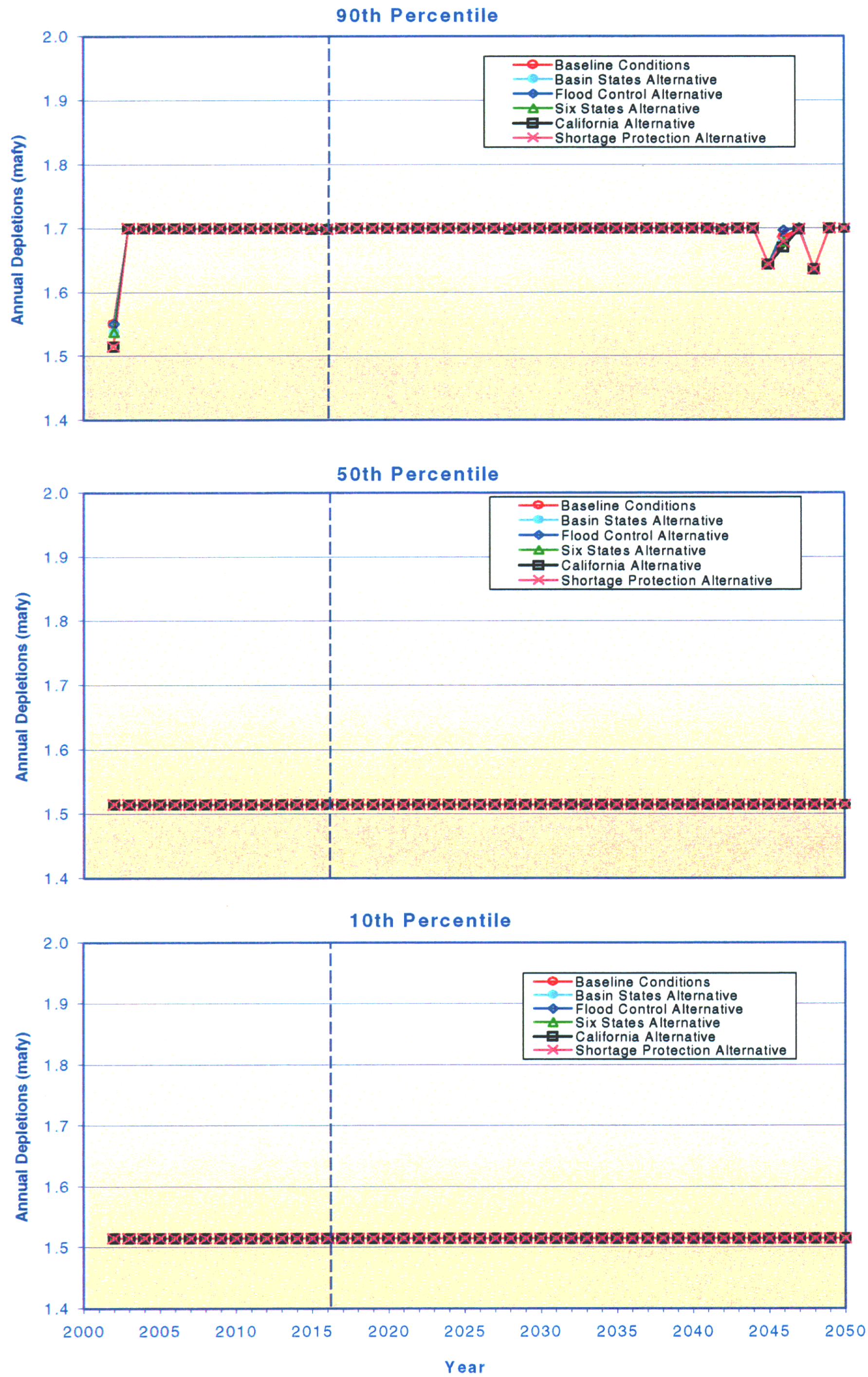
Table 3.4-4
Summary of Mexico Modeled Annual Depletions
Comparison of Surplus Alternatives to Baseline Conditions

Alternative/Conditions	Years 2002 to 2016			Years 2017 to 2050		
	Normal*	Surplus	Shortage	Normal*	Surplus	Shortage
Baseline Conditions	100%	26%	0%	100%	19%	0%
Basin States	100%	23%	0%	100%	18%	0%
Flood Control	100%	27%	0%	100%	20%	0%
Six States	100%	23%	0%	100%	18%	0%
California	100%	19%	0%	100%	18%	0%
Shortage Protection	100%	19%	0%	100%	18%	0%

*The values under normal represent the total percentage of time that depletions would be at or above the normal depletion conditions.

The percentage values presented under the column heading labeled "Normal" in Table 3.4-4 represent the total percentage of time that depletions under the noted conditions would be at or above the normal depletion schedule amount. The values presented under the column labeled "Surplus" represent the total percentage of time that depletions under the noted conditions exceed the normal depletion schedule amount. The values presented under the column labeled "Shortage" represent the total percentage of time that depletions under the noted conditions would be below the normal depletion schedule amount.

Figure 3.4-20
Mexico Modeled Annual Depletions
Comparison of Surplus Alternatives to Baseline Conditions
90th, 50th and 10th Percentile Values



3.5 WATER QUALITY

3.5.1 INTRODUCTION

This section addresses the salinity of the Colorado River and mainstream reservoirs, and the quality of Lake Mead water available for municipal and industrial purposes. The potential changes in the operation of the Colorado River system downstream from Lake Powell under interim surplus criteria alternatives could temporarily affect the salinity of Colorado River water, which affects municipal and industrial uses in the Lower Basin. In addition, changes in Lake Mead water levels could affect the quality of water arriving at the SNWS pump intakes in the Boulder Basin of Lake Mead, and thereby affect the quality of the water supply for the Las Vegas Valley.

3.5.2 COLORADO RIVER SALINITY

This section discusses potential effects that could result from the implementation of the interim surplus criteria alternatives under consideration. Salinity has long been recognized as one of the major problems of the Colorado River. "Salinity" or "total dissolved solids" (TDS) include all of the soluble constituents dissolved in a river and the two terms are used interchangeably in this document. This section considers potential changes in salinity concentrations from Lake Mead to Imperial Dam. The section also presents a general discussion of the adverse effects of increased salinity concentrations on municipal and industrial systems.

3.5.2.1 METHODOLOGY

Reclamation's model for salinity is used to create salinity reduction targets for the Colorado River Basin Salinity Control Program (SCP). To do this, the model simulates the effects of scheduled water development projects to predict future salinity levels. This data is then used to compute the amount of new salinity control projects required to reduce the river's salinity to meet the standards at some point in the future (2015). The model itself does not include future salinity controls because implementation schedules for future salinity control projects are not fixed and vary considerably. The salinity control standards are purposefully designed to be long-term (nondegradation) goals, rather than exceedence standards used for industry or drinking water.

By definition, the SCP is designed to be flexible enough to adjust for any changes caused by the various alternatives being considered. Therefore, it could be concluded that there would be no change in compliance with the standards caused by selecting any one of the alternatives. However, for the purposes of this analysis, each alternative has been evaluated using fixed (existing) levels of salinity controls to identify the differences between alternatives and the baseline conditions.

General effects of salinity were determined from review of records of historic river flow and salinity data available and economic impacts presented in *Quality of Water Colorado River Basin – Progress Report No. 19*, 1999, U.S. Department of the Interior; *Water Quality Standards for Salinity Colorado River System, 1999 Review*, June 1999, Colorado River Basin Salinity Control Forum and *Salinity Management Study*, Technical Appendices, June 1999, Bookman-Edmonston Engineering, Inc.

The salinity program as set forth in the Forum's 1999 Annual Review enables the numeric criteria to be met through the year 2015. Therefore, it was presumed that the criteria would be maintained through 2015. Although the 1999 Review considers only the period to 2015, it was presumed that future additions to the salinity control program will be sufficient to maintain the criteria through 2050.

3.5.2.2 AFFECTED ENVIRONMENT

3.5.2.2.1 Historical Data

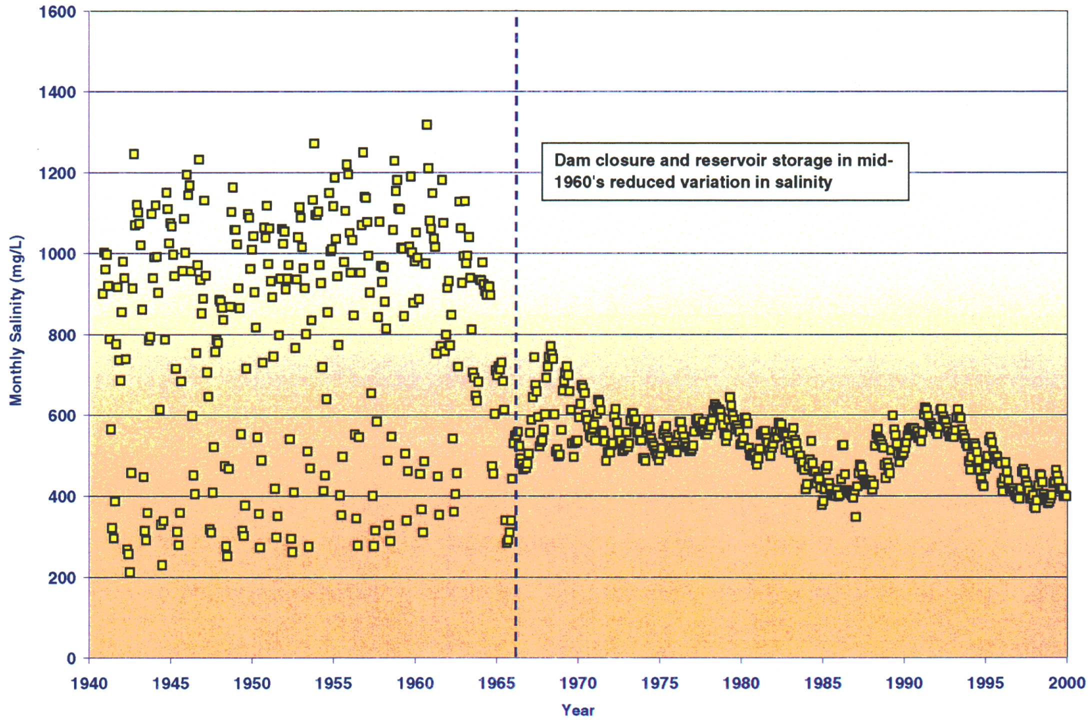
The Colorado River increases in salinity from its headwaters to its mouth, carrying an average salt load of nine million tons annually past Hoover Dam. Approximately half (47 percent) of the salinity concentration is naturally caused and 53 percent of the concentration results from human activities including agricultural runoff, evaporation and municipal and industrial sources (Forum, 1999).

Salinity of the river has fluctuated significantly over the period of record 1941 through 1997. Below Hoover Dam, annual salinity concentrations have ranged from 833 milligrams per liter (mg/l) in 1956 to 517 mg/l in 1986. However, the maximum monthly fluctuation in any year is approximately 50 mg/l. Salinity of the river is influenced by numerous factors including reservoir storage, water resource development (and associated return flows), salinity control, climatic conditions and natural runoff.

The impact of reservoir storage has all but eliminated seasonal fluctuations in salinity. Annual variations in salinity are primarily driven by natural, climatic variations in precipitation and snowmelt runoff. These hydrologic variations cause differences in both flow and salinity.

As shown in Figure 3.5-1, the salinity of the river varied by as much as 1000 mg/l prior to the construction of Glen Canyon Dam in 1961. By the 1980s, that variation was reduced to about 200 mg/l due to the mixing and dampening effect of the large volume of storage in Lake Powell. Figures 3.5-2 and 3.5-3 show the comparison between mainstream flows and salinity. Figure 3.5-2 shows the outflow from Glen Canyon and Imperial Dams. Figure 3.5-3 shows the salinity at Imperial, Hoover and Glen Canyon dams.

Figure 3.5-1
Historical Monthly Salinity Concentrations Below Glen Canyon Dam (1940-1995)



3.5.2.2.2 Regulatory Requirements and Salinity Control Programs

In 1972, the EPA promulgated regulations requiring water quality standards for salinity, numeric criteria and a plan of implementation for salinity control. The Seven Colorado River Basin States, acting through the Forum, adopted numeric criteria for flow-weighted average annual salinity, at three points on the river as shown below:

Below Hoover Dam	723 mg/l
Below Parker Dam	747 mg/l
At Imperial Dam	879 mg/l

Figure 3.5-2
Historical Glen Canyon Dam and Imperial Dam Releases

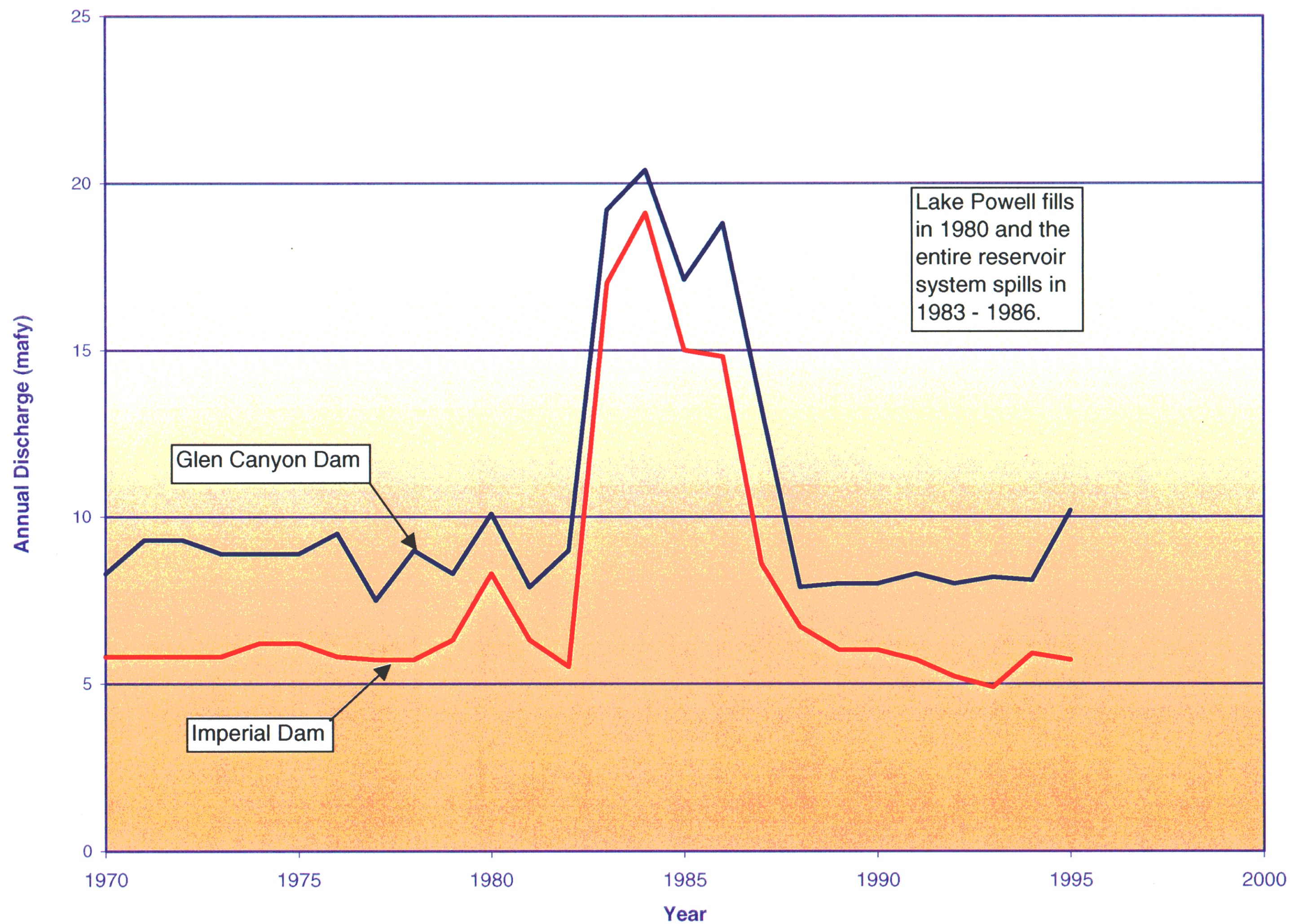
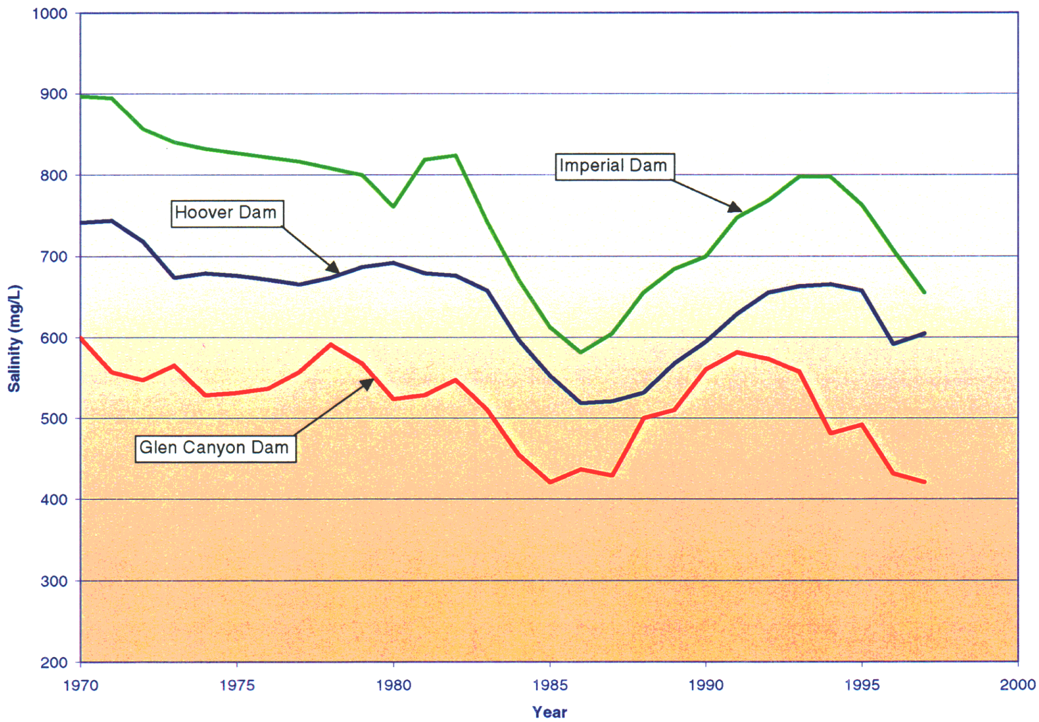


Figure 3.5-3
Historical Salinity Concentrations of Releases from Glen Canyon, Hoover, and Imperial Dams



These criteria applied only to the lower portion of the Colorado River from Hoover Dam to Imperial Dam. Below Imperial Dam, salinity control is a federal responsibility to meet the terms of Minute 242 to the U.S.-Mexico Water Treaty of 1944. Minute 242 requires that salinity concentrations upstream of Mexico's diversion be no more than 115 mg/l $\pm$ 30 mg/l TDS higher than the average salinity of water arriving at Imperial Dam.

In 1974, the Colorado River Basin Salinity Control Act (P.L. 93-320) was enacted. The Act contains two Titles: 1) Title I provides the means for the United States to meet its commitment to Mexico; and 2) Title II creates a salinity control program within the Colorado River Basin in order that the numeric criteria will be maintained while the Basin States continue to develop their apportionment of Colorado River water.

The federal/state salinity control program is designed to maintain the flow-weighted average annual salinity at or below the numeric criteria. The program is not intended to counteract short-term salinity variations resulting from short-term water supply. Federal regulations provide for temporary increases above the criteria due to natural variations in flows.

The seven Basin States acting through the Forum reviews the numeric criteria and plan of implementation every three years and makes changes in the plan of implementation to accommodate changes occurring in the Basin States. The latest review was in 1999. The review is currently undergoing adoption by the Basin States and approval by EPA.

At each triennial review, the current and future water uses are analyzed for their impact on the salinity of the Colorado River. If needed, additional salinity control projects are added to the plan to assure compliance with the standards.

The need for one or more additional salinity control projects is determined by monitoring the salinity of the river and making near-term projections of changes in diversions from and return flows to the river system. When an additional project is needed, it is selected from a list of potential projects that have undergone feasibility investigation. A proposal to implement the project is made through coordination with the Basin States. In selecting a project, considerable weight is given to the relative cost-effectiveness of the project. Cost-effectiveness is a measure of the cost per ton of salt removed from the river system or prevented from entering the river system. Other factors are also considered, including environmental feasibility and institutional acceptability.

It is estimated that 1,478,000 tons of salt will need to be removed or prevented from entering the Colorado River system to maintain the salinity concentration at or below the criteria through 2015. To date, over 720,000 tons have been controlled and an additional 756,000 tons will need to be controlled through 2015.

3.5.2.2.3 General Municipal, Industrial, and Agricultural Effects of Increased Salinity Concentrations

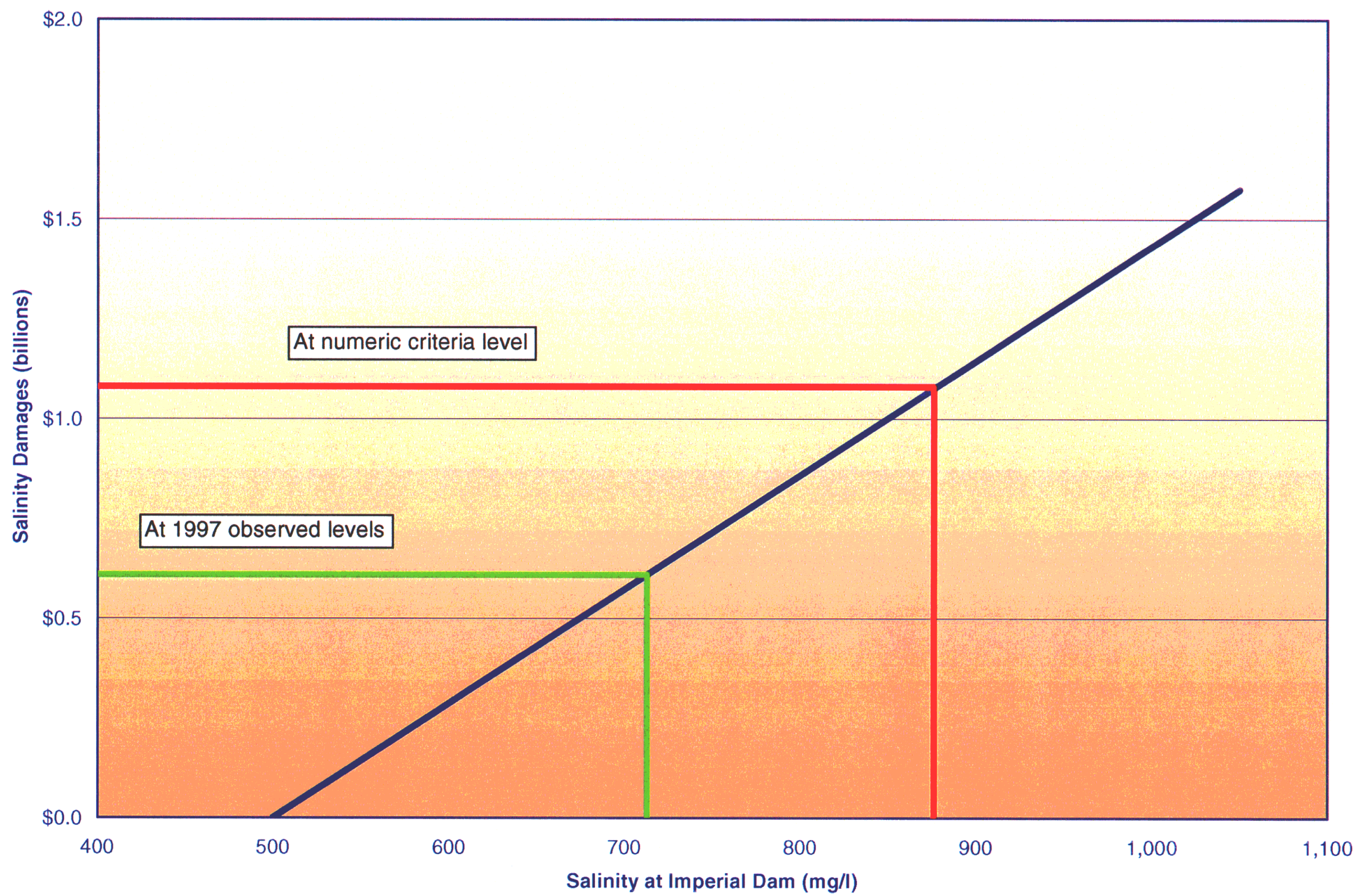
High salinity concentrations can cause corrosion of plumbing, reduce the life of water-using appliances, and require greater use of cleaning products. Industrial users incur extra water treatment costs. Increased salinity in drinking water can create unpleasant taste, often resulting in the purchase of bottled water or water treatment devices. Agriculture experiences economic losses from high salinity through reduced crop productivity and the need to change from less salt-tolerant high value crops, to more salt-tolerant low value crops. Increased salinity can also require more extensive agricultural drainage systems.

High salinity is a significant constraint to water recycling and groundwater replenishment programs. Compliance with regulatory requirements imposed by local water quality management programs to protect groundwater supplies can add significantly to the economic impacts. Restrictions have been placed on reuse or recharge of waters that exceed specific salinity levels. Such restrictions significantly constrain groundwater replenishment programs and wastewater reuse programs. Should salinity of the Colorado River increase, these regulatory actions could create a need for more expensive water treatment processes, such as reverse osmosis, prior to disposal or reuse. If disposal is selected, additional water supplies would need to be developed to meet demands that could have been met by water reuse.

Reclamation has determined that the economic damages from Colorado River salinity in the three Lower Division states served by Colorado River water amount to $2.5 million per mg/l. Figure 3.5-4 shows the relationship between costs of damages and salinity concentrations.

Therefore it is assumed for this analysis that the baseline conditions will reflect the numeric criteria at each station of interest (below Hoover Dam, below Parker Dam, and at Imperial Dam).

Figure 3.5-4
Estimated Cost of Damages Associated with Increased Salinity Concentrations



3.5.2.3 ENVIRONMENTAL CONSEQUENCES

The effects of the alternatives on the salinity of Colorado River water focus on their differences from baseline conditions. Since the current model configuration does not include any salinity control projects beyond those currently in place, modeling of baseline conditions indicates increases in salinity due to projected increased water consumption in the Upper Basin. However, in practice, these increases would be offset by salinity control projects that would continue to be implemented.

Tables 3.5-1 and 3.5-2 present these differences for years 2016 and 2050, respectively. The TDS values represent the mean values for the flow-weighted annual averages for the given year. The first column under each monitoring station heading in the tables presents the model projected TDS concentrations under the five alternatives calculated by applying the difference to the baseline TDS level. The second column presents the difference between the values for each alternative compared with baseline conditions.

As shown in Table 3.5-1, there is, in general, very little effect on TDS (less than one percent) due to interim surplus criteria in the year 2016. The exception is the decrease at Imperial Dam for the California Alternative of 19 mg/l (about 2.2 percent). This is due to the assumption in the model of an additional transfer from PVID to MWD of 100,000 af during normal and Tier 3 surplus conditions, which reduces the salt pickup in the return flows.

In general, the surplus alternatives tend to decrease TDS values slightly. These decreases are due to increased equalization releases from Lake Powell relative to baseline.

As shown in Table 3.5-2, interim surplus criteria have no effect on TDS values by the year 2050, with the exception of the PVID to MWD transfer assumed in the California Alternative.

3.5.3 LAKE MEAD WATER QUALITY AND LAS VEGAS WATER SUPPLY

This analysis addresses potential impacts of interim surplus criteria alternatives on water quality in Lake Mead, and potential changes to water quality and levels of contaminants at the SNWA intakes. This is a qualitative analysis based on system modeling and existing limnological studies.

3.5.3.1 METHODOLOGY

Evaluation of the environmental consequences of each operational alternative to Lake Mead water quality and Las Vegas water supply are based on a qualitative assessment of existing limnological and hydrodynamic data, and hydrologic modeling as discussed in Section 3.3. Each interim surplus criteria alternative was modeled for comparison to baseline projections. Modeling focused on the probability of decreased Lake Mead

Table 3.5-1
Estimated Colorado River Salinity in 2016
Unit: Total Dissolved Solids (mg/l)

Alternative	Below Hoover Dam		Below Parker Dam		At Imperial Dam	
	Value	Departure from Baseline	Value	Departure from Baseline	Value	Departure from Baseline
Baseline Conditions[1]	723	NA	747	NA	879	NA
Basin States	719	-2	737	-2	879	0
Flood Control	723	0	745	-0	879	0
Six States	719	-2	738	-2	881	0
California	712	-5	734	-5	853	-19
Shortage Protection	715	-4	736	-4	872	-3

1 Baseline conditions assume compliance with the numeric criteria at the locations cited.

Table 3.5-2
Estimated Colorado River Salinity in 2050
Unit: Total Dissolved Solids (mg/l)

Alternative	Below Hoover Dam		Below Parker Dam		At Imperial Dam	
	Value	Departure from Baseline	Value	Departure from Baseline	Value	Departure from Baseline
Baseline Conditions[1]	723	NA	747	NA	879	NA
Basin States	723	0	747	0	877	0
Flood Control	723	0	747	0	879	0
Six States	723	0	747	0	878	0
California	722	-1	745	0	857	-24
Shortage Protection	722	-1	747	0	876	0

1 Baseline conditions assume compliance with the numeric criteria at the locations cited.

surface elevations, which could exacerbate effects of discharge of Las Vegas Wash water into Boulder Basin.

Assessment of potential effects on water quality of Lake Mead, including consideration of Las Vegas Wash inflow on the SNWA intake, relied primarily on system modeling information associated with the probability of future Lake Mead surface elevations. Previous studies of Lake Mead were also an important source of information, particularly those focusing on Boulder Basin, Las Vegas Wash, and hydrodynamics potentially affecting intake water quality.

As discussed in Section 3.3, modeling identified probabilities associated with surface water elevations under baseline conditions as well as projections associated with implementation of the interim surplus criteria alternatives over a 50-year period. As discussed previously, model output utilized for this water quality analysis assumes shortage determinations would occur, if necessary, to protect a surface elevation of 1083 feet msl, which is the Lake Mead minimum power pool elevation. The primary SNWA intake at Saddle Island is at 1050 feet msl, and the secondary intake is at 1000 feet msl. Thus, assuming a strategy to protect 1083 feet msl also provides a level of protection to SNWA's intake water quality.

As discussed below, contaminant dilution and lake water quality are directly proportional to lake volume. As such, a critical element in this assessment is a comparison of projected Lake Mead volumes under the five action alternatives relative to baseline conditions. Using hydrologic modeling output, median Lake Mead volumes and surface areas were identified for each of the alternatives associated with projected reservoir elevations under the median modeled probabilities. Modeling results indicating these parameters were then developed for the years 2016, 2026, 2036, and 2050. Separate comparisons were then made of the volume and surface area for each alternative as compared to baseline conditions.

3.5.3.2 AFFECTED ENVIRONMENT

The focus of this section is a description of the affected environment related to Lake Mead water quality and the SNWA intake locations, with specific consideration of hydrodynamics of the Colorado River Basin, limnology and water quality (factors that may be influenced by implementation of interim surplus criteria alternatives).

3.5.3.2.1 General Description

Lake Mead is a large mainstream Colorado River reservoir in the Mohave Desert, within the States of Arizona and Nevada as shown on Map 3.2-1. Lake Mead, formed in 1935 following the construction of Hoover Dam, is the largest reservoir in the United States by volume (26 maf active storage). At full pool (reservoir elevation 1221 feet msl), Lake Mead extends 108 miles from Black Canyon (Hoover Dam) to Separation Canyon at the upstream end. Lake Mead has four large sub-basins including Boulder, Virgin, Temple and Gregg. Between these basins are four narrow canyons: Black, Boulder, Virgin and Iceberg. Over 170,000 square miles of the Colorado River Basin watershed are located above Hoover Dam. Boulder Basin, SNWA intake locations and the Las Vegas Wash are shown on Map 3.5-1.

The Muddy and South Virgin mountains border the reservoir on the north, and the Virgin and Black mountains and various desert hills border the reservoir on the south. The shoreline is extremely irregular with a Shoreline Development Value (SLD) of 9.7 (Paulson and Baker, 1981). SLD is the ratio of the length of the shoreline of a lake or reservoir to the length of the circumference of a circle with an area equal to that of the lake (Wetzel, 1975). The shoreline includes several large bays, including Las Vegas and Bonelli, and numerous coves. The principal morphometric characteristics of Lake Mead are summarized below in Table 3.5-3.

Table 3.5-3
Morphometric Characteristics of Lake Mead

Parameter	Units	Value
Normal operating level (spillway crest)	feet	1,205
Maximum depth	feet	590
Mean depth	feet	180
Surface area	square miles	231
Volume (including dead storage)	maf	30
Maximum length	miles	108
Maximum width	miles	17
Shoreline development	Index Value	9.7
Discharge depth	feet	310
Annual discharge (approximate)	maf	10
Replacement time at maximum operating level	years	3.9

Derived from Interior (1966), Lara and Sanders (1970), Hoffman and Jonez (1973)

LaBounty and Horn (1997) conducted a study of the influence of drainage from the Las Vegas Valley on the limnology of Boulder Basin that is highly relevant to the issue addressed in this section. Unless otherwise noted, the descriptions of reservoir characteristics, hydrodynamics, and general limnology of Lake Mead are drawn from this study.

The Colorado River contributes about 98 percent of the annual inflow to Lake Mead; the Virgin and Muddy rivers and Las Vegas Wash provide the remainder. Annual flows from Las Vegas Wash are approximately 155,000 af, providing the second highest inflow into Lake Mead. Discharge from Hoover Dam is hypolimnetic and occurs 285 feet below the normal operating shown above (1205 feet msl). Average annual discharge is approximately 10 maf.

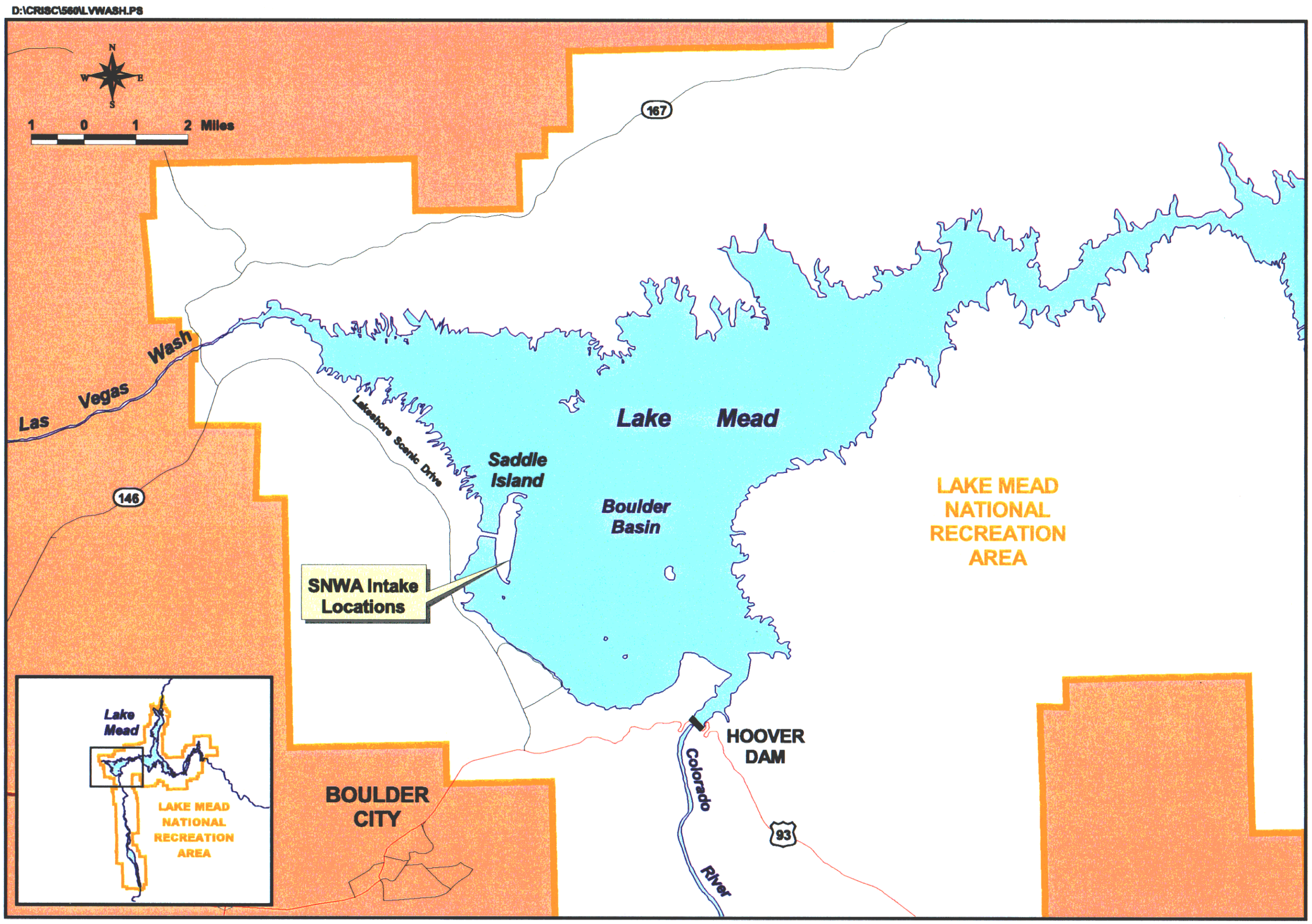
Boulder Basin, the lowermost basin of Lake Mead, receives all nonpoint surface and groundwater discharges and treated effluent from the Las Vegas Valley and municipal wastewater treatment facilities via drainage from Las Vegas Wash into Las Vegas Bay. Boulder Basin is 9.3 miles wide from Boulder Canyon to Hoover Dam (Black Canyon), and the distance from the confluence of Las Vegas Wash to Hoover Dam is approximately 9.9 miles. The historical Colorado River channel lies along the eastern side of Boulder Basin.

Due to effects of urban runoff and treatment plant effluents on the discharge through Las Vegas Wash (discussed later in this section), Boulder Basin has the highest nutrient concentrations in the Lake Mead system (Paulson and Baker, 1981; Prentki and Paulson, 1983). This is in contrast to the normal upstream-downstream decrease in the pattern of productivity more typical of reservoirs, and results in several limnological features within Boulder Basin that are normally associated with upstream reaches (Kimmel et al., 1990).

Overall, Lake Mead is mildly mesotrophic based on several classification indices (Vollenweider 1970; Carlson 1977), including chlorophyll *a* concentration and secchi transparency measurements. Chlorophyll concentration is a measure of algal biomass and can, therefore, be interpreted as an index of lake productivity. Secchi disk measurements are used to determine the depth to which light penetrates lake water and help to establish the euphotic zone which marks that area of a lake where primary productivity (energy production by photosynthesis) occurs.

Due to abundant nutrient input into Las Vegas Bay, chlorophyll concentrations have been measured greater than 100 milligrams per cubic meter (mg/m^3). Secchi transparency readings of less than two feet have been measured in the inner bay (LaBounty and Horn, 1997). However, secchi transparency increases to over 16 feet, and chlorophyll *a* is reduced by 90 percent within the first 2.6 miles from the Las Vegas Wash inflow. These findings suggest that Boulder Basin is a relatively isolated embayment and that it is much more productive than the lake as a whole.

Map 3.5-1
Las Vegas Wash and SNWA Lake Mead Intake Facilities at Saddle Island



The Federal Water Pollution Control Act (Clean Water Act) Amendments of 1972 and 1977 require the control of all sources of water pollution in meeting the goals of the Act. Section 208 of the Act requires that all activities associated with water pollution problems are planned and managed through an integrated area-wide water quality management program. It also defines the schedule and scope of area-wide wastewater treatment management plans. The 1997 Las Vegas Valley 208 Water Quality Management Plan Amendment certified by the State of Nevada and EPA, is a 20-year plan that comprehensively addresses the quality and quantity of the Valley's point source (discharges from wastewater treatment facilities) and non-point sources (groundwater, stormwater issues, Las Vegas Wash, agricultural diffuse sources), and revisions of water quality standards.

The water quality requirements currently being met by the wastewater discharges of the Las Vegas Valley have a long history. Beginning in the 1950s with requirements for secondary treatment, through the 1970s and the promulgation of the Clean Water Act, and into the 1990s with more advanced nutrient removal requirement, the quality and volume of treated wastewater discharged to Lake Mead has continued to increase and will continue to meet standards into the future through the Section 208 process (Clark County, 1997).

The Lake Mead Water Quality Forum, established by the Nevada Division of Environmental Protection (NDEP), has been identified in the Plan as an avenue for coordinated research opportunities and solutions to the water quality issues that face Las Vegas Valley and Lake Mead in the future. The forum is comprised of federal, state and local agencies with a vested interest in Lake Mead's water quality. The Lake Mead Water Quality forum is responsible for issue identification, coordination and defining the process approach in identifying issues regarding water quality and potential impacts to the water supply. The Las Vegas Wash Coordination Committee (LVWCC) is comprised of more than two dozen members of local, state, and federal agencies, business owners and members of the public. The LVWCC was tasked with the support, development and implementation of the Las Vegas Wash Comprehensive Adaptive Management Plan (LVWCAMP). The planning phase of the LVCAMP is now complete, and various actions presented in the plan are currently in progress to restore the wash, its wetlands, and its ability to improve the quality of return flows into Lake Mead. Reclamation is an active member of both of these groups and has been independently funding research on Lake Mead water quality prior to their formation and is now a funding partner with other agencies for ongoing studies on the Wash and Lake Mead. Water quality in Lake Mead and Las Vegas Wash are the subject of numerous articles and the chemical and physical analyses of raw and treated Lake Mead source water is published on SNWA's website (http://www.snwa.com).

3.5.3.2.2 Lake Mead Water Quality and Limnology

Water quality of Lake Mead and the Colorado River is alkaline with a pH of 8.3 and an average concentration of TDS of approximately 700 mg/l. Chemical characteristics of the river at the inflow to Lake Mead, near the outflow at Hoover Dam, and at Lake Mohave are shown below in Table 3.5-4.

Table 3.5-4
Chemical Characteristics of Colorado River

Parameter	Units	Gage Station Location[1]		
		Grand Canyon	Hoover Dam	Davis Dam
pH		8.0	7.7	8.0
Conductivity	umho/cm^2	945	1086	1089
Total Dissolved Solids	mg/l	617	705	714
Calcium	mg/l	74	86	84
Magnesium	mg/l	26	28	29
Potassium	mg/l	4.1	4.9	5.0
Bicarbonate	mg/l	170	163	157
Sulfate	mg/l	228	283	293
Chloride	mg/l	79	85	87
Silica	mg/l	7.0	8.3	7.8
Nitrate	mg/l	.50	.41	.28
Phosphate	mg/l	.010	.013	--

[1]USGA data, average for October 1975 – September 1976

The principal constituents of TDS are the anions of sulfate, carbonate and chloride and the cations of sodium, calcium, magnesium and potassium. Nitrate concentrations are moderate (0.28 to 0.50 mg/l), but phosphorus is extremely low (0.01 to 0.03 mg/l). Silica is present in very high concentrations (7.0 to 8.3 mg/l).

Limnological investigations of Lake Mead have found that 80 percent of the inorganic nitrogen within the lake is provided by the Colorado River, and that Las Vegas Wash contributes 70 percent of the inorganic phosphorus (Paulson, Baker, Deacon, 1980). The Upper Basin of Lake Mead was found to be phosphorus-limited, and the Lower Basin nitrogen-limited during the summer. Equal proportions of nitrogen and phosphorous were retained in the Upper Basin of Lake Mead, but nitrogen retention decreased to seven percent, and phosphorus to 33 percent in the Lower Basin. Additionally, the high nitrate loss from Hoover Dam greatly reduced nitrogen retention in the Lower Basin of Lake Mead.

In 1978 the EPA estimated that Lake Mead retained 93 percent of the total phosphorus input versus 52 percent of total nitrogen (EPA, 1978). Phosphorus concentrations are low in the Upper Basin of the lake due to the low input from the Colorado River, a result of sediment trapping that occurs upstream within Lake Powell.

As recently as 1998, new contaminants to Lake Mead have been discovered as a part of the nonpoint pollutant load of Las Vegas Wash (EPA, 2000). Perchlorate has been detected in the water of the Colorado River and Lake Mead. Ammonium perchlorate is manufactured as an oxygen-adding compound in solid rocket fuel propellant, missiles and fireworks. The EPA identified two facilities that manufactured ammonium perchlorate in Henderson, Nevada, that were found to have released perchlorate to groundwater, resulting in four to 16 parts per billion (ppb) concentrations in Lake Mead and the Colorado River (EPA, 2000).

The NDEP and the SNWA have initiated a collective investigation to locate and clean up perchlorate in the Colorado River system in coordination with the EPA. The primary objectives are to locate the source, the groundwater discharge sources, clean it up, and prevent it from becoming a problem in the future. The EPA has not established concentration levels of perchlorate because it is not considered a water contaminant. However, California's Department of Health Services and NDEP have established an interim action level of 18 ppb for drinking water. Concentrations lower than 18 ppb are not considered to pose a health concern for the public, including children and pregnant women. All SNWA drinking water has tested at 11 ppb or lower for perchlorate. Average perchlorate values for water samples collected at their intake were 9.5 ppb between June 1999 and August 2000. Perchlorate is not regulated under the Federal Safe Drinking Water Act and thus information is limited regarding its potential health risks but it is known to affect how the thyroid processes iodine and is used to treat Graves Disease. In March 1998, perchlorate was added to the Contaminant Candidate List as part of the Safe Drinking Water Act due to the concern over potential public health impact, need for additional research in areas of health effects, treatment technologies, analytical methods, and more complete occurrence data.

The SNWA identified a major surface flow of perchlorate-laden water from a groundwater discharge point along Las Vegas Wash in late 1999. Other discharge points are being investigated. Kerr-McGee Chemical Company, with the NDEP, and Reclamation as the land management agency, worked together to begin intercepting that surface flow for treatment. This program is now underway and has significantly reduced the amount of perchlorate entering the Las Vegas Wash, Lake Mead, and the Colorado River. This remediation program will continue into the future and will continue to reduce perchlorate contamination in groundwater and Colorado River water in Lake Mead and downstream.

In a soon to be published article on contaminants found in Lake Mead fish by Dr. Jim Cizdziel, University Nevada Las Vegas, only one fish sampled of approximately 300 fish tissues sampled for mercury indicated results above the Federal Department of Agriculture's 1.0 ppm level of concern. During this 1998-1999 investigation for metals found in Lake Mead fish tissue, most fish sampled for mercury were less than 0.5 ppm (Pollard, 1999). After reviewing this work, the State of Nevada has decided not to issue any fish consumption advisories for any contaminates for Lake Mead fish (Pohlmann, 1999).

The rate and volume of inflow from the Colorado River are major determinants of the limnology of Lake Mead, with minor contributions to volume coming from the Virgin and Muddy rivers and the Las Vegas Wash (see Table 3.5-5). Due to its lower conductivity within Lake Mead, Colorado River flows can be identified through the reservoir. Flows into Lake Mead average approximately 17,900 to 21,400 cfs. During a seven-day controlled flood in 1996, inflows of 44,600 cfs resulted in a three-foot rise in surface elevation. Flows of this magnitude influence reservoir limnology of Lake Mead well into Boulder Basin (LaBounty and Horn, 1997).

Table 3.5-5
Hydraulic Inputs for Lake Mead

Input	Flow (af)	% of Total
Colorado River	8,800,000	98
Virgin River	92,000	1
Las Vegas Valley Wash	59,000	0.60
Muddy River	29,000	0.34
TOTAL INPUT	**9,000,000**	**100**

Derived from USGS data from October 1975 – September 1976

The two major outflows from Lake Mead are both in Boulder Basin: Hoover Dam and the SNWA intake. Hoover Dam is operated for flood control, river regulation and power production purposes. The operating elevation for Hoover Dam powerplant ranges from 1083 feet to a maximum elevation of 1221 feet msl. The dam's four intake towers draw water from the reservoir at approximate elevations 1050 and/or 900 feet msl to drive the generators within the dam's powerplant. SNWA pumps water from two adjacent intakes located at Saddle Island that operate down to elevations of 1050 feet and 1000 feet msl. Hoover Dam outflows vary on a daily basis from approximately 2000 cfs to 50,700 cfs. Capacity of the SNWA intake is 600 cfs. Despite its much smaller volume, the SNWA intake has been shown to influence deep water currents near the entrance to Las Vegas Bay (Sartoris and Hoffman, 1971).

LaBounty and Horn (1997) cite the rarity of complete turnover in Lake Mead due to the great depth (590 feet), and relatively constant temperature gradient. The thermal regime over the period of 1990 through 1996 was characterized by surface temperatures of 14 degrees Celsius (°C) in December and January to over 30°C in August. Seasonal thermoclines range from 50 feet in early summer to 100 feet in late summer. Hypolimnetic temperatures remain near 12°C year-round. Though full reservoir turnover seldom occurs, turnover occurs to a depth of approximately 200 to 230 feet in January and February, a sufficient depth for complete mixing in Las Vegas Bay.

As with other reservoirs, dam operation exerts a great influence on the water quality and ecology of the system (Thornton, 1990). The hydrodynamics of this large reservoir are complex and not completely understood. Each basin within Lake Mead is ecologically unique, and therefore responds differently to the inflow-outflow regime. Furthermore, the different sources of water entering Lake Mead often retain their identity for substantial distances into the reservoir and do not necessarily mix completely with the rest of the water column (Ford, 1990). This spatial heterogeneity can lead to significant underestimates of actual water retention time, conveyance and fate of materials transported into the reservoir.

3.5.3.2.3 Hydrodynamics of Lake Mead and Boulder Basin

The Colorado River, Virgin and Muddy rivers and Las Vegas Wash all form density currents in Lake Mead (Anderson and Pritchard, 1951; Deacon and Tew, 1973; Deacon 1975, 1976, 1977; Baker et al., 1977; Baker and Paulson, 1978). Anderson and Pritchard (1951) conducted a detailed investigation of density currents in 1948-1949 using temperature and TDS relationships to trace the river inflows. They found that the Colorado River flowed along the bottom of the old river channel in winter (January-March). The underflow was detectable well into the Virgin Basin and at times extended to Boulder Basin. The underflow created a strong convergence at the point where river water flowed beneath lake water. Up-lake flow of surface water occurred due to frictionally induced, parallel flow of lake water (entrainment) along the boundary of the cold river inflow. This produced a large circulation cell in the Upper Basin of Lake Mead, as surface water was pulled up-lake to replace that entrained by the underflow.

Hydrodynamics within Las Vegas Bay have also been the subject of research and are particularly important from the standpoint of potential interactions between Las Vegas Wash water and intake water quality. LaBounty and Horn (1997) provide an excellent discussion of flow patterns in this area of Lake Mead. These authors cite unique signatures of both Colorado River water and Las Vegas Wash water that allow mapping of higher conductivity intrusions from Las Vegas Wash into Boulder Basin. Depending on conditions, the intrusion can be measured for over five miles into Lake Mead. Seasonally, the Las Vegas Wash intrusion is deepest in January and February (130 to 200 feet) and shallowest in early spring (33 to 50 feet).

Water quality in Las Vegas Wash, and ultimately in Boulder Basin, is heavily influenced by urban runoff, as well as the treated effluent from three major sewage treatment facilities upstream. Historically, flows in this basin drained wetlands, which allowed for natural cooling and nutrient removal. Flows today are warmer and have doubled in volume over the last 15 years, from 110 cfs to 215 cfs (LaBounty and Horn, 1997). These factors have tended to force the intrusion higher in the water column of Las Vegas Bay.

The existence of contaminants in sediments and fish tissue in Las Vegas Bay, and poor water quality has been well documented (LaBounty and Horn, 1996; Roefer et al., 1996; Bevans et al., 1996). LaBounty and Horn (1997) cite the relatively close proximity of the SNWA intake at Saddle Island to potential intrusions of the Las Vegas Wash, and conclude that changes in hydrodynamics of the basin (i.e., due to drought or management actions) are critical considerations in assessing effects of the Las Vegas Wash on drinking water quality.

3.5.3.3 ENVIRONMENTAL CONSEQUENCES

3.5.3.3.1 General Effects of Reduced Lake Levels

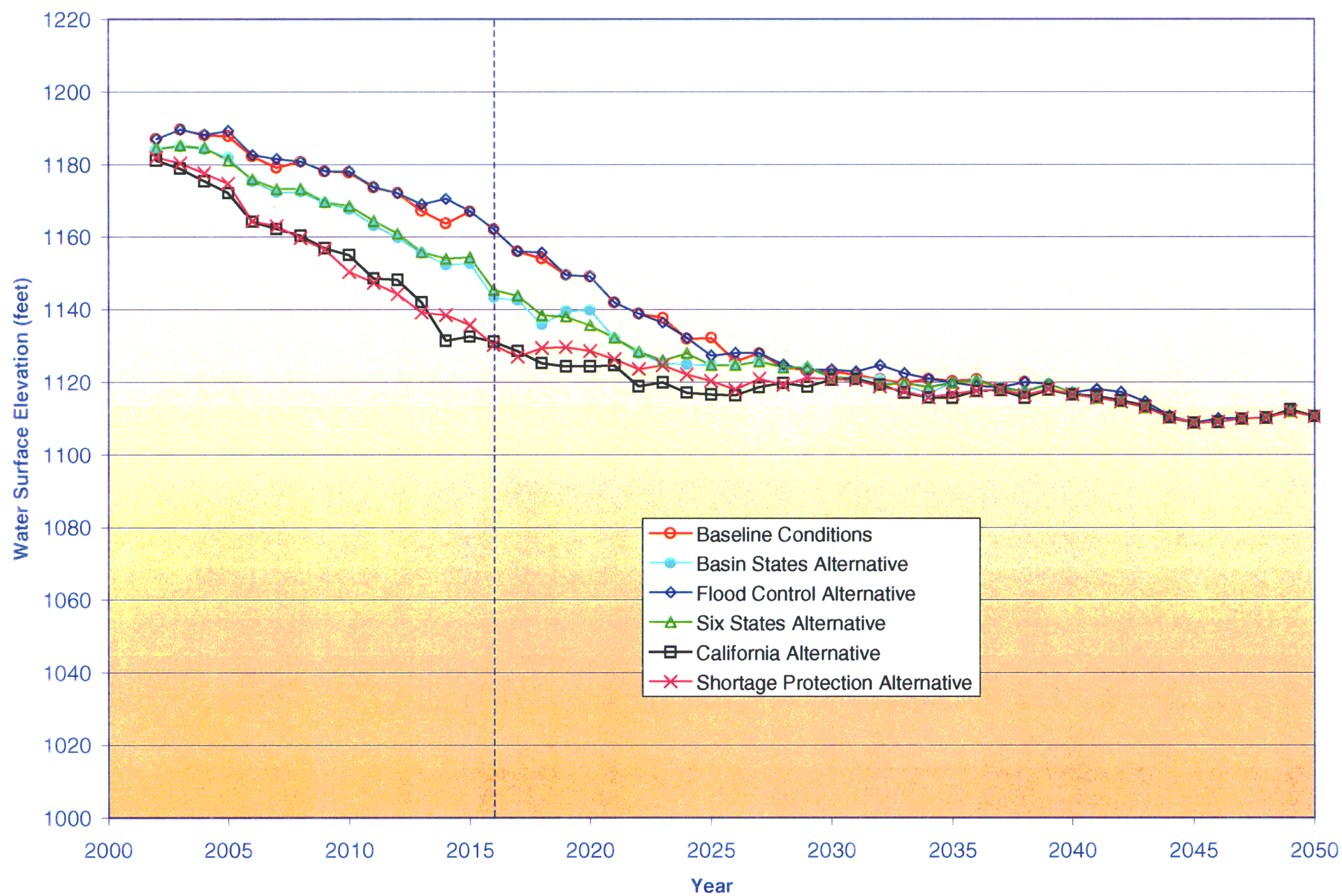
This section presents potential water quality changes in Lake Mead associated with reductions in lake levels, and potential effects of these changes on the concentration of Las Vegas Wash water at SNWA water supply intakes. In addition, this section addresses general limnological changes in Lake Mead that may occur under each alternative.

It is important to note that estimates of potential changes in Lake Mead surface elevations are based on system modeling discussed in Section 3.3. Water quality modeling has not been conducted as a part of this investigation; however, literature review and assumptions with regard to Las Vegas Wash mixing in the Boulder Basin under various Lake Mead elevations have been used to estimate potential future water quality conditions.

Results of model runs conducted for this analysis indicate that projections of baseline conditions and each of the interim surplus criteria alternatives indicate increased potential over time for the occurrence of declining Lake Mead surface elevations within and beyond the interim 15-year period, as indicated by the plots of median elevations on Figure 3.5-5.

The potential degradation of SNWA intake water is not demonstrated quantitatively in this FEIS, rather the expectation of degradation is based on the assumption that decreasing lake levels, and therefore lake volume and surface area, could result in decreased water quality and, more specifically, increased concentration of Las Vegas Wash inflow at the intake locations. The potential effects associated with Lake Mead elevation declines are described below, and are followed by a tabular comparison of the projected Lake Mead volume and surface area changes under the alternatives and baseline conditions.

Figure 3.5-5
Lake Mead End-of-Year Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
50th Percentile Values



3.5.3.3.1.1 Volume Reduction

Reduction in the volume of Lake Mead would likely have effects on lake water quality and, potentially, on water quality withdrawn by SNWA. These effects occur as a result of changes in mixing patterns in Boulder Basin. Given the hydrodynamics of Boulder Basin associated with the relatively confined nature of the embayment, effects of reduction in volume of Lake Mead would likely be disproportionately greater in Boulder Basin than in the lake as a whole. LaBounty and Horn (1997) cite the importance of salinity and thermal gradients in determining the extent of intrusion of the Las Vegas Wash into Boulder Basin. Lower lake volumes could increase the overall salinity of the Boulder Basin, thereby lowering the differential between lake water and inflows of the Las Vegas Wash. This in turn may act to disperse the intrusion, causing a more diffuse flow from Las Vegas Wash, a greater concentration of nutrients and contaminants throughout Boulder Basin, and greater availability of nonpoint contaminants in the vicinity of the SNWA intakes. Clark County's 208 Water Quality Plan certified by EPA and NDEP, regulates the quality and quantity of discharges from wastewater treatment facilities that flow into Lake Mead. These discharges currently meet standards and will do so into the future (Clark County, 1997). The SNWA is in the process of upgrading its raw water treatment facilities and these state of the art facilities will be able to meet any treatment challenges from reduced reservoir levels caused by drought or declines from interim surplus alternatives.

3.5.3.3.1.2 Tributary Water Quality

Lower water surface elevations in Lake Mead could also impact the quality of tributary flows from the Las Vegas Wash, Virgin and Muddy rivers. These effects would be a result of longer channels, and thus, longer travel times for influent streams. Potential effects on Lake Mead could include increased temperature due to warmer tributary flows. Higher evaporative losses and greater concentration of salts and contaminants may also occur in tributaries due to longer channels, leading to higher concentrations of pollutants in the Las Vegas Wash, and potentially greater concentrations of contaminants near the SNWA intakes. However, new riparian habitat development near the mouths and in these tributaries would likely develop and would be expected to offset impacts to tributary water quality. Restoration of the Las Vegas Wash wetlands will trap surface and groundwater contaminants, cool return flows and further improve the quality of return flows before it reaches Lake Mead.

3.5.3.3.2 Comparison of Baseline Conditions and Alternatives

Section 3.5.3.3.1, above, discussed the general water quality effects that may be expected given reduced Lake Mead surface elevations and volumes. The following sections compare predicted surface elevations, volume, and surface area of Lake Mead under baseline and alternative conditions. This analysis is based on system modeling results; specifically the 50 percent (median) probability elevations, as shown on Figure 3.5-5.

Characteristics of Lake Mead (elevation, volume, surface area) under baseline and alternative conditions are shown below for four selected years (i.e., years 2016, 2026, 2036 and 2050) within the modeled period, as shown in Table 3.5-6. A comparison of the percentage difference between the alternatives and baseline conditions is shown in Table 3.5-7. It should be noted that median elevations converge with the baseline condition towards the end of the period of analysis, resulting in minimal differences among the alternatives and baseline conditions in the year 2050.

3.5.3.3.2.1 Baseline Conditions

Baseline projections indicate a general trend of decreasing Lake Mead surface elevations, volume and surface area over the period of analysis, as shown above on Figure 3.5-5 and in Table 3.5-4. At the end of the interim surplus criteria period, 2016, the median elevation for Lake Mead is 1162 feet msl, a reduction of 15 feet from the surface elevation in 2002. The median baseline elevation in 2050 is 1111 feet msl for a total reduction in the median elevation of 76 feet over the entire period of analysis. This increased potential for lake level reductions would be expected to result in an increased potential for declining water quality of Lake Mead and associated effects on the SNWA intake (discussed in Section 3.5.3.3.1, above) over time under baseline conditions.

3.5.3.3.2.2 Basin States Alternative

Modeling of the Basin States Alternative indicates intermediate reductions in surface elevations, surface area and volume compared with baseline conditions in the year 2016 (when the largest differences among the alternatives are seen). The median elevation in year 2016 under the Basin States Alternative is 1143 feet msl, or 1.6 percent lower than baseline conditions in the same year, with reservoir volume approximate 12 percent lower than baseline conditions and volume becoming slightly greater than baseline by the year 2026 and slightly less than baseline in 2036. By the year 2050 no differences between this alternative and baseline conditions are present.

Table 3.5-6
Modeled Characteristics of Lake Mead Under Baseline and Alternative Conditions

Alternative	Elevation[1] (feet above msl)				Volume (maf)				Surface Area (x 1000 acres)			
	2016	2026	2036	2050	2016	2026	2036	2050	2016	2026	2036	2050
Baseline Conditions	1162.1	1125.7	1120.7	1110.6	17.9	13.9	13.4	12.5	120.2	99.8	97.6	93.6
Basin States	1143.3	1124.7	1120.4	1110.6	15.8	13.8	13.4	12.5	108.1	99.3	97.4	93.6
Flood Control	1162.1	1128.0	1118.9	1110.6	17.9	14.1	13.2	12.5	120.2	100.7	96.8	93.6
Six States	1145.5	1124.7	1120.5	1110.6	16.0	13.8	13.4	12.5	109.4	99.3	97.5	93.6
California	1131.2	1116.4	1117.6	1110.6	14.5	13.0	13.1	12.5	102.1	95.9	96.3	93.6
Shortage Protection	1130.2	1117.9	1117.6	1110.6	14.4	13.2	13.1	12.5	101.7	96.5	96.3	93.6

[1] Values shown are median elevations (50th percentile) for each year group.

Table 3.5-7
Modeled Comparisons of Alternatives to Baseline Conditions

Alternative	Elevation Change				Volume Change				Surface Area Change			
	2016	2026	2036	2050	2016	2026	2036	2050	2016	2026	2036	2050
Basin States	-1.6%	-0.1%	0.00%	0.00%	-11.7%	-0.7%	0.00%	0.00%	-10.1	-0.5	-0.2	0.00%
Flood Control	0.00%	0.2%	-0.2%	0.00%	0.00%	1.4%	-1.5%	0.00%	0.00%	0.9%	-0.8%	0.00%
Six States	-1.4%	-0.1%	0.00%	0.00%	-10.6%	-0.7%	0.00%	0.00%	-9.0%	-0.5%	-0.2%	0.00%
California	-2.7%	-0.8%	-0.3%	0.00%	-19.0%	-6.5%	-2.2%	0.00%	-15.1%	-3.9%	-1.3%	0.00%
Shortage Protection	-2.7%	-0.7%	-0.3%	0.00%	-19.6%	-5.0%	-2.2%	0.00%	-15.4%	-3.3%	-1.3%	0.00%

3.5.3.3.2.3 Baseline Conditions

Baseline projections indicate a general trend of decreasing Lake Mead surface elevations, volume and surface area over the period of analysis, as shown above on Figure 3.5-5 and in Table 3.5-4. At the end of the interim surplus criteria period, 2016, the median elevation for Lake Mead is 1162 feet msl, a reduction of 15 feet from the surface elevation in 2002. The median baseline elevation in 2050 is 1111 feet msl for a total reduction in the median elevation of 76 feet over the entire period of analysis. This increased potential for lake level reductions would be expected to result in an increased potential for declining water quality of Lake Mead and associated effects on the SNWA intake (discussed in Section 3.5.3.3.1, above) over time under baseline conditions.

3.5.3.3.2.4 Basin States Alternative

Modeling of the Basin States Alternative indicates intermediate reductions in surface elevations, surface area and volume compared with baseline conditions in the year 2016 (when the largest differences among the alternatives are seen). The median elevation in year 2016 under the Basin States Alternative is 1143 feet msl, or 1.6 percent lower than baseline conditions in the same year, with reservoir volume approximate 12 percent lower than baseline conditions and volume becoming slightly greater than baseline by the year 2026 and slightly less than baseline in 2036. By the year 2050 no differences between this alternative and baseline conditions are present.

3.5.3.3.2.5 Flood Control Alternative

Modeling of the Flood Control Alternative produces similar surface elevations, surface area, and volume compared with baseline conditions in the year 2016, with the elevation, surface area and volume becoming slightly greater then baseline by the year 2026 and slightly less than baseline in 2036. By the year 2050 no differences between this alternative and baseline conditions are present.

3.5.3.3.2.6 Six States Alternative

Modeling of the Six States Alternative indicates a Lake Mead surface elevation 1.4 percent lower and a volume 10.6 percent lower than baseline conditions in 2016. By the year 2026 and for the remaining period of analysis, differences between baseline conditions and this alternative are within one percent.

3.5.3.3.2.7 California Alternative

Modeling of the California Alternative indicates a volume of Lake Mead in the year 2016 that is 19 percent lower than baseline conditions, with the difference decreasing to 6.5 percent and 2.2 percent in the years 2026 and 2036, respectively.

3.5.3.3.2.8 Shortage Protection Alternative

Modeling of the Shortage Protection Alternative indicates similar changes in volume reduction as the California Alternative throughout the period of analysis, with volume 19.6 percent lower than baseline conditions in 2016, 6.5 percent lower in 2026 and 2.2 percent lower in 2036.

3.5.3.3.2.9 Summary of Changes in Lake Mead Volume and Elevation

Tables 3.5-6 and 3.5-7 summarize modeled changes in Lake Mead surface elevation, area, and volume under each of the alternatives as compared with baseline conditions. With the exception of the Flood Control Alternative, each of the alternatives indicate an increase potential for lower surface elevations, surface area and lake volume. These difference are most pronounced in year 2016, the end of the interim surplus criteria period. The greatest differences compared with baseline conditions are associated with the California and Shortage Protection alternatives, with intermediate differences indicated by the Basin States and Six States alternatives.

3.5.4 WATER QUALITY BETWEEN HOOVER DAM AND SOUTHERLY INTERNATIONAL BOUNDARY

There have been concerns from the EPA and others about contaminants in the Lower Colorado River between Hoover Dam and the SIB. However, there is little site specific data from this segment of the river. A USGS (1995) study of mercury and other contaminants found in fish and wildlife located in the Yuma Valley area concluded that mercury is not a problem.

The above study also indicates that selenium is also not a problem for fish and wildlife. Selenium in Colorado River water in the Yuma Valley had a median value of less than one micrograms per liter (μg/l). This research also confirms what other previous selenium studies have concluded: selenium in the LCR and its biota remains below the DOI level of concern of five μg/l. A 1986-1987 study by the USGS indicated a finding of 3.4 μg/l or less for dissolved selenium at several sites in the Lower Colorado River (USGS, 1988). Department of Interior's Pre-reconnaissance Investigation Guides (1992) reported similar findings of less than 3.4 μg/l in Colorado River water at Pilot Knob. In the 1995 USGS study of the Yuma area, measured selenium in 18 water samples averaged 1.72 μg/l, with a maximum of 8.0 μg/l and a minimum of less than 1.0 μg/l. Nine of the 18 measurement results were reported to be less than 1.0 μg/l. Currently there are no state fish consumption advisories for mercury, selenium or any other contaminants on the Lower Colorado River (Ketinger, 2000). Water quality studies will continue in this segment of the river during the 15-year period of proposed interim surplus criteria. None of the action alternatives are anticipated to increase concentrations of contaminants beyond the noted limits.

3.6 RIVERFLOW ISSUES

3.6.1 INTRODUCTION

This section considers the potential effects of interim surplus criteria on three types of releases from Glen Canyon Dam and Hoover Dam. The Glen Canyon Dam releases analyzed are those needed for restoration of beaches and habitat along the Colorado River between the Glen Canyon Dam and Lake Mead, and for a yet to be defined program of low steady summer flows to be provided for the study and recovery of endangered Colorado River fish, in years when releases from the dam are near the minimum. The Hoover Dam releases analyzed are the frequency of flood releases from the dam and the effect of flood flows along the river downstream of Hoover Dam.

3.6.2 BEACH/HABITAT-BUILDING FLOWS

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 is reduced sediment supply. Because the dam traps virtually all of the incoming sediment from the Upper Basin in Lake Powell, the Colorado River is now released from the dam as clear water. The second major change is the reduction in the high water zone from the level of pre-dam annual floods to the level of powerplant releases. Thus, the height of annual sediment deposition and erosion has been reduced.

During the investigations leading to the preparation of the *Operation of Glen Canyon Dam Final EIS* (Reclamation, 1995b), the relationships between releases from the 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 ROD (Reclamation, 1996e) for the *Operation of the Glen Canyon Dam FEIS*, at a then-assumed frequency of one in five years.

In addition to the BHBF releases described above that exceed the hydraulic capacity of the Glen Canyon Powerplant, the *Operation of Glen Canyon Dam FEIS* identified the need for Beach/Habitat Maintenance Flow 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 releases and Beach/Habitat Maintenance Flows serve as a tool for maintaining a mass balance of sediment in Glen Canyon and Grand Canyon.

3.6.2.1 METHODOLOGY

The frequencies at which BHBF releases from Glen Canyon Dam would occur under baseline conditions and under operation of the interim surplus criteria alternatives were estimated through the use of modeling as described in Section 3.3.

The model was configured to simulate BHBF releases by incorporating the BHBF triggering criteria (contained in Section 3.6.2.2) into the Glen Canyon Dam operating rules. The model was also configured to make no more than one BHBF release in any given year.

3.6.2.2 AFFECTED ENVIRONMENT

Sediment along the Colorado River below 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 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, 1995b). The suspended sediment load is sporadic in occurrence, depending on Glen Canyon Dam releases and tributary inputs.

Beneficial sediment mobilization and deposition below 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 sand 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 ROD cited above, the representatives of the AMP further refined specific criteria under which BHBFs would be made. The criteria provide that under 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.

3.6.2.3 Environmental Consequences

The effects of the interim surplus criteria 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 baseline conditions, and then compares the probability of BHBF releases under each interim surplus criteria alternative with the baseline conditions.

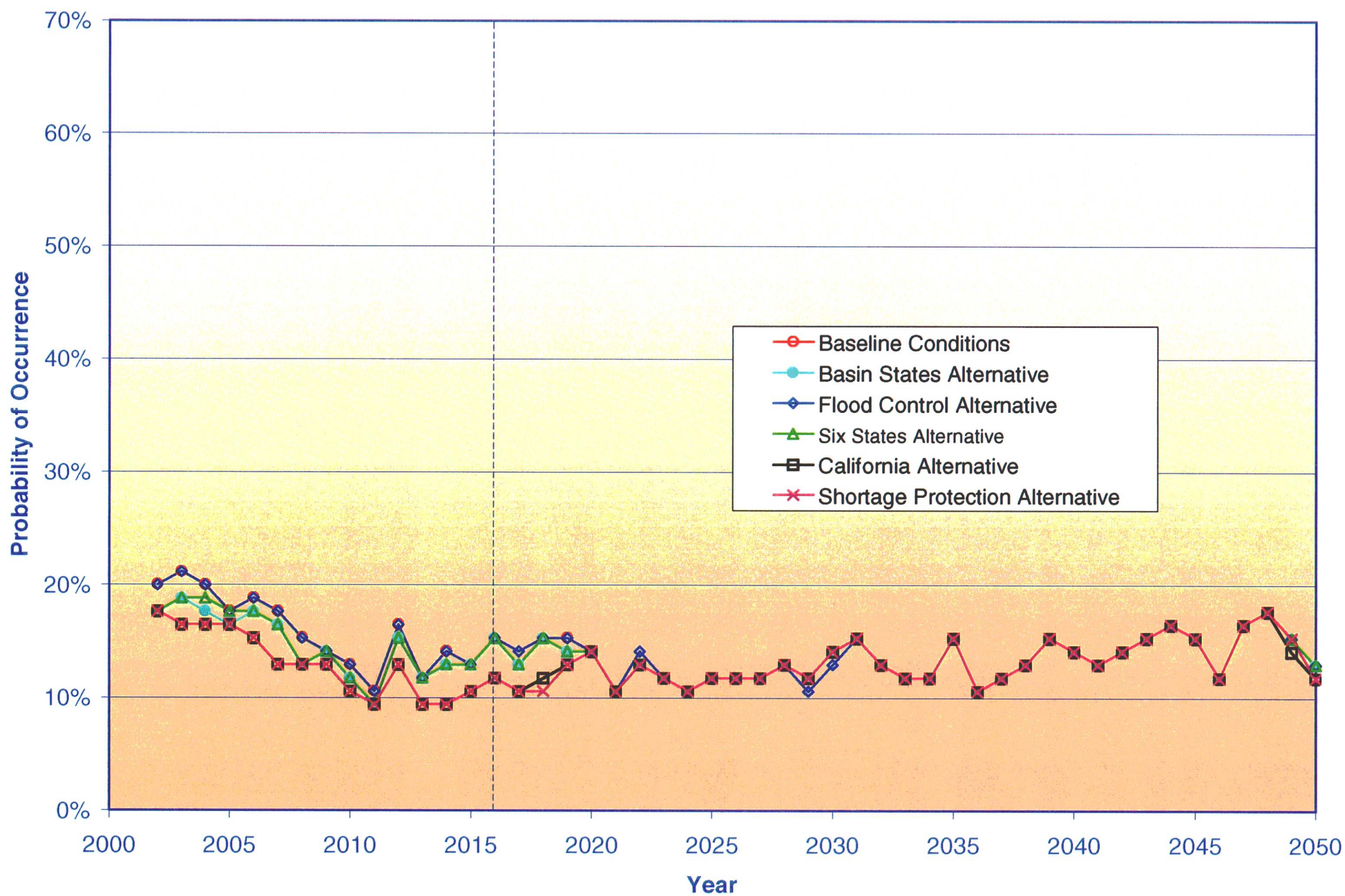
Figure 3.6-1 shows the probabilities that BHBF releases could be made under baseline conditions and the action alternatives. The plots show that the probabilities will decrease over the first decade to an irregular range of approximately 10 to 15 percent or lower, which is maintained until a slight rising trend appears in the last 15 years of the period of analysis. The trends result from the interaction of various factors, including projected increases in depletions by the Upper Division states and the requirements for equalization of storage in Lakes Powell and Mead. The operational parameter most directly comparable to the plotted relationships is the future median water level of Lake Powell. As can be seen on Figure 3.3-6, the median level of the reservoir is projected to recover somewhat in the last 15 years of the period of analysis. This correlates to the slight rise in BHBF release probabilities in the final 15 years.

Table 3.6-1 summarizes the BHBF release probabilities during the interim period and the subsequent period to 2050, based on the data plotted in Figure 3.6-1. The table reflects the higher average probability during the interim period than during the succeeding period ending in 2050.

Table 3.6-1
Probabilities of BHBF Releases from Glen Canyon Dam

	Percent of Time That Conditions Needed for BHBF Releases Would Occur at Lake Powell					
Period	**Baseline Condition**	**Basin States Alternative**	**Flood Control Alternative**	**Six States Alternative**	**California Alternative**	**Shortage Protection Alternative**
Through 2016	15.9%	14.8%	15.9%	14.9%	13.0%	13.0%
2017-2050	13.5%	13.4%	13.5%	13.4%	13.2%	13.2%

Figure 3.6-1
Lake Powell Releases
Probability of Occurrence of BHBF Flows



3.6.2.3.1 Baseline Conditions

During the interim period, the average probability under baseline conditions that BHBF releases could be made in a given year is approximately 15.9 percent, which is equivalent to about one year in six. During the subsequent period ending in 2050, the average probability is approximately 13.5 percent, which is equivalent to about one year in seven. The reduction in probability after 2015 under baseline conditions results from the fact that with time, the Lake Powell water level will probably decline because of increased Upper Basin depletions, as illustrated in Section 3.3. This water level decline would gradually reduce the probability that the BHBF triggering criteria would occur.

3.6.2.3.2 Basin States Alternative

During the interim period, the average probability under the Basin States Alternative that BHBF releases could be made in any single year is approximately 14.8 percent, which equates to approximately one year in seven. During the subsequent period ending in 2050, the average probability is approximately 13.4 percent, which is equivalent to about one year in seven.

3.6.2.3.3 Flood Control Alternative

During the interim period, the average probability under the Flood Control Alternative that BHBF releases could be made in any single year is approximately 15.9 percent, which equates to approximately one year in six. During the subsequent period ending in 2050, the average probability is approximately 13.5 percent, which is equivalent to about one year in seven.

3.6.2.3.4 Six States Alternative

During the interim period, the average probability under the Six States Alternative that BHBF releases could be made in any single year is approximately 14.9 percent, which equates to approximately one year in seven. During the subsequent period ending in 2050, the average probability is approximately 13.4 percent, which is equivalent to about one year in seven.

3.6.2.3.5 California Alternative

During the interim period, the average probability under the California Alternative that BHBF releases could be made in any single year is approximately 13.0 percent, which equates to approximately one year in eight. During the subsequent period ending in 2050, the average probability is approximately 13.2 percent, which is equivalent to about one year in eight.

3.6.2.3.6 Shortage Protection Alternative

During the interim period, the average probability under the Shortage Protection Alternative that BHBF releases could be made in any single year is approximately 13.0 percent, which equates to approximately one year in eight. During the subsequent period ending in 2050, the average probability is approximately 13.2 percent, which is equivalent to about one year in eight.

3.6.3 LOW STEADY SUMMER FLOW

3.6.3.1 AFFECTED ENVIRONMENT

During preparation of the *Operation of Glen Canyon Dam FEIS*, it was hypothesized that steady flows with a seasonal pattern may have a beneficial effect on the potential recovery of special status fish species down stream of Glen Canyon Dam. Accordingly, development of an experimental water release strategy was recommended by the Service to achieve steady flows when compatible with water supply conditions and the requirements of other resources. The strategy included developing and verifying a yet to be defined program of experimental flows which would include providing high steady flows in the spring and low steady flows in summer and fall during water years when a volume of approximately 8.23 maf is released from Glen Canyon Dam. This strategy, commonly referred to as the low steady summer flow program, was contained in the *Final Biological Opinion on the Operation of Glen Canyon Dam* (Service, December 1994c), and recognized in the ROD for the *Operation of Glen Canyon Dam FEIS* (USDI, 1996).

3.6.3.2 ENVIRONMENTAL CONSEQUENCES

The ability to test the low steady summer flow release strategy at Glen Canyon Dam according to the ROD could be affected by the implementation of interim surplus criteria. This matter was investigated by analyzing the model releases from Glen Canyon Dam to determine the probabilities at which minimum releases of 8.23 maf per water year would occur.

Figure 3.6-2 shows the annual probabilities of minimum releases from Glen Canyon Dam during the period of analysis. Note that the first year plotted is 2003, since 2003 would be the first complete water year (October 1, 2002 through September 30, 2003) during the interim period. The plots show that the probabilities increase through 2023, from approximately 20 to 25 percent to approximately 60 percent, which is maintained until another increase to 67 percent occurs during the last 15 years of the analysis. The trends result from the interaction of various factors that affect annual releases from Glen Canyon Dam, including projected increases in depletions by the Upper Division states and the requirements for equalization of storage in Lakes Powell and Mead.

Figure 3.6-2
Lake Powell Releases
Probability of Approximately 8.23 maf Annual Release

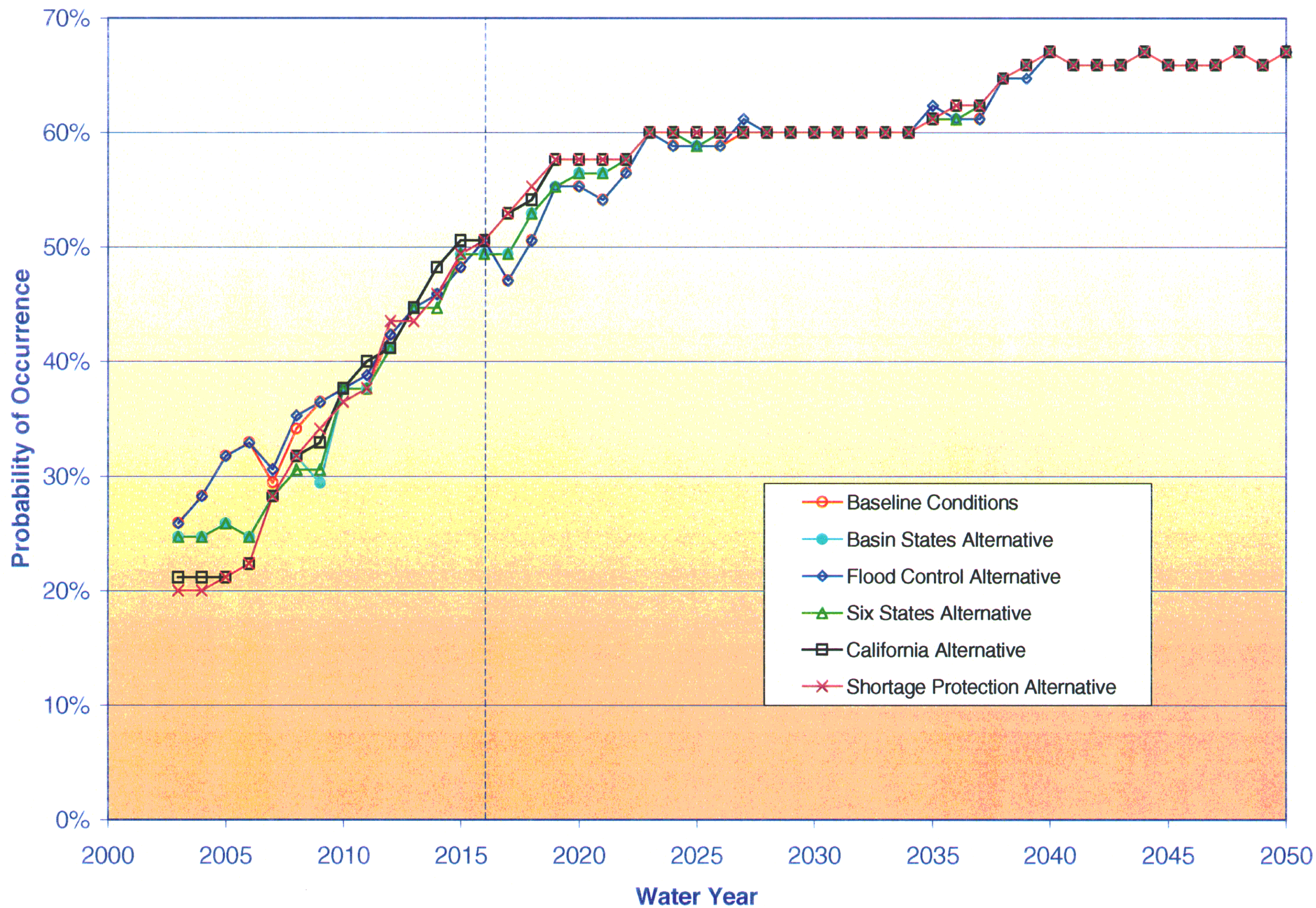


Table 3.6-2 summarizes the probabilities that minimum releases would occur during the interim period and the subsequent period to 2050, based on data plotted in Figure 3.6-2. Probabilities are summarized by water year because releases from Glen Canyon Dam are accounted for by water year under provisions of the LROC. The results indicate that under baseline conditions, the probability of 8.23 maf annual releases from the dam is approximately 38.2 percent during the interim period and 61.6 percent during the subsequent period ending in 2050. The probabilities under all alternatives are similar to those under baseline conditions after 2006. Under the Flood Control Alternative, the probability is approximately the same as for baseline conditions, as shown on Table 3.6-2. The probabilities under the remaining four interim surplus criteria alternatives during the interim period are one to two percent less than under baseline conditions. During the subsequent period through 2050, the probabilities resulting from the remaining four surplus criteria would be one to two percent higher than under baseline conditions.

Table 3.6-2
Probability of Minimum Glen Canyon Dam Releases
(Annual Releases of 8.23 maf)

Period (Water Years)	Baseline Condition	Basin States Alternative	Flood Control Alternative	Six States Alternative	California Alternative	Shortage Protection Alternative
Through 2016	38.2%	36.3%	38.4%	36.2%	35.8%	36.3%
2017-2050	61.6%	61.9%	61.6%	61.9%	62.2%	62.1%

Note: The "water year" on which this accounting is based extends from October 1 to September 30.

3.6.4 FLOODING DOWNSTREAM OF HOOVER DAM

Under the BCPA, flood control was 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 Corps) will prescribe regulations for flood control for projects authorized, wholly or in part, for such purposes.

The Los Angeles District of the Corps published the current flood control regulations in the *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 Corps 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 Corps and Reclamation; however, the Corps 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. Any deviation from the flood control operating instructions must be authorized by the Corps.

This analysis addresses the flooding that occurs along the Colorado River below Hoover Dam. The evaluation focuses on the change in the probability that various "threshold" flows would be released from Hoover, Davis and Parker Dams. A threshold flow rate is one at which flood damages have been found to begin to occur along the river. The analysis is not limited to dam releases made expressly in connection with flood control operation, but also includes releases made for water supply and power generation purposes. For example, power generation requirements can cause releases from Hoover Dam to exceed 19,000 cfs, with such releases being regulated in Lake Mohave downstream. In addition, the analysis presents data on land use and anticipated flood damages that were developed by the Los Angeles District Corps of Engineers in the *Review of Flood Control Regulations, Colorado River Basin, Hoover Dam, July 1982* (Corps, 1982).

3.6.4.1 AFFECTED ENVIRONMENT

Historical flows downstream of Hoover Dam have caused flood damages at various points along the lower Colorado River. A key threshold level was established as a result of flooding that occurred in 1983 when uncontrolled releases occurred over the Hoover Dam spillways. The high Colorado River flows caused damages primarily to encroachments in the Colorado River floodplain. In addition, several lower thresholds that are significant along various reaches are evaluated in the following subsections.

The Colorado River Floodway Protection Act (Floodway Act) originated from Congressional hearings held in 1983 following the flood. The Floodway Act called for the establishment of a federally declared floodway from Davis Dam to the SIB. The floodway is to accommodate either a 1-in-100 year river flow consisting of controlled releases and tributary inflow, or a flow of 40,000 cfs, whichever is greater. As discussed in Section 3.3.1, certain flood release rates from Hoover Dam are required depending on flood flow into Lake Mead and the amount of available storage space.

Estimates of development in the flood plains below Hoover Dam were last made by the Corps based on 1979 data (Corps, 1982). These data are presented in Table 3.6-3.

3.6.4.1.1 Hoover Dam to Davis Dam

Critical flood flows for the reach between Hoover Dam and Davis Dam are 19,000 cfs, 28,000 cfs, 35,000 cfs, 43,000 cfs, and 73,000 cfs.

3.6.4.1.2 Davis Dam to Parker Dam

The river is within levees for most of the reach from Davis Dam to Parker Dam. Historical flood flows have caused damage to some of the bank protection. Minor damage begins to occur at flows of 26,000 cfs.

Table 3.6-3
Development in Flood Plains Between Hoover Dam and SIB, 1979 Data[1]

	(Number of structures unless otherwise noted)					
Flood Flow (cfs)	**Mobile Homes**	**Residential**	**Commercial/ Industrial**	**Public/ Semipublic**	**Agriculture (acres)**	**Recreation Facilities [5]**
100,000	1,609	1,457	74	70	55,089	278
71,000 [2]	758	786	54	66	15,861	277
48,000[3]	164	198	13	10	2,671	277
38,000[4]	101	138	4	6	176	232
28,000	17	44	1	0	90	201

[1] Corps of Engineers, Colorado River Basin Hoover Dam, Review of Flood Control Regulations. Final Report, July 1982. Table C-1.
[2] 78,000 cfs at Needles.
[3] 50,000 cfs at Needles.
[4] 40,000 cfs at Needles.
[5] Recreation facilities are primarily boat docks that would sustain significant damage with high flows.

3.6.4.1.3 Hoover Dam to Davis Dam

Critical flood flows for the reach between Hoover Dam and Davis Dam are 19,000 cfs, 28,000 cfs, 35,000 cfs, 43,000 cfs, and 73,000 cfs.

3.6.4.1.4 Davis Dam to Parker Dam

The river is within levees for most of the reach from Davis Dam to Parker Dam. Historical flood flows have caused damage to some of the bank protection. Minor damage begins to occur at flows of 26,000 cfs.

3.6.4.1.5 Parker Dam to Laguna Dam

Below Parker Dam, significant damage to permanent homes has occurred during releases within the flood operation criteria. This area has been further developed since the flood operations in 1983. Minor damage begins at 19,000 cfs along the Parker Strip (the reach of river between Parker Dam and the town of Parker, Arizona). Backwater regions, which function as wildlife refuges and recreational areas, accumulated sediment, and in some cases, became isolated from the Colorado River. Historical flood flows have also resulted in damage to infrastructure of government agencies.

3.6.4.1.6 Laguna Dam to SIB

Below Laguna Dam, the banks of the Colorado River are not protected. Historical flood flows have resulted in significant damage to the banks. Associated increases of groundwater level in the Yuma area have also resulted in some lands becoming water logged and caused drains to cease functioning. During the scoping process for this

DEIS, a letter from the Yuma County Water Users' Association states that "[o]ur landowners are harmed by such releases, particularly should the flood control releases be required to go beyond the 19,000 cubic feet per second Hoover release level" (Pope, 1999). The letter indicates that a flood control release of 28,000 cfs or greater could result in upwards of $200 million in damages to the Yuma area. Other injured parties could include the City of Yuma, the County of Yuma, Cocopah Indian Tribe, the Gila Valley, Bard Irrigation District, and the Quechan Indian Tribe.

Additional flows of concern include:

- Laguna Dam south to Pilot Knob: 9,000 cfs is the threshold value. Flows of 10,000 cfs to 11,000 cfs impact leach fields of trailer parks located within levees.

- Pilot Knob to SIB: 15,000 cfs is a threshold value. Above that level, high groundwater, localized crop damage and damage to the United States Bypass Drain occur.

3.6.4.2 Environmental Consequences

The effects of the interim surplus criteria on flood flows were analyzed by determining the probabilities that releases from Davis and Parker Dams would reach or exceed certain flow rates that have been found to be thresholds for damages. In addition, the analysis addressed the probabilities that releases of various magnitudes would be made from Hoover Dam corresponding to the required flood control releases discussed in Section 3.3.1.2, Operation of Hoover Dam. The release probabilities were determined from results of river system modeling described in Section 3.3. The results of the analysis are shown in Table 3.6-4.

The results portrayed on Table 3.6.3 show that except for the Flood Control Alternative, the action alternatives would reduce the probability of flows at or above the damage thresholds.

The Corps estimated the likely damage to development based on the 1979 land use data (Corps, 1982). These data are presented in Table 3.6-5.

The data on direct, physical damages presented in Table 3.6-5 are based on simultaneous flooding along all reaches of the river from Hoover Dam to the SIB. The data show that damages increase much more rapidly than the size of the flow. For example, a 48,000-cfs flow has 15 times the impact of a 22,000-cfs flow, while the flow increases by only 2.2 times. A 48,000 cfs flow has a less than one-in-500 probability of occurring in any one year, while a 22,000 cfs flow has a greater than one-in-20 probability of occurring in any one year under all alternatives.

Table 3.6-4
Discharge Probabilities from Hoover, Davis and Parker Dams

Release Point	Discharge (cfs)[1]	Percent of Years With Flows Greater Than or Equal to Discharge					
		Baseline Conditions	Basin States Alternative	Flood Control Alternative	California Alternative	Six States Alternative	Shortage Protection Alternative
Years 2002 to 2016							
Hoover Dam	19,000	20.8	18.8	21.2	16.3	18.6	16.9
Hoover Dam	28,000	7.5	7.2	7.7	5.5	7.1	5.8
Hoover Dam	35,000	2.1	2.0	2.1	1.6	2.0	1.7
Hoover Dam	40,000	0.2	0.2	0.2	0.2	0.2	0.2
Hoover Dam	73,000	0.0	0.0	0.0	0.0	0.0	0.0
Davis Dam	26,000	8.6	8.1	9.1	7.0	8.0	7.1
Parker Dam	19,500	10.4	9.4	11.3	7.8	9.3	8.0
Years 2017 to 2050							
Hoover Dam	19,000	14.6	14.1	14.9	13.9	14.1	13.8
Hoover Dam	28,000	4.0	3.8	4.2	3.7	3.8	3.6
Hoover Dam	35,000	0.9	1.7	0.9	0.8	0.9	0.8
Hoover Dam	40,000	0.2	0.1	0.2	0.1	0.2	0.1
Hoover Dam	73,000	0.0	0.0	0.0	0.0	0.0	0.0
Davis Dam	26,000	4.8	4.6	5.0	4.4	4.6	4.5
Parker Dam	19,500	5.9	5.7	6.1	5.6	5.7	5.6

[1] Average monthly discharge

Table 3.6-5
Estimated Flood Damages Between Hoover Dam and the SIB
(1979 level of development and 2000 price level[1])

Flood Flow (cfs)	Flood Damages
100,000	$201,000,000
71,000[2]	$ 55,700,000
48,000[3]	$ 9,210,000
38,000[4]	$ 1,550,000
22,000	$ 610,000

[1] Corps of Engineers, Colorado River Basin Hoover Dam, Review of Flood Control Regulations. Final Report, July 1982. Table C-5. Adjusted from June 1978 to March 2000 price level by Consumer Price Index-all Urban Consumers. (June 1978 is 65.2, March 2000 is 167.8, Adjustment factor: 2.57.)

[2] 78,000 cfs at Needles

[3] 50,000 cfs at Needles

[4] 40,000 cfs at Needles

3.7 AQUATIC RESOURCES

3.7.1 INTRODUCTION

The analyses presented in this section consider two specific issues associated with aquatic resources. These issues are potential effects to Lake Mead and Lake Powell aquatic species habitat and potential effects to sport fisheries at Lake Powell, Lake Mead, and the Colorado River between Lake Powell and Lake Mead. The interim surplus criteria are not expected to result in any changes to aquatic resources below Hoover Dam.

3.7.2 LAKE HABITAT

The primary lake habitats identified for potential affect within the project area include Lake Powell and Lake Mead. Other reservoirs downstream of Lake Mead (Lake Mohave and Lake Havasu) are not expected to be affected by the proposed interim surplus criteria because operation of the system keeps lake levels at specified target elevations to facilitate power generation and water deliveries (Reclamation, 2000).

Native Colorado River fishes have not fared well in the reservoirs. Non-native fish species, which prey on and compete with native species, have become well-established in both lakes. While some native species may spawn within the reservoirs and others have young that drift into the lakes, predation and competition is believed to eliminate young native fish from the reservoirs and precludes their survival and recruitment. A discussion of native Colorado River fishes is presented in Section 3.8, Special-Status Species.

3.7.2.1 METHODOLOGY

Existing literature was reviewed to determine the historic and current status of fish assemblages in Lake Powell and Lake Mead. Literature reviewed included recent publications and draft documents on the operations at Lake Powell and Lake Mead, biological assessments, fish management plans, and biological opinions. Investigation into critical lake elevations, water quality, and temperature limits were made based on the fish species known to inhabit these lakes, including the use of these lakes by endangered species. Because no "threshold" lake elevations associated with significant adverse effects on lake habitat were identified for any of the fish species, the use of system modeling relied upon a comparison of general reservoir surface elevation trends under baseline conditions and the alternatives, shown in Figures 3.3-6 and 3.3-13. A qualitative analysis of potential lake habitat changes was made by comparing the differences between lake level trends under baseline conditions and the various alternatives.

3.7.2.2 AFFECTED ENVIRONMENT

3.7.2.2.1 Lake Powell

Aquatic habitat in Lake Powell is a result of the lake's physical and geographical characteristics. Lake Powell has a surface area of 255 square miles and contains up to 24.3 maf of active storage. At full pool, depth of the reservoir near the dam is 561 feet. The thermocline (the boundary layer between a strata of colder and warmer water) changes seasonally, but below approximately 150 feet deep, the cold hypolimnion (a low oxygen, low light, deep water layer of the lake) is consistently maintained due to thermal and chemical properties. Lake Powell exhibits a trophic gradient from the shallow productive inflows where nutrients and sediments are delivered by rivers, to the clear nutrient-poor water by the dam. As the reservoir gradually shallows moving away from the dam, the depth and extent of the thermocline and hypolimnion change. Lake elevations change from year to year depending on numerous factors, including Upper Basin runoff. The clear water reservoir offers habitat beneficial to non-native fish. Generally, the reservoir is oligotrophic (characterized by low dissolved nutrients and organic matter); deep, clear, and low in chlorophyll abundance (NPS, 1996).

Non-native fish species became established by intentional and unintentional introductions. Largemouth bass and crappie populations were stocked initially and subsequently 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, fluctuation, and aging of the reservoir resulted in changing habitat that eliminated most of the vegetation and favored different 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).

Other species common 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, include fathead minnow, mosquitofish, red shiner and plains killifish (NPS, 1996). Table 3.7-1 lists fish species present in the project area.

Native fish species were displaced by habitat loss and alteration associated with construction and operation of mainstream dams and reservoirs, as well as competition with and predation by introduced non-native species. Bonytail is the native species believed to be in the most peril of imminent extinction because they are virtually eliminated in the Upper Basin. Bonytail were reported in Lake Powell soon after closure of Glen Canyon Dam; however, annual gill-net surveys conducted by the Utah Department of Wildlife Resources have failed to produce any bonytail in the last 20 years.

Table 3.7-1
Fish Species Present in the Project Area

Species	Scientific Name	Origin
Black bullhead	*Ictalurus melas*	Invading sport fish
Black crappie	*Pomoxis nigromaculatus*	Introduced sport fish
Bluegill	*Lepomis macrochirus*	Invading sport fish
Bluehead sucker	*Catastomus discobolus*	Native to Colorado River
Bonytail	*Gila elegans*	Native to Colorado River
Brown Trout	*Salmo trutta*	Introduced sport fish
Carp	*Cyprinus carpio*	Invading fish
Channel catfish	*Ictalurus punctatus*	Invading sport fish
Colorado pikeminnow	*Ptychocheilus lucius*	Native to Colorado River
Fathead minnow	*Pimephales promelas*	Invading forage fish
Flannelmouth sucker	*Catostomus latipinnis*	Native to Colorado River
Green sunfish	*Lepomis cyanellus*	Invading fish
Humpback chub	*Gila cypha*	Native to Colorado River
Largemouth bass	*Micropterus salmoides*	Introduced sport fish
Mosquitofish	*Gambusia affinis*	Invading forage fish
Northern pike	*Esox lucius*	Invading sport fish
Rainbow trout	*Oncorhynchus mykiss*	Introduced sport fish
Razorback sucker	*Xyrauchen texanus*	Native to Colorado River
Red shiner	*Notropis lutrensis*	Invading forage fish
Roundtail chub	*Gila robusta*	Native to Colorado River
Smallmouth bass	*Micropterus dolomieui*	Introduced sport fish
Speckled dace	*Rhinichthys osculus*	Native to Colorado River
Spotted sculpin	*Cottus bairdi*	Native to Colorado River
Striped bass	*Morone saxatilis*	Introduced sport fish
Threadfin shad	*Dorosoma petenense*	Introduced forage fish
Walleye	*Stizostedion vitreum*	Invading sport fish

Other native species that may still persist in Lake Powell include the Colorado pikeminnow and humpback chub. Although there have been no reports of Colorado pikeminnow in the lake since 1977, they are believed to still inhabit the Colorado River inflow area. Very few humpback chub have been found in Lake Powell and it is presumed that they are not present in the lake at this time; however, unidentified chub species were collected by seines and light traps in the Colorado River inflow area (NPS, 1996). Small numbers of razorback suckers have persisted in Lake Powell since the closure of Glen Canyon Dam, occurring mainly near the inflow of the San Juan River. Flannelmouth suckers are probably the only native fish to inhabit the main body of Lake Powell in detectable numbers. However, there has been a declining trend in population size and reproductive recruitment has not been documented. Additional discussion of special-status fish species is included in Section 3.8.

3.7.2.2.2 Lake Mead

Lake Mead has a surface area of 245 square miles and a storage capacity of 26 maf. Over two-thirds of the volume of Lake Mead remains at 55°F (13°C) throughout the year, resulting in a constant, cool discharge at Hoover Dam (USBR, 1996d). At full pool, depth of the reservoir near the dam is approximately 550 feet. Because of its physical similarity to Lake Powell, the limnological characteristics of Lake Mead are also similar. The thermocline changes seasonally and a cold hypolimnion is consistently maintained due to thermal and chemical properties. Surface elevations change from year to year depending on numerous factors, including Upper Basin runoff. The clear water reservoir offers habitat beneficial to non-native fish.

Native fish species were displaced by habitat loss and alteration associated with construction and operation of mainstream dams and reservoirs, as well as competition and predation with introduced non-native species. Razorback sucker, federally listed as an endangered species, is the only native species that maintains a remnant population in Lake Mead (USBR, 1996a,b).

Non-native fish species became established by intentional and unintentional introductions. Introduced fish species found in Lake Mead include largemouth bass, striped bass, rainbow trout, channel catfish, crappie, threadfin shad and carp (USBR, 1996). Bonytail populations are supported by specific management activities designed to re-establish this species in Lake Mohave. Remnant populations of these species exist downstream of Lake Mead in Lake Mohave and Lake Havasu and groups such as the Native Fish Wok Group (NFWG) and Lake Havasu Fishery Improvement Project (HAVFISH) are currently engaged in activities conducted under Section 7(a)(1) of the ESA to aid in the conservation and recovery of these species in the lower Colorado River Basis (USBR, 1999).

Releases from Lake Mead are the predominant influence on inflows to two other reservoirs, Lake Mohave and Lake Havasu. Operations at Lake Mead typically keep lake elevations at the downstream reservoirs at specific target elevations to facilitate power generation and water deliveries. The operation of Lake Mohave through 2002 is anticipated to limit reservoir fluctuations as a measure to assure that potential impacts to razorback sucker will be minimized during the spawning season (USBR, 1996).

3.7.2.2.3 General Effects of Reservoir Operation

Lake habitat in both Lake Powell and Lake Mead consists primarily of deep, clear, open water habitats with a cold hypolimnion that is consistently maintained due to thermal and chemical properties. The habitat found in these lakes is drastically different from the riverine habitat that existed prior to the construction of the dams, and is more suitable for non-native species than native species. Non-native fish species were introduced into the lakes, and subsequently established naturally reproducing populations. Habitat changes resulting from fluctuating lake levels have favored introduced species tolerant of the conditions and temperatures found in the lakes. These species are able to reproduce in the lakes and are not expected to be affected by fluctuating lake levels. In Lake Powell for example, striped bass have experienced "unprecedented natural reproduction and survival" that allowed them to become "the most numerous sport fish and dominate the fish community of Lake Powell" (NPS, 1996).

The ability of native species to adapt to the lake habitat is limited mainly by the decreased survival of eggs and the lack of recruitment of young individuals into the adult population. The primary reason for low recruitment of native fish is predation of eggs and young by the established populations of non-native species. In some cases, nutrition may also influence recruitment (Horn, June 2000).

3.7.2.3. ENVIRONMENTAL CONSEQUENCES

There are no specific "threshold" lake levels that are definitive for evaluation of potential impacts to lake habitat in Lake Powell or Lake Mead. Projections of Lake Powell and Lake Mead surface the elevations are discussed in Sections 3.3.4.2 and 3.3.4.4, respectively. These reservoirs will continue to be subjected to varying inflows and fluctuating surface elevations, primarily due to hydrologic conditions present in the watershed and increasing water use in the Upper Basin. Historically, reservoir conditions have resulted in lake habitat that is favorable to non-native species and unfavorable to native species. Because the projected declines in reservoir surface elevation in both Lake Powell and Lake Mead are within the normal operational range of fluctuations, they are not likely to result in substantial changes to lake habitat.

3.7.3 SPORT FISHERIES

This section considers potential effects of the interim surplus criteria alternatives on sport fisheries in Lake Powell, Lake Mead and below Hoover Dam. Potential effects on recreation associated with sport fisheries are discussed in Section 3.9.5.

The sport fishery within the Colorado River corridor from Glen Canyon Dam to Separation Canyon is not analyzed in detail in this FEIS because annual release patterns from Glen Canyon Dam are determined in accordance with the 1996 ROD and are monitored through the Glen Canyon Dam Adaptive Management Program. Through this process, the effects of dam operations on downstream resources, including sport fish, are monitored and studied. The results are used to formulate potential recommendations on refinements to dam operations, to ensure that the purposes of the Grand Canyon Protection Act are met.

The possibility of changes in river water temperature downstream of Hoover Dam was also investigated. Reclamation conducted an analysis predicting water temperatures downstream of Hoover Dam with a Lake Mead water surface elevation of 1120 feet msl and a steady release of 62,000 cfs (30 percent higher than powerplant capacity). Under these conditions, the warmest temperature predicted was 58.5°F in late summer. The midsummer discharge temperature was predicted to be 58.5°F (Reclamation, 1991). Under actual conditions with a reservoir elevation of 1120 feet msl, however, maximum discharge would be equal to the powerplant capacity of 49,000 cfs. At this lesser flow, discharges would be cooler than the temperatures predicted in the analysis, since less discharge water would be drawn from the warm upper portion of the reservoir than at higher flows. Therefore, it is assumed that increases of release temperatures corresponding to the median decline of lake levels under baseline conditions and the action alternatives would result in temperatures less than those predicted in the 1981 analysis.

Staff from the Willow Beach Federal Fish Hatchery, located about 12 miles downstream of Hoover Dam, reported that over the long term, river water temperatures have typically ranged from 56°F to 58°F, with occasional lows of 54°F. Modeled Hoover Dam discharges are not significantly different from those during periods when water temperatures were measured by hatchery personnel. It is expected that the minor changes in river water temperature described above would not be expected to adversely affect fish populations or the sport fishery in the river below Hoover Dam. The hatchery rears both trout and native fish. For native species, the hatchery warms the river water with solar panels. The projected increase in river temperatures may be a benefit to the hatchery's native fish program. River temperatures are not addressed further in this section.

3.7.3.1 METHODOLOGY

Existing literature was reviewed to determine the historic and current status of sport fish assemblages in Lake Powell and Lake Mead. Literature reviewed included recent publications on the status of sportfishing in both reservoirs, along with a review of water quality data including limnological reports and journal articles for information on contaminants found within the lakes and in fish tissue. Potential effects on sport fisheries identified herein are based on the analysis of lake habitat discussed in Section 3.7.2. Potential effects on sport fisheries are based on model output showing general trends of reservoir surface elevations, river flow rates and temperature. No specific threshold elevations or flows are used in the analysis.

3.7.3.2 AFFECTED ENVIRONMENT

Currently, Lake Powell and Lake Mead provide habitat for numerous species of introduced (non-native) fish which support outstanding recreational sport fishing opportunities. The fish species present in the GCNRA are listed in Table 3.7-1.

A similar species assemblage exists for Lake Mead. The two most common sportfish species found in Lake Powell and Lake Mead are striped bass and largemouth bass.

3.7.3.2.1 Reservoir Sport Fisheries

The primary sport fisheries management challenge in the reservoirs is trying to stabilize a striped bass population that reproduces beyond the limits of available forage. As a result of unlimited striped bass reproduction, pelagic (open water) stocks of threadfin shad upon which they prey have been decimated. Decimation of the shad population then results in striped bass starvation. Reduction of striped bass numbers allows the shad population to rebound from adult stocks residing in turbid, thermal refuges where they are less vulnerable to striped bass predation. As shad reenter the pelagic zone in large numbers, they are subsequently eaten by young striped bass who grow rapidly, mature, and once again eliminate shad from the pelagic zone. This widely fluctuating predator-prey cycle occurred during the 1990s and still occurs today.

Threadfin shad in Lake Powell exist in the northernmost portion of their range. Lower lethal temperatures for shad are reported as 40°F to 41°F (4.5°C to 5°C). Shad currently survive winters where water temperatures consistently range near the lethal limit by seeking deep strata where the water temperature is warmer and stable. An additional temperature reduction of even 2°F (1.0°C) may remove the thermal refuge and result in loss of shad over winter. The absence of a pelagic forage fish would not eliminate striped bass, which now subsist on plankton for the first year or two of life, but would eventually result in a permanently stunted striped bass population without quality sport fishing value (NPS, 1996).

The sport fishery at Lake Mead has been managed in much the same manner as in Lake Powell and has resulted in many of the same management challenges. The introduction of threadfin shad as a forage species and striped bass as the main predator has produced similar interactions between the two species.

3.7.3.3 ENVIRONMENTAL CONSEQUENCES

3.7.3.3.1 Reservoir Sport Fisheries

The sport fishery in Lake Powell and Lake Mead is primarily based on the presence of striped bass. Other sport fish found in the lakes include largemouth bass, catfish and trout. Since the predator-prey relationship between striped bass and threadfin shad can result in large variations of the striped bass population, stabilizing the population of striped bass and maintaining the threadfin shad population is an ongoing challenge to sport fish management in the lakes.

Although the occurrence of prey base fluctuations is more directly related to striped bass populations, a thermal refuge for adult threadfin shad is critical. Under baseline conditions and each of the alternatives, the challenge of stabilizing striped bass and threadfin shad populations in the lakes will continue and may include the need to alter the size or catch limit of striped bass or planting of fish from hatchery stock. All of the other sport fish, with the possible exception of trout, are well-adapted to habitats found in the lakes and are largely unaffected by fluctuating lake levels and water temperatures. Trout populations in the reservoirs are sustained by planting fish from hatchery stock.

3.7.3.3.2 Colorado River Sport Fisheries

The primary sport fish in the Colorado River between Glen Canyon Dam and the 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 main stem habitat. These variables are directly related to patterns of flow releases from Lake Powell. Under baseline conditions and each of the alternatives, an increase in the temperature of water released from Glen Canyon Dam could occur if reservoir levels in Lake Powell fall below an elevation of 3590 feet msl. The probability of elevations below 3590 feet msl is limited to the 10 percentile rankings and is not projected to occur until approximately years 2018 to 2028. Water releases from Glen Canyon Dam are controlled by operating criteria contained in the 1996 ROD and are monitored for compliance with the Grand Canyon Protection Act through the Adaptive Management Program. As a result, Colorado River sport fisheries would not be affected by the interim surplus criteria alternatives.

3.8 SPECIAL-STATUS SPECIES

3.8.1 INTRODUCTION

This section identifies potential effects of proposed interim surplus criteria to aquatic and terrestrial species of concern and their habitat, from Lake Powell to the SIB. Potential impacts to special-status species in Mexico are discussed in Section 3.16, Transboundary Impacts. As discussed in Section 1.4, a considerable amount of information pertinent to this analysis is available from various documents prepared by Reclamation and the Service under NEPA and/or the ESA, and is incorporated by reference.

Special-status species are species that are listed, or are proposed for listing, as "threatened" or "endangered" under the federal ESA that may be present in the area affected by the proposed action, and also include species of special concern to states or other entities responsible for management of resources within the area of analysis. This section contains a discussion of the life history requirements of each species, followed by an analysis of potential impacts to the species and its habitat.

Reclamation is consulting with the Service (and NMFS) to meet its responsibilities under Section 7 of the ESA on the effects of the proposed action to federally listed species. Reclamation prepared a biological assessment (BA) which evaluates the potential effects on listed species which may occur in the area from the headwaters of Lake Mead to the SIB (Reclamation, 2000). Preliminary evaluation of the effects to listed species which may be present in the Colorado River corridor from Glen Canyon Dam to the headwater of Lake Mead led to the conclusion that the interim surplus criteria would not affect any species. Therefore, this area was not addressed in the BA. Refinements to the model used to predict future operations of Glen Canyon Dam for this EIS indicated there would be a minor change in the frequency with which flows recommended by the 1994 biological opinion concerning operation of Glen Canyon Dam would be triggered. It was determined that this change may affect listed species. The results of this analysis were provided to the Service in a November 29, 2000 memorandum as supplemental information to the BA, which is included in Attachment S.

Potential impacts to special-status species occurring in Mexico are discussed separately in Section 3.16, Transboundary Impacts. Specifically, Section 3.16 considers the potential effects on the following species: desert pupfish, vaquita, totoaba, Southwestern willow flycatcher, Yuma clapper rail, yellow-billed cuckoo, California black rail, elf owl, Bell's vireo, and Clark's grebe. Although consultation on species occurring in Mexico may not, as a matter of law, be required by the ESA, Reclamation is also supplementing the BA to include information pertinent to federally listed species from this analysis.

3.8.2 METHODOLOGY

Information on the affected environment and special-status species that may occur in the analysis area was compiled based on review of the pertinent documents listed in Section 1.4, available published and unpublished literature, and through personal communication with agency resource specialists. Species' distribution, range and habitat requirements were reviewed. These requirements formed the basis for compiling an initial list of plant, wildlife and fish species to be considered.

This analysis first discusses vegetative communities that exist throughout the analysis area, from Lake Powell to the SIB. Potentially affected plant, wildlife and fish species are then determined by considering hydrologic requirements and other habitat elements important to the species, such as nesting or breeding habitat for birds and spawning and rearing areas for fish. Species that are not known to be present in the analysis area, do not depend on terrestrial or aquatic habitat associated with the area under consideration or have a hydrologic connection are addressed briefly and removed from further consideration. The analysis of effects to the remaining potentially affected plant, animal and fish species and their habitat follows the section on the affected environment.

3.8.3 AFFECTED ENVIRONMENT

Vegetative communities within the analysis area are discussed, based on if they are located alongside the reservoirs (lakeside habitat) or along the Colorado River (riverside habitat). The special-status species are then identified. The species are divided into three main categories: plants, wildlife and fish. Tables in this section list the species' common and scientific names and current status, and indicate if critical habitat has been federally designated. Following each table, the occurrence and requirements of the species is provided. Species that would not be affected by the interim surplus criteria are identified and removed from further analysis.

3.8.3.1 LAKE AND RIPARIAN HABITAT

A description of lakeside vegetation associated with Lake Powell and GCNRA is provided below, followed by a description of vegetation associated with Lake Mead and LMNRA (which includes Lake Mohave) and Lake Havasu. This section then describes riverside habitat along the Colorado River corridor from Separation Canyon to the Lake Mead delta and below Hoover Dam. Aquatic habitat is discussed in the previous section on Aquatic Resources (Section 3.7).

3.8.3.1.1 Lakeside Habitat

Riparian and marsh vegetation around Lake Powell and Lake Mead is extremely restricted because of the desert terrain that extends directly to the water's edge (Reclamation, 1999d), and the continuously fluctuating lake levels that precludes establishment of vegetation. Tamarisk or salt cedar (*Tamarix ramosissima*), a non-native invasive shrub- to tree-like plant along the Lake Powell shoreline is still becoming established and has not yet formed stable ecosystems. These communities will probably attain some importance as insect and wildlife (particularly bird) habitat in the future, and already provide habitat for fish during high lake levels when the plants are inundated (NPS, 1987).

Small intermittent or seasonal streams occur in many of the side canyons of Lake Powell. Fluctuations in lake levels may result in standing water in these side canyons where riparian vegetation has become established. Dominant plants found in these canyons include Fremont cottonwood (*Populus fremontii*), tamarisk, and cattail (*Typha* sp.) (NPS, undated b). The vegetation within these side canyons has been altered by the lake itself as a result of periodic inundation in association with fluctuating lake levels. In areas where there are springs and seeps, cattail marshes may be found. The most serious adverse influence on canyon and spring riparian zones associated with intermittent or seasonal streams in the side canyons of Lake Powell is domestic and feral livestock use (NPS, 1987).

The GCNRA also has many springs, seeps that are common in alcoves along the 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 (NPS, 1987).

The seeps that are common in alcoves along the walls of the canyon support hanging gardens. Hanging gardens are a specialized vegetation type and have a unique flora associated with them. 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 is found at various elevations around Lake Powell and is typically not affected by reservoir fluctuations. GCNRA hanging gardens are characterized by Eastwood monkeyflower (*Mimulus eastwoodiae*), alcove columbine (*Aquilegia micrantha*), Rydberg's thistle (*Cirsium rydbergii*) and alcove primrose (*Primula specuicola*). None of these are special-status species at this time, although all four are endemic to the Colorado Plateau. Maidenhair fern (*Adiantum* sp.) is the most typical species in hanging gardens throughout the Plateau (Spence, 1992). Other species typically associated with hanging gardens include maidenhair fern, golden columbine (*Aquilegia chrysantha*) and scarlet monkeyflower (*Mimulus cardinalis*).

The highest concentration of habitat associated with Lake Mead in the LMNRA is found in the Lake Mead and Virgin River deltas. 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 (McKernan, 1997). When lake levels decline, vegetation in the Lake Mead and Virgin River deltas begins to establish on clay/silt deposits. The dynamic nature of fluctuating lake levels and deposition of sediment in the Lake Mead delta is expressed as a change in plant species composition and relative abundance over time. In 1963, tamarisk was the dominant tree species in the Lake Mead delta (McKernan, 1997). In 1996, habitat descriptions for Southwestern willow flycatcher study sites at the Lake Mead delta reported 95 percent of the vegetation as willow or cottonwood with only five percent as tamarisk (McKernan, 1997). An increase in sediment deposition in the deltas followed by lower lake levels allows establishment of native riparian habitat if the lowering of the lake is timed to match native seed dispersal. As such, conditions for establishment of native vegetation at the Lake Mead delta have improved since 1963 allowing cottonwood and willow to become the dominant vegetation.

Germination of willows at the Lake Mead delta likely occurred in the spring of 1990 at the approximate water surface elevation of 1185 feet msl (McKernan, 1997 and Reclamation, 1998c). The water surface elevations in 1996 and 1997 were 1192 feet and 1204 feet, respectively (Reclamation, 1998c). These higher lake levels inundated willow habitat in the Lake Mead delta and the Lower Grand Canyon (McKernan, 1997). Until 1998, the Lake Mead delta contained an extensive growth of riparian vegetation principally composed of Goodding willow (*Salix gooddingii*) (McKernan, 1997). By 1999 the Lake Mead delta willow habitat was completely inundated. To a lesser degree, these same effects may also be seen at the Virgin River delta. A higher delta gradient at the Virgin River delta results in a shorter period of inundation at high (greater than 1192 feet msl) lake levels (Reclamation, 1998c).

Section VI of the BA (Reclamation, 2000) provides additional information on fluctuations in lake levels and development of riparian habitat at Lake Mead. It notes that determining exactly how many acres of riparian habitat that may be formed due to declining levels at Lake Mead under the proposed interim surplus criteria is problematic. It further states that the majority of the Lake Mead shoreline does not have the soil necessary to regenerate riparian habitat, and that riparian habitat created by declining lake levels would most likely occur in four areas: Lake Mead delta, Virgin River delta, Muddy River delta and the portion of the Lower Grand Canyon influenced by Lake Mead.. However, future wet hydrologic cycles, would inundate the newly established riparian habitat.

Although higher lake levels may be detrimental to riparian vegetation at the Lake Mead and Virgin River deltas, it may be beneficial to the development of riparian habitat in the lower Grand Canyon downstream of Separation Canyon, and the Virgin and Muddy rivers above Lake Mead (Reclamation, 1998c). Riparian habitat extends from the lake deltas upstream into the lower Grand Canyon and Virgin River Canyon. Development of riparian habitat in these canyons is directly dependent upon fluctuating lake levels and periods of inundation in the canyons. Data collected on riparian vegetation from 1998 Southwestern willow flycatcher surveys (McKernan, 1999) indicate a well-developed riparian corridor composed primarily of willow (*Salix* spp.) and tamarisk that forms extensive and continuous stands in some portions of the lower Grand Canyon. Lower water levels in Lake Mead that expose sediments in the Lake Mead, Virgin River and Muddy River deltas have the potential to benefit establishment of riparian habitat in these areas. However, lower water levels in Lake Mead do not benefit establishment of riparian and marsh habitat in the lower Grand Canyon. In order for riparian and marsh habitats to become established along the Colorado River in the lower Grand Canyon, higher water levels in Lake Mead are necessary.

A few literature sources briefly examine influences of fluctuating lake levels on marsh habitat at the Lake Mead and Virgin River deltas. In 1995, the Lake Mead delta supported hundreds of acres of cattail and bulrush marsh (Reclamation, 1996a). This vegetation type increased after a period of high flows from 1983 to 1986. Deposits containing clay/silt sediments are necessary for the development of emergent marsh vegetation (Stevens and Ayers 1993). Low water velocity sites, such as the Lake Mead and Virgin River deltas, permit clay/silt particles to settle from suspension. These deposits provide a higher quality substrate for seed germination and seedling establishment than underlying sand because of their greater nutrient levels and moisture-holding capacity. With the appropriate water regime (i.e., higher river flows during winter with lower flows during summer), these sites are more likely to support emergent marsh vegetation (Reclamation, 1995b). Marsh vegetation that develops during low lake periods would be lost during periods of high lake levels; however, this habitat is more likely than cottonwood/willow to reestablish as lake levels fluctuate (Reclamation, 1996a). Marsh vegetation that develops during low lake levels is important habitat for many species, particularly breeding birds.

The interim surplus criteria BA (Reclamation, 2000) provides additional information on fluctuations in lake levels and development of riparian habitat at downstream reservoirs (Lake Mohave and Lake Havasu). The interim surplus criteria are not expected to affect levels of the downstream reservoirs as they would be continue to be regulated to meet downstream flood control, power generation and water delivery purposes.

3.8.3.1.2 Riverside Habitat

The riparian vegetation along the Colorado River is among the most important wildlife habitat in the region. Though not common, springs can be found within the GCNRA in intermittent drainages where they often support wetland plant communities. Between Glen Canyon Dam and Lees Ferry, springs are created by several spontaneous, copious flows from the lower canyon walls (NPS, 1987). The *Water Resources Management Plan and Environmental Assessment* for the GCNRA speculates that this spring flow originates from Lake Powell bank storage in the Navajo Sandstone (NPS, 1987), and thus, this area could be affected by changes in Lake Powell surface levels. Overall, lower lake levels are not likely to have any impacts on gardens around Lake Powell, but may have some impacts on springs directly associated with Glen Canyon Dam and extending downriver approximately two to three miles. In the lower canyon, arrowweed *(Pluchea sericea)* and horsetail are common. Below Havasu Creek, bermuda grass becomes the dominant ground cover at many sites (Reclamation, 1996a).

Mesquite (*Prosopis glandulosa*) historically occurred on the broad alluvial floodplains of the Colorado River on secondary and higher terraces above the main channel (LCRMSCP, undated). It still is a dominant species above the scour zone through the Grand Canyon (Ohmart et al., 1988; Turner and Karpiscak, 1980); however, tamarisk is replacing mesquite in many areas along the Colorado River.

Catclaw acacia occurs along watercourses and other areas where a summer water supply may be present (Barbour and Major, 1995; Brown, 1994; Holland, 1986; Sawyer and Keeler-Wolf, 1995). This species occurs in both upland and riparian vegetation associations (Reclamation, 1996a). Catclaw acacia in the Grand Canyon can occur with Apache plume (*Fallugia paradoxa*), a typical constituent in the acacia-mesquite habitat. It may also be found with desert broom (*Baccharis* spp), which is an obligate riparian species that occurs in the cottonwood-willow habitat type (Turner and Karpiscak, 1980).

Two types of marsh plant associations have been identified along the Colorado River (Stevens and Ayers, 1991). Marshes were historically found along oxbow lakes and in backwater areas along the Colorado River. Cattails, bulrushes, common reed and some less common emergent plants occur in marsh areas that develop on sediment deposits containing about half clay/silt and half sand (Reclamation, 1995).

In the lower Grand Canyon above Lake Mead, the interim surplus criteria may affect backwater marshes due to the changes in water levels. These changes in water levels could affect temperature and other water quality considerations, as well as the establishment of marsh vegetation. Section V of the BA (Reclamation, 2000) discusses historic and existing marsh, backwater and aquatic habitat on the lower Colorado River below Hoover, Davis and Parker dams.

3.8.3.2 SPECIAL-STATUS PLANT SPECIES

The list of special-status plants in Table 3.8-1 below is based on documented or potential occurrence within vegetation communities of the Glen Canyon National Recreation Area (GCNRA), Lake Mead National Recreation Area (LMNRA) and the Colorado River corridor in the lower Grand Canyon. No special-status plant species were identified for analysis below Hoover Dam. Nineteen plant species were removed from detailed consideration, as discussed in the next section. Four species could be affected by interim surplus criteria alternatives and are considered further.

Table 3.8-1
Special-Status Plant Species Potentially Occurring Within the Area of Analysis

Common Name	Scientific Name	Status
Alcove bog orchid	*Habenaria zothecina*	Federal Species of Concern
Alcove daisy	*Erigeron zothecinus*	Federal Species of Concern
Alcove deathcamas	*Zigadenus vaginatus*	Federal Species of Concern
Barrel cactus	*Ferrocactus acanthodes var. lecontei*	Northern Nevada Native Plant Society (NNNPS) Watch List species and Listed as Sensitive by the Service (Intermountain Region)
Brady's footcactus	*Pediocactus bradyi*	Federally Listed Endangered
Canyonlands sedge	*Carex scirpoidea var. curatorum*	Federal Species of Concern
Geyer's milkvetch[1]	*Astragalus geyeri var. triquetrus*	Federal Species of Concern; Nevada Critically Endangered
Grand Canyon evening-primrose[1]	*Camissonia specuicola ssp. Hesperia*	Federal Species of Concern
Hole–in-the-Rock prairie clover	*Dalea flavescens*	Federal Species of Concern
Jones cycladenia	*Cycladenia humilis var. jonesii*	Federally Listed Threatened
Kachina daisy	*Erigeron kachinensis*	Federal Species of Concern
Las Vegas bear poppy[1]	*Arctomecon californica*	Nevada Listed Critical Endangered
Navajo sedge	*Carex specuicola*	Federally Listed Threatened
New Mexico raspberry	*Rubus neomexicana*	Federal Species of Concern
Rock Daisy	*Perityle specuicula*	Federal Species of Concern
Rosy bicolored beardtongue	*Penstemon bicolor ssp. Roseus*	Federal Species of Concern
Satintail grass	*Imperata brevifolia*	Federal Species of Concern
Sawgrass	*Cladium californicum*	Federal Species of Concern
Sticky buckwheat[1]	*Eriogonum viscidulum*	Federal Species of Concern
Thompson's indigo-bush	*Psorothamnus thompsoniae var. whittingii*	Federal Species of Concern
Ute ladies' tresses	*Spiranthes diluvialis*	Federally Listed Threatened
Virgin River thistle	*Cirsium virgenense*	Federally Listed Species of Concern; Arizona Salvage-restricted, Protected Native Plant
Western hophornbeam	*Ostrya knowltonii*	Federal Species of Concern

[1] Species with the potential to be affected by the interim surplus criteria that are considered further.

3.8.3.2.1 Plant Species Removed from Further Consideration

This section discusses the reasons for eliminating certain special-status plant species from detailed consideration.

Special-status plant species that occur in hanging gardens at GCNRA include alcove bog orchid, alcove daisy, alcove deathcamas, canyonlands sedge, Kachina daisy, Navajo sedge, New Mexico raspberry, sawgrass, western hophornbeam and Virgin River thistle. The water source for these species comes from seepage from the Navajo sandstone that would not be affected by hydrologic changes associated with interim surplus criteria.

Barrel cactus, Brady's footcactus, rosy bicolored beardtongue, Jones cycladenia and Thompson's indigo-bush are desert species. This habitat type and associated plant species would not be affected by interim surplus criteria.

Hole-in-the-Rock prairie clover occurs in the Hall's Creek and Escalante drainages in the GCNRA, which would not be affected by hydrologic changes associated with the interim surplus criteria.

Rock daisy occurs at Cedar Mesa in GCNRA, growing in sandstone along the margins of an ephemeral stream channel at the canyon bottom that would not be affected by interim surplus criteria.

Satintail grass occurs within lower Wilson's Creek in the GCNRA, an area that would not be affected by interim surplus criteria.

Sawgrass has been found in the riparian zone of Alcove Canyon in Grand Canyon National Park, and in the riparian zone of Garden Canyon on the cliffs above Lake Powell. These riparian zones would not be affected by interim surplus criteria.

Ute ladies' tresses occur in moist to wet meadows along perennial streams at elevations between 4,300 and 7,000 feet msl. These occurrences are above those elevations that occur within the area under consideration. As such, this species would not be affected by interim surplus criteria.

Virgin River thistle occurs on sandy or gravelly alkaline slopes and washes and around saline seeps, alkaline springs or stream terraces. It occurs between elevations of 1968 and 6562 feet msl, and is associated with Mojave mixed scrub habitat. This habitat type would not be affected by interim surplus criteria. As such, this species would not be affected by interim surplus criteria.

3.8.3.2.2 Plant Species Considered Further

Geyer's Milkvetch - Geyer's milkvetch is known to occur along the shoreline of Lake Mead and is associated with stabilized sand dunes and sandy soils. Population trends have not been well documented for Geyer's milkvetch. Germination may be tied to rainfall, and poor seed production and insect infestations may contribute to the limited distribution and/or small population sizes observed for this variety (Mozingo and Williams, 1980). Some populations have been directly affected by rising water levels at Lake Mead (i.e., Middle Point). Additional causes of decline for this taxon may include shoreline recreation, trampling and grazing by burros and livestock, off-road vehicle use, and utility corridors (Niles et al., 1995).

Threats to Geyer's milkvetch in the study area have not been well defined. This variety may be potentially threatened by: 1) loss of habitat from inundation and rising water levels at Lake Mead; 2) invasion of shoreline (beach) habitat by other plant species (i.e., tamarisk and arrowweed); and possibly 3) trampling and grazing by burros. Geyer's milkvetch occurs further back from the shoreline and may be less affected by these factors (E. Powell, 2000). Shoreline recreation does not currently appear to be a major threat to this species because the beaches where it occurs do not receive heavy recreational use. In addition, the species typically flowers and sets seed prior to the beginning of heavy use periods at Lake Mead (Niles et al., 1995; E. Powell, 2000). However, rising lake levels may potentially affect this species directly by inundation of plants or indirectly through inundation of suitable habitat.

Grand Canyon Evening Primrose - Grand Canyon evening primrose is a clustered herbaceous perennial plant with small flowers that are yellow or white at anthesis (flowering), but may turn to pink or lavender with aging. The Grand Canyon evening primrose occurs on beaches along or near the main stem Colorado River in the vicinity of Separation Canyon and downstream of Diamond Creek where available beach habitat is exposed (Brian, 2000 and Phillips, 2000). This species is likely adversely affected when beaches are disturbed through erosion or deposition of sediments during flood events. Some degree of flooding occurs seasonally as the result of increases in side-channel inflows during rainfall events. Additional flood flows result from periodic BHBF releases from Glen Canyon Dam. The degree to which flooding adversely affects this subspecies and which water levels are detrimental to the plants and its habitat is unknown. However, the amount of beach habitat in the Grand Canyon has decreased under post-dam conditions, and the remaining habitat is often invaded by riparian vegetation (Schmidt et al., 1998). Because this subspecies is found on good camping beaches, particularly in the lower portion of the Grand Canyon, it may also be adversely affected by disturbance associated with recreational beach use; however, this potential effect is not related to the interim surplus criteria.

Las Vegas Bear Poppy - Las Vegas bear poppy is a short-lived perennial species, occurring along the lower levels of the Lake Mead shoreline (E. Powell, 2000). This plant occurs on gypsum soils below the high water line of Lake Mead (1225 feet msl) on sloping flats. Little is known about the life cycle of the Las Vegas bear poppy, and populations vary in a "boom or bust" pattern (E. Powell, 2000). This species would benefit from lower water levels at Lake Mead, and could be adversely affected by increases in water levels although timing of water fluctuations and associated effects to this species are unknown.

Sticky Buckwheat - Sticky buckwheat is found primarily along the Overton Arm of Lake Mead (Reveal and Ertter 1980, Niles et al., 1995). Smaller, potentially significant populations occur in the vicinity of Overton Beach, along the Virgin River Valley, and along the Muddy River. Major threats to sticky buckwheat at Lake Mead include: 1) loss of habitat from inundation and rising water levels at Lake Mead; 2) invasion of shoreline (beach) habitat by other plant species (i.e., tamarisk and arrowweed); and possibly three) trampling and grazing by burros. Shoreline recreation does not currently appear to be a major threat to this species because the beaches where it occurs do not receive heavy recreational use. In addition, the species typically flowers and sets seed prior to the beginning of heavy use periods at Lake Mead (Niles et al., 1995). This species would benefit from lower water levels at Lake Mead, and could be adversely affected by increases in water levels.

3.8.3.3 SPECIAL-STATUS WILDLIFE SPECIES

Special-status wildlife species with the potential to occur within the area under consideration in the United States are listed in Table 3.8-2. Two invertebrate, two amphibian, and one reptile species are of concern. Eleven bird species and two mammals are of concern. A number "1" after the species on the table indicates the species has the potential to be affected by the interim surplus criteria alternatives, and is therefore assessed in more detail.

Table 3.8-2
Special-Status Wildlife Species Potentially Occurring Within the Area of Analysis

Common Name	Scientific Name	Status
Invertebrates		
MacNeill's sootywing skipper	*Hesperopsis gracielae*	Federal Species of Concern
Kanab ambersnail	*Oxyloma haydeni kanabensis*	Federally Listed Endangered; Arizona Wildlife of Special Concern
Amphibians		
Northern leopard frog	*Rana pipiens*	Arizona Candidate for Listing
Relict leopard frog	*Rana onca*	Nevada State Protected; Arizona Wildlife of Special Concern
Reptiles		
Sonoran mud turtle	*Kinosternon sonoriense sonoriense*	California Species of Special Concern
Birds		
American peregrine falcon	*Falco peregrinus anatum*	California Endangered; Nevada State Protected and Endangered
Arizona Bell's vireo[1]	*Vireo bellii arizonae*	California Endangered
Bald eagle[1]	*Haliaeetus leucocephalus*	Federally Listed Threatened; California Endangered; Nevada State Protected and Endangered
California black rail[1]	*Laterallus jamaicensis coturniculus*	Federal Species of Concern; California Threatened
Clark's grebe[1]	*Aechmophorus clarkii*	Arizona Wildlife of Special Concern
Cooper's hawk[1]	*Accipiter cooperii*	California Species of Special Concern
Elf owl[1]	*Micrathene whitneyi*	California Endangered
Gilded flicker[1]	*Colaptes chrysoides*	California Endangered
Southwestern willow flycatcher[1]	*Empidonax traillii extimus*	Federally Listed Endangered (critical habitat designated); California Endangered; Nevada State Protected
Yuma clapper rail[1]	*Rallus longirositris yumaniensis*	Federally Listed Endangered; California Threatened
Western yellow-billed cuckoo[1]	*Coccyzus americanus*	Federally Proposed Endangered; California Endangered; Nevada State Protected
Mammals		
Colorado River cotton rat	*Sigmodon arizonae plenus*	Federal Species of Concern; California Species of Special Concern
Occult little brown bat	*Myotis lucifugus occultus*	Federal Species of Concern; California Species of Special Concern

[1] Species with the potential to be affected by the interim surplus criteria that are considered further in this analysis.

3.8.3.3.1 Wildlife Species Removed from Further Consideration

The Kanab ambersnail occurs in semi-aquatic habitat associated with springs and seeps. In the Grand Canyon, Kanab amber snail were originally known to occur only at Vasey's Paradise, a large perennial spring. As part of an effort to recover the species, Kanab amber snails 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 level of any potential future flood flows past Glen Canyon dam. These populations would not be affected by the adoption of interim surplus criteria. Reclamation has consulted with the Service on the effects to the Vasey's Paradise population from the operations of Glen Canyon Dam. The resulting biological opinion (USFWS, 1996) continues to be implemented and will not be affected by the proposed action. There will be no effect from the adoption of interim surplus criteria.

The northern leopard frog is known to occur in association with a spring at one site below Glen Canyon Dam. The population was monitored before and after the 1996 BHBF and found to persist under these flows. This species receives consideration under the Glen Canyon Dam AMP (see Section 3.2.2). The minor changes to operations of Glen Canyon due to adoption of the interim surplus criteria are not expected to affect the northern leopard frog.

Historically, the relict leopard frog (*Rana onca)* was known from several locations along the Virgin river, and from the Overton arm of Lake Mead to north of St. George, Utah. This species was also known from the Muddy River and Meadow Valley Wash in Nevada, northwest of the Overton Arm. This species was thought to be extinct, but was rediscovered at three of 51 potential habitat sites surveyed in 1991. Surveys conducted for relict leopard frog included potential habitat within the historical range of the species (Bradford and Jennings 1997). There are confirmed sightings of this species at springs about two miles (3.2 km) west of Stewarts Point on the Overton Arm of Lake Mead. A fourth population of leopard frog on the Virgin River near Littlefield, Arizona is within the range of the lowland leopard frog (*R. yavapaiensis)* and is still awaiting additional studies to confirm its taxonomic status. Other unconfirmed sightings are on the Virgin River near Littlefield, Arizona and about four km (2.5 miles) downstream from Hoover Dam.

In general, leopard frogs inhabit springs, marshes, and shallow ponds, where a year-round water supply is available. Emergent or submergent vegetation such as bulrushes or cattails provides the necessary cover and substrate for cover and oviposition (Jennings et al., 1994). Suitable aquatic habitat, as well as, adjacent moist upland or wetland soils is required by the relict leopard frog. In addition, dense herbaceous cover and a canopy of cottonwoods or willows characterize habitat for this species.

The relict leopard frog populations located near the Overton Arm of Lake Mead are associated exclusively with geothermally influenced and perennial desert spring communities. Because the known populations are currently confined within a five-mile

(8km) area (Bradford and Jennings 1997), they are susceptible to extirpation from localized impacts. Threats to this species include habitat destruction, lowering of the water table, and predation by introduced bullfrogs (AGFD, 1996; AGFD 1998).

The known occurrences of relict leopard frogs are in association with springs that will not be affected by the interim surplus criteria alternatives being considered. If additional emergent marsh vegetation develops at the Lake Mead and Virgin River deltas as the result of lower lake levels, it may provide potential habitat for the relict leopard frog. However, predation by introduced fishes and bullfrogs may preclude occurrence of the leopard frogs in these areas. Reclamation concludes that the interim surplus criteria do not have the potential to affect the relict leopard frog.

MacNeill's sootywing skipper is a butterfly found along the Colorado River from southern Utah and Nevada to Arizona and southeastern California (Reclamation, 1996a). Confirmed records of this species are reported for the Arizona counties of Mohave, La Paz, Yuma, Yavapai, Maricopa and Pinal. The MacNeill's sootywing skipper is also present in San Bernardino, Riverside and Imperial counties in California. This species also occurs along the Muddy River above Lake Mead (Austin & Austin, 1980).

The larval host plant for MacNeill's sootywing skipper is quailbrush (*Atriplex lentiformis*). Quailbrush is the largest salt bush found in Arizona and forms dense thickets along the drainage system of the Colorado River (Emmel and Emmel, 1973). Quailbrush is associated with floodplains located in alkaline soil areas with adequate water resources (Kearney and Peebles, 1951). Specific surveys for this species and larval host plants have not been conducted in the lower Grand Canyon; however, the documented occurrence of MacNeill's sootywing skipper along the Muddy River above Lake Mead indicates there is a likelihood of occurrence in the lower Grand Canyon. Suitable habitat for this species likely requires stands of more than one host plant (W. Wiesenborn, 1999). Although this species occurs in the area of analysis, the host plant occurs on alluvial floodplains and has little potential to be affected by the alternatives considered for the interim surplus criteria.

Lake Powell and Lake Mead provide breeding and wintering habitat for American peregrine falcons. The peregrine falcon breeds at sites on Lake Mead, and the upper portion of Lake Mohave. Wintering and breeding peregrines are also found around Lake Powell, with an estimated 50 breeding areas (Interior, 1995), and 19 wintering territories (Hetzler, 1992a). Based on historical data, the average height above water of peregrine nests at GCNRA is approximately 460 feet (141 meters), with average cliff heights of 630 feet (193 meters) (Hetzler 1992a, Hetzler 1992b). These data include nest sites in Glen Canyon immediately below the Glen Canyon Dam as well as sites on Lake Powell. Glen Canyon Dam operations have resulted in increased riparian vegetation which supports a larger population of passerines and increased the food base for peregrine falcons.

Existing and potential American peregrine falcon breeding habitat also occurs in the Grand Canyon between Glen Canyon Dam and Lake Mead and in Black Canyon, (south of Lake Mead). Because their nesting sites are well above the water and their food base has increased, peregrine falcons would not be affected by hydrologic changes associated with the interim surplus criteria and have been eliminated from further analysis.

The Sonoran mud turtle, Colorado River cotton rat, and occult little brown bat were removed from further consideration because there are no known occurrences in the analysis area.

3.8.3.3.2 Special-Status Wildlife Species Considered Further

Arizona Bell's Vireo - The Arizona Bell's vireo (*Vireo bellii arizonae*) is distributed throughout the river systems of the Southwest desert and have been documented in the Virgin and Muddy rivers, and the lower Colorado River. Since 1900, populations of this subspecies of Bell's vireo have declined along the lower reaches of the Colorado River, where it is now a rare, to locally uncommon, summer resident from Needles south to Blythe (Brown et al., 1983; Zeiner et al., 1990a; Rosenberg et al., 1991). Since the completion of Glen Canyon Dam in 1963, the Bell's vireo has expanded its range eastward into Grand Canyon National Park (Brown et al., 1983). An extensive riparian scrub, that has developed along the Colorado River in the Grand Canyon largely composed of tamarisk and willow, supports a significant population of Bell's vireo (Brown et al., 1983). The Grand Canyon population of Bell's vireo is regionally important due to the substantial decline of this subspecies at lower elevations. The riparian habitat utilized by Arizona Bell's vireo may potentially be affected by the interim surplus criteria.

Bald Eagle - The bald eagle historically ranged throughout North America except extreme northern Alaska and Canada and central and southern Mexico. In 1978, in response to lowering population and reproductive success, the Service listed the bald eagle throughout the lower 48 states as endangered except in Michigan, Minnesota, Wisconsin, Washington and Oregon, where it was designated as threatened (43 FR 6233, February 14, 1978). In 1982, a recovery plan was developed specifically for the southwestern bald eagle; the geographic boundary includes southeast California within 10 miles of the Colorado River or its reservoirs. The bald eagle population has clearly increased in number and expanded its range since it was listed. This improvement is a direct result of the banning of DDT and other persistent organochlorines, habitat protection, and from other recovery efforts (60 FR 36001, July 12, 1995). On August 11, 1995, FWS reclassified the bald eagle from endangered to threatened in the lower 48 states. (60 FR 133, pg. 3600, August 12, 1995).

Reclamation's 1996 BA concluded that its Lower Colorado river operations and maintenance activities are not likely to adversely affect the food resources, foraging opportunities, or the nesting habitat of the bald eagle. Based on data from bald eagle winter counts conducted by the AGFD since 1992, eagles are not considered rare within the project area. Wintering birds are expected to continue using the river and most likely will congregate where food resources are plentiful and excessive disturbance from recreation can be avoided. The 1996 BA also cites studies by Hunt et al., (1992) that conclude reservoirs and dams did not appear to have a negative effect on bald eagle reproduction. River operations and maintenance may affect establishment of newly regenerated cottonwood/willow stands that could provide future nesting and perching substrate for eagles. However, as documented in Hunt et al. (1992), bald eagles can successfully nest on other substrates (cliffs, pinnacles). Reclamation's ongoing native riparian plant restoration program has the potential to increase available tree nesting and perching habitat along the river. No evidence exists to suggest that the food resources available in the reservoirs and river are limiting nesting. Because of the minor changes to the operation of Glen Canyon Dam and the minor hydrologic changes in the reservoirs and along the river, Reclamation determined that adoption of the interim surplus criteria would not adversely affect the bald eagle.

California Black Rail - California black rail (*Laterallus jamaicensis coturniculus*) have recently been documented in the Virgin River Canyon, including the corridor above Lake Mead (McKernan, 1999). In general, Flores and Eddleman (1995) found that black rails utilize marsh habitats with high stem densities and overhead coverage that were drier and closer to upland vegetation than randomly selected sites. Marsh edges with water less than 2.5 centimeters (1 inch) deep dominated by California bulrush and three-square bulrush (*Scirpus californicus* and *S. americanus,* respectively) are utilized most frequently. Areas dominated by cattail are also used regularly, but only in a small proportion to their availability and generally within 50 meters (164 feet) of upland vegetation where water depth is 3.0 centimeters (1.2 inch). The occurrence and potential impacts to species along the river corridor in Mexico are also discussed in Section 3.16.

Clark's Grebe – Clark's grebes (*Aechmophorus clarkii*) are typically less abundant than the western grebe at most locations throughout their range (Ratti, 1981; Zeiner et al., 1990a). A 1977 winter survey found Clark's grebes comprised less than 12 percent of *Aechmophorus* grebe sightings at locations within California and areas near Lake Mead (Ratti, 1981). At Lake Mead, a total of 321 western grebes were detected during the winter, while only three Clark's grebes were observed. At Lake Havasu, western grebes are also more abundant than Clark's grebes in the winter. However, Clark's grebes are more numerous in the breeding season, making up approximately 65 percent of the breeding colony (Rosenberg et al., 1991). Although the cattail and bulrush marsh habitat found at the Lake Mead delta exhibits characteristics preferred by Clark's grebe, it is not known whether this species currently occurs at the delta. The marsh habitat at the Lake Mead and Virgin River deltas, and in the Colorado and Virgin rivers above Lake Mead may potentially be utilized by Clark's grebe and may be affected by the interim surplus criteria.

Cooper's Hawk – Cooper's hawks (*Accipiter cooperii*) are associated with deciduous mixed forests and riparian woodlands and nests mainly in oak woodlands, but also use willow or eucalyptus woodlands. The Cooper's hawk nests near streams and prefers mature trees with a well-developed understory for nesting sites (Ziener et al., 1990a). Breeding activity has been documented in the lower Grand Canyon, below Separation Canyon, and in the lower Virgin River above Lake Mead (McKernan, 1999). The riparian habitat currently utilized by Cooper's hawk in the lower Grand Canyon and lower Virgin River may be affected by the interim surplus criteria.

Elf Owl – The elf owl (*Micrathene whitneyi*) is a secondary cavity nester and, as a result, the population status of the elf owl is directly dependent on available nesting holes in trees made by woodpeckers. As an insectivore, the elf owl is also dependent on sufficient numbers of insects during the breeding season (Johnsgard, 1988). In California, at the extreme northwest edge of its range, the elf owl is likely declining in the few desert riparian habitats that it occupies (Johnsgard, 1988). There may also be a general decline in Arizona, although it may be increasing its range in north-central Arizona and western New Mexico. The species' overall status in the Southwest has not been determined. The elf owl was never a common or widespread species along the lower Colorado River. Surveys of riparian habitats in the lower Colorado River Valley in 1987 reported between 17 and 24 owls at ten different sites (CDFG, 1991). Population estimates in California for the early 1990s were 17 to 25 breeding pairs (CDFG, 1991; Rosenberg et al., 1991). Riparian habitat in the Grand Canyon may provide suitable breeding habitat for the elf owl; however, based on the available information, it is unknown whether elf owls occur. The riparian habitat along the Colorado River above Lake Mead may be utilized by elf owl and has the potential to be affected by the interim surplus criteria.

Gilded Flicker – The gilded flicker (*Colaptes chrysoides*) occurs along the lower Colorado River Valley in southern Arizona and southeastern California (Rosenberg et al., 1991). In California, the gilded flicker is an uncommon resident along the Colorado River north of Blythe (Garrett and Dunn, 1981, CDFG, 1991). During the breeding season, the gilded flicker is found in saguaro habitats, mature cottonwood-willow riparian forests, and occasionally mesquite habitats with tall snags (CDFG, 1991; Rosenberg et al., 1991). This species was historically widespread in riparian habitat all along the Colorado River Valley. Based on available information, it is not known whether this species occurs in the lower Grand Canyon, although suitable habitat is present in both the riparian and mesquite habitats.

Southwestern Willow Flycatcher – The Southwestern willow flycatcher (*Empidonax traillii extimus*) is a riparian obligate, neotropical migratory insectivore that breeds along rivers, streams, and other wetlands where dense willow, cottonwood, tamarisk, or other similarly structured riparian vegetation occurs (Service, 1995a; McKernan 1999; AGFD, 1997e). Populations of breeding Southwestern willow flycatchers have been recorded at the upper Lake Mead delta, the Virgin River delta, Mormon Mesa North, and the Lower Grand Canyon (AGFD, 1997e; Sogge et al., 1997). However, due to high lake levels, as discussed previously, the Lake Mead and Virgin River delta willow flycatcher habitat has been inundated. This change in reservoir elevation has permitted suitable willow riparian habitat to develop in the Colorado River corridor from Lake Mead up to approximately Separation Canyon (McKernan, 1999). The occurrence of this species and habitat below Lake Mead to the SIB is discussed in the BA for this proposed action (Reclamation, 2000).

The Grand Canyon population of Southwestern willow flycatcher is important from a scientific and management perspective because it is one of the longest continuously monitored populations in the southwest (Sogge et al., 1997). In support of this view, the USFWS designated river mile 39 downstream to river mile 71.5 as critical habitat for this species (USFWS, 1997a, 1997c). This habitat occurs in the upper Grand Canyon and will not be affected by the interim surplus criteria.

High lake levels (above 1192 feet) appear to be detrimental to Southwestern willow flycatcher nesting habitat at Lake Mead delta due to potential loss of suitable nest trees (Reclamation, March 1998). Lake levels below 1192 feet during the willow flycatcher breeding season (April through August) appear to allow for increased willow habitat establishment which would be beneficial to the species. From January 1978 until June 1990, Lake Mead elevations were above 1182 feet on a continuous basis. In June 1990, Lake Mead elevation declined to approximately 1182 feet and stayed below that elevation until the end of 1992 (Reclamation, 2000). If saturated soils are present in areas occupied by willow flycatcher, declines in lake levels during June have little to no effect on nesting. In contrast, when Lake Mead's elevation is high enough to inundate the delta, which typically occurs during June and July (Reclamation, 2000), willow flycatchers would not be affected because their territories and possibly nest sites would be established. Because suitable habitat utilized by Southwestern willow flycatcher may be affected by changes in Lake Mead water levels that would result from implementation of the interim surplus criteria, the species is considered in the environmental consequences section below. The interim surplus criteria are not expected to result in hydrologic changes below Hoover, Davis and Parker dams that would adversely affect the flycatcher.

Yuma Clapper Rail – The Yuma clapper rail (*Rallus longirostris yumanensis*), one of seven North American subspecies of clapper rails, occurs primarily in the lower Colorado River Valley in California, Arizona and Mexico. It is a fairly common summer resident from Topock Gorge south to Yuma in the United States, and at the Colorado River delta in Mexico. In the area under consideration, the Yuma clapper rail is associated with freshwater marshes with the highest densities of the subspecies occurring in mature stands of cattails and bulrush (Reclamation, August 1999). In recent years, individual clapper rails have been heard at Laughlin Bay and Las Vegas Wash in southern Nevada (NDOW, 1998), and individuals have been documented at the Virgin and Muddy rivers including the Virgin River floodplain between Littlefield, AZ and the Virgin River Delta, NV (McKernan, 1999), and at sites within the lower Grand Canyon (McKernan, 1999). The occurrence of the Yuma Clapper below Lake Mead to the SIB is discussed the BA for this proposed action (Reclamation, 2000). The marsh habitat utilized by Yuma clapper rail has the potential to be affected by the interim surplus criteria.

Western Yellow-billed Cuckoo – Historically, the western form of the yellow-billed cuckoo (*Coccyzus americanus*) was a fairly common breeding species throughout the river bottoms of the western United States and southern British Columbia (Gaines and Laymon, 1984). Due to the loss of riparian woodland habitat, the cuckoo has become an uncommon to rare summer resident in scattered locations throughout its former range. Western yellow-billed cuckoo have been documented in riparian habitat in the lower Grand Canyon and Virgin River above Lake Mead (McKernan, 1999) (Reclamation, 2000) as well as in habitat along the river corridor below Lake Mead and has the potential to be affected by the interim surplus criteria.

3.8.3.4 SPECIAL-STATUS FISH SPECIES

Described below are special-status fish species present within the area under consideration. Table 3.8-3 lists special-status fish species including common name, scientific name and status. Currently, the Service is supplementing existing recovery plans for the four endangered fish species included in this analysis.

Critical habitat has been designated for each of the federally listed fish species (Federal Register: March 21, 1994), and portions of this habitat exist within the area of potential effect (Reclamation, 2000).

Table 3.8-3
Special-Status Fish Species Potentially Occurring Within the Area of Analysis

Common Name	Scientific Name	Status
Bonytail	*Gila elegans*	Federally Listed Endangered (critical habitat designated); California Endangered; Nevada State Protected
Colorado pikeminnow	*Ptychocheilus lucius*	Federally Listed Endangered (critical habitat designated); California Endangered
Flannelmouth sucker	*Catostomus latipinnis*	Federal Species of Concern; Arizona Wildlife Species of Concern; Bureau of Land Management Nevada Special Status Species
Humpback chub	*Gila cypha*	Federally Listed Endangered (critical habitat designated)
Razorback sucker	*Xyrauchen texanus*	Federally Listed Endangered (critical habitat designated)

Bonytail – Adult bonytail (*Gila elegans*) were once found throughout the big rivers and major tributaries of the Colorado River basin. Younger fish utilize the smaller streams and quiet areas. Bonytail prefer substrate which consists of clay, soft mud, or mud and sand, or occasionally rocks, gravel or rubble with little or no vegetation (Sigler and Miller, 1963; Wydoski, 1995). Adults range between eight and 17 inches in length and weigh just over one pound. The species can live for over 40 years. Spawning occurs in late spring to early summer usually over gravel bars with no nest being constructed. Gravid females can carryover 10,000 eggs each. Bonytail are carnivorous, feeding on insects, crustaceans, small fish, and snails; however, filamentous algae are often consumed (NPS, 1998).

The bonytail is now the rarest native fish within the Colorado River Basin (NPS, 1998). The decline in the number of bonytail are thought to be a result of changes in historical stream flow and water temperatures, blockage of migratory routes by dams and introduction of non-native fish species. At Lake Powell, present numbers are accounted for by fish older than 40 years of age; no recruitment has been demonstrated in recent years (NPS, 1998).

Bonytail are believed to be extirpated in the Colorado River from Glen Canyon Dam to Hoover Dam (McCall, 1979 and Reclamation, 1996a). Small populations may still exist in the Upper Basin, but there is much confusion in fish identification due to the similarity in physical appearance with roundtail chubs (Reclamation, 1996a). Five suspected bonytail were captured in Cataract Canyon between 1985 and 1988, with one caught in Lake Powell near Wahweap Marina (Maddux et al., 1993 and Reclamation, 1995).

Critical habitat for bonytail includes the Colorado River from Hoover Dam to Davis Dam, including Lake Mohave. It also includes the Colorado River from the northern boundary of Havasu National Wildlife Refuge to Parker Dam, including Lake Havasu. The largest remaining population of bonytail in the entire Colorado River Basin resides in Lake Mohave. There were at least nine augmentation stockings of bonytail into Lake Mohave between 1981 and 1991 (Reclamation, 1996a). Efforts are being undertaken to repatriate bonytail back to Lake Havasu from lakeside coves using young obtained from Dexter National Fish Hatchery (Reclamation, 1996a). The primary limiting factor for bonytail appears to be non-native fish predation of the early life stages (egg to subadult) (Reclamation, 1996a).

Colorado pikeminnow – The Colorado pikeminnow (*Ptychocheilus lucius*) is the largest member of the minnow family within North America and is endemic to the Colorado River system. It was, historically, the top predator fish in the Colorado River, but native populations are now restricted to the upper Colorado River Basin (Reclamation, 1996a). A portion of their current distribution includes the Colorado River from Palisades, Colorado, downstream to Lake Powell (NPS, 1998). Colorado pikeminnow have been captured in Lake Powell as recently as 1999 (Reclamation, file data). Designated critical habitat within the area of effect for the analysis is limited to the normal pool elevation of Lake Powell. Colorado pikeminnow are now considered extirpated from the entire Lower Basin; where they were once extremely abundant. The last known wild adults from the lower Colorado River were captured in the 1960s, and the last known specimens from the Gila River basin were collected in 1958 (Minckley, 1973). Colorado pikeminnow were taken from Lake Havasu in the 1970s. Populations in the upper basin are thought to be stable or increasing, with documented natural recruitment.

The species is adapted to large seasonal flow variations, high concentrations of silt, turbulence, periodically low food availability and naturally variable riverine subsystems. It is typically a big river fish where the current is strong and the water heavily silt laden. Colorado pikeminnow are migratory and can utilize anywhere from 100 to 200 miles of river to complete their life cycle. Spawning takes place from spring to late summer depending on water temperatures. Larva and juvenile pikeminnow can drift 60 to 150 miles from spawning beds into nursery areas where they mature to a size that mostly prevents predation (Maddux et al., 1993; Sigler and Miller, 1963).

Flannelmouth sucker – The flannelmouth sucker (*Catostomus latipinnis*) was historically found in medium to large rivers throughout the upper and lower Colorado River drainage (Joseph et al., 1977; AGFD, 1996a). Although the flannelmouth sucker is currently widely distributed in the upper Colorado River Basin (Holden and Stalnaker 1975a, b; McAda, et al., 1994), its occurrence in the lower Colorado River Basin has become more restricted. The species' range in the Upper Basin includes the main stem of the Colorado River, numerous tributaries that drain a large portion of Colorado and Utah, and the San Juan River drainage in New Mexico and Utah. In the Lower Basin, the flannelmouth sucker occurs only in localized areas of suitable habitat (Sublette et al., 1990). Populations in the Lower Basin occur in the Little Colorado River, Virgin River, Colorado River in Glen Canyon, Grand Canyon, and immediately below Davis Dam, and several small tributaries to the Colorado River above Lake Mead (AGFD, 1996a; Valdez and Carothers, 1998).

Flannelmouth suckers typically require medium to large flowing streams and react poorly to impounded habitats or habitats influenced by impoundments (Minckley, 1973), and the artificial thermal regime created by impoundments. Subadult flannelmouth suckers in the Grand Canyon use sheltered shoreline habitats, backwaters, and tributary inflows (Valdez and Ryel, 1995). Conversely, adults can be found in a variety of mainstem habitats, including: tributary mouths, vegetated shorelines, mid-channel cobble bars (Valdez and Ryel, 1995), eddies (Holden and Stalnaker, 1975a; and Valdez and Ryel, 1995) and riffles (Holden and Stalnaker, 1975a). Spawning can take place from spring to early summer and is often preceded by an upstream migration.

Since 1986, the AGFD has conducted yearly monitoring of flannelmouth sucker populations in the Colorado River from Lees Ferry downstream to Lake Mead. The Glen Canyon Monitoring and Research Center (1998) has funded monitoring and research activities for this species. The objective of this program is to provide the knowledge base required to implement ecosystem management strategies within an adaptive management framework.

Humpback chub – Endemic to the Colorado River, the humpback chub (*Gila cypha*) inhabits the canyon-bound sections of the Colorado, Green and Yampa rivers, with high fidelity for particular localized sites. Young are not known to widely disperse. The historical abundance and distribution of the fish is not well known. Designated critical habitat includes the Colorado River from Nautiloid Canyon to Granite Park in the Grand Canyon, and the lower eight miles of the Little Colorado River, including its confluence with the Colorado River. The largest population still extant is found in and near the Little Colorado River within the Grand Canyon (Maddux et al., 1993; Valdez and Ryel, 1995). This population uses the Little Colorado River for spawning and rearing. The possibility exists that humpback chub found in the Middle Granite Gorge and lower Grand Canyon may represent a separate population (Reclamation, 1996a).

Humpback chub becomes reproductively active between May and July depending on location and the hydrograph. Males become reproductively mature within three years. Spawning occurs during the highest spring flows when water temperatures approach 68°F (20°C) over cobble or gravel surfaces. 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).

Young humpback chub feed mainly from the bottom eating small invertebrates and diatoms. Adults also feed mainly from the bottom but also feed on floating aquatic and terrestrial insects (SWCA, 1997; Valdez and Ryel, 1995; Wydoski, 1995).

Razorback sucker – The razorback sucker (*Xyrauchen texanus*) was formerly the most widespread and abundant of the big-river fishes in the Colorado River. In the lower basin, razorback sucker apparently began to decline shortly after impoundment of Lake Mead in 1935. Today the species occupies only a small portion of its historical range, and most occupied areas have very low numbers of fish. Critical habitat for the razorback sucker includes Lake Mead and Lake Mohave, and the river reach between them. It also includes the Colorado River and its 100-year floodplain from Parker Dam to Imperial Dam. Reclamation's BA includes a detailed discussion of this species occurrence and requirements (Reclamation, 2000).

In Lake Mead, the fish were abundant for many years after the reservoir filled, but declined during the 1960s and 1970s. The current population in Lake Mead is estimated to be less than 300 fish. The capture of a small number of juvenile adults since 1997 along with recent capture of larval razorback sucker in the spring of 2000 (Holden, Personal communication) indicates some successful recruitment is taking place. There are two populations of razorback sucker in Lake Mead in Las Vegas Bay and Echo Bay. A five-year study is underway to determine population size and movements of this fish and to determine why there is a small number of fish able to recruit, thus enabling a small number of razorback sucker to persist in Lake Mead.

The razorback sucker is a large fish, reaching over two feet in length and eight pounds in weight. Reproduction in the lower basin has been studied in Lake Mead and Lake Mohave. Spawning in Lake Mohave typically begins in January or February, while in Lake Mead it begins slightly later (Jonez and Sumner, 1954). Spawning typically runs 30 to 90 days at water temperatures ranging from 55°F to 70°F (13°C to 21°C). Spawning areas tend to be wave-washed, gravelly shorelines and shoals. Fish spawn in water from three to 20 feet in depth with the majority of fish in the five- to 10-foot range. Razorback suckers apparently spawn continuously throughout the spawning season, with females releasing only a portion of their gametes at each event. Spawning occurs both day and night on Lake Mohave (Reclamation, file data). Eggs hatch in five to 10 days depending on water temperature. Optimal hatching success is around 68°F (20°C); hatching does not occur at extremes of cold or hot (50°F or 86°F; 10 C to 30 C) (Marsh and Minckley, 1985). Larvae swim up within several days and begin feeding on plankton. Juvenile razorback suckers in lakeside rearing ponds hide during the day in dense aquatic vegetation and under brush and debris and in rock cavities (Reclamation, 1996a, 2000).

Most of the remnant populations of razorback sucker are found in Lake Mead and Lake Mohave (Reclamation, 2000). They are considered rare in the Grand Canyon and have been documented in Lake Powell as recently as 1999 (Reclamation, file data). Spawning success has been limited by the predation of eggs and young by non-native species. Currently, efforts are being made to introduce razorback sucker that have been raised in areas free of predators into Lake Mohave to help establish a larger population of breeding adults, and continued study of the persistent population in Lake Mead is planned (Reclamation, 2000).

3.8.4 ENVIRONMENTAL CONSEQUENCES

This section evaluates the potential effects on special-status species and their habitat that could occur as a result of implementation of the interim surplus criteria alternatives under consideration. This section is divided into three main special-status species categories: plants, wildlife and fish. For each category, the potential effects under baseline conditions are presented first, followed by a discussion of the alternatives as compared to baseline conditions.

3.8.4.1 EFFECTS ON SPECIAL-STATUS PLANT SPECIES

Only four plant species would potentially be affected by hydrological changes associated with the interim surplus criteria alternatives: Geyer's milkvetch, Grand Canyon evening primrose, Las Vegas bear poppy and sticky buckwheat.

3.8.4.1.1 Baseline Conditions

Geyer's milkvetch, which occurs along the shoreline of Lake Mead, is mainly threatened by loss of habitat from inundation as a result of rising water levels at Lake

Mead, invasion of shoreline (beach) habitat by tamarisk and arrowweed, and possibly trampling and grazing by burros. Shoreline recreation does not currently appear to be a major threat to this species because the beaches where it occurs do not receive heavy recreational use. This species would be affected by variations in Lake Mead surface elevations if suitable habitat were inundated. Baseline conditions indicate a decreased potential over time for such inundation to occur. If lake levels decline, exposing sand dune habitat and sandy soils, the species could benefit. However, if these areas are colonized by tamarisk after being exposed, there would be no net benefit.

Grand Canyon evening primrose are found in beach habitat within the Grand Canyon. The beach habitat in the Grand Canyon is often invaded by riparian vegetation and is also utilized by recreationists, which results in adverse conditions for Grand Canyon evening primrose establishment. To the extent that beach habitat is altered by releases from Glen Canyon Dam, this species is covered under the Glen Canyon Dam ROD (1996) and Adaptive Management Program. Indirect effects to the habitat for this species may, however, result from fluctuations in Lake Mead pool elevations. Under baseline conditions, Lake Mead elevations are projected to decline over time. Reductions in Lake Mead elevations would likely result in an increase in exposed beach habitat in the lower Grand Canyon to Lake Mead that would potentially provide more suitable habitat for Grand Canyon evening primrose.

Las Vegas bear poppy occurs along the lower levels of the Lake Mead shoreline. As with the Geyer's milkvetch, this species would benefit from lower water levels at Lake Mead and would be adversely affected by any increases in water levels. Benefits of lower surface elevations would be negated if invasion of exposed areas by tamarisk or other weedy exotic plant species were to occur.

Sticky buckwheat is found primarily along the Overton Arm of Lake Mead with smaller, potentially significant populations occurring in the vicinity of Overton Beach, along the Virgin River Valley, and along the Muddy River. As with the other three special-status plant species discussed, the major threats to sticky buckwheat at Lake Mead are the loss of habitat from inundation as the result of rising water levels at Lake Mead, and the invasion of shoreline (beach) habitat by tamarisk and arrowweed. This species could potentially benefit from lower lake levels at Lake Mead provided the newly exposed habitat was not colonized by weedy exotic plant species.

3.8.4.1.2 Effects of the Alternatives

Potential effects to special-status plant species under the each of the alternatives would be similar to baseline conditions. Each alternative would result in Lake Mead elevations that would vary from those under baseline conditions, with the Flood Control Alternative resulting in slightly higher reservoir elevations, and the Basin States, Six States, California and Shortage Protection alternatives having lower reservoir elevations as compared to baseline projections. (Section 3.3 discusses the modeling results concerning potential future reservoir elevation trends in detail.) The differences in potential future Lake Mead elevations under the alternatives as compared with baseline conditions are not expected to adversely affect the special-status plant species discussed above, as lower Lake Mead elevation trends may benefit these species.

3.8.4.2 EFFECTS ON SPECIAL-STATUS WILDLIFE SPECIES

Special-status wildlife species with potential to occur in the area under consideration are Arizona Bell's vireo, bald eagle, California black rail, Clark's grebe, Cooper's hawk, elf owl, gilded flicker, Southwestern willow flycatcher, Yuma clapper rail and western yellow-billed cuckoo.

Under baseline conditions and each of the alternatives, the water surface elevation projected for Lake Powell indicates a potential for slightly declining water levels during the first 15 years of the period of analysis. Figure 3.3-6 in Section 3.3 shows modeled Lake Powell elevations. The differences between the alternatives and baseline conditions would not affect any special-status wildlife species identified for this analysis and as a result, Lake Powell is not discussed further.

3.8.4.2.1 Baseline Conditions

Water fluctuations of Lake Mead generally preclude development of shoreline riparian vegetation, with the exception of tributary inflow areas such as the Virgin River and Lake Mead deltas (Reclamation, 1999). Woody riparian vegetation (i.e., cottonwood and willow) become abundant from below Separation Canyon to the Lake Mead delta as lake levels declined following high runoff years of 1983-1986 (Reclamation, 1995). As the probability for declining reservoir levels increases over time under baseline projections (as shown on Figure 3.3-13 in Section 3.3), an increase in the amount of sediment exposed in the Lake Mead and Virgin River deltas would again create favorable conditions for establishment of woody riparian habitat. An increase in riparian habitat along the deltas would potentially benefit Arizona Bell's vireo, Cooper's hawk, elf owl, gilded flicker, western yellow-billed cuckoo and Southwestern willow flycatcher. The interim surplus criteria alternatives are not expected to impact these species in the river corridor below Hoover Dam to the SIB (Reclamation, 2000).

The increase in the probability for Lake Mead water levels to decline under baseline projections would also increase potential for sediment exposure that may create suitable conditions for marsh vegetation to develop and/or expand at the Lake Mead and Virgin River deltas, as well as along the Colorado, Virgin and Muddy rivers above Lake Mead. This would in turn increase the amount of preferred habitat for California black rail, Clark's grebe and Yuma clapper rail.

Riparian and marsh vegetation is typically located within the shallow water table zone near the lake shoreline. Although lowering lake levels has the potential to increase the amount of riparian and marsh vegetation because of increased sediment exposure, these habitat types would only become established if lake levels do not drop excessively. If the exposed sediment is too far above the water table, riparian and marsh habitat is not likely to become established.

3.8.4.2.2 Effects of the Alternatives

Potential effects on special-status wildlife species would be similar to baseline conditions. Each alternative would result in Lake Mead elevations that would vary from those under baseline conditions, with the Flood Control Alternative resulting in slightly higher reservoir elevations, and the Basin States, Six States, California, and Shortage Protection alternatives having lower reservoir elevations as compared to baseline projections. (Section 3.3 discusses the modeling results concerning potential future reservoir elevation trends in detail.) Under each of the alternatives, vegetation associated with Lake Mead, including riparian and marsh habitat in the Virgin River and Lake Mead deltas, would experience changes similar to those described above under baseline conditions. Consequently, the potential for changes in special-status species' habitat associated with Lake Mead, and the Lake Mead and Virgin River deltas under the alternatives would be similar to those described for baseline conditions above.

3.8.4.3 EFFECTS ON SPECIAL-STATUS FISH SPECIES

Operations at Glen Canyon Dam and Hoover Dam include various programs designed to aid in the conservation and recovery of endangered native species in the lower Colorado River basin. These programs include Section 7 consultations under the ESA, the Glen Canyon Dam Operation AMP and ROD (1996), and the LCRMSCP. Reclamation is also a participant in the Upper Colorado and San Juan River Basin Recovery Implementation Programs for endangered fish in the upper Colorado River basin. Critical habitat for all four of the endangered fish species has been designated by the Service. Adverse modification of these habitats is prohibited under Section 7 of the ESA. These programs and protections will remain in effect under baseline conditions and each of the interim surplus criteria alternatives. As discussed, conditions are not favorable for endangered fish. Future baseline conditions and each of the interim surplus criteria are expected to increase, to varying degrees, the potential for reduced reservoir surface elevations. The following discuss effects of the alternatives on each of the special-status fish species.

3.8.4.3.1 Baseline Conditions

Bonytail - Under baseline conditions, it is anticipated that bonytail in the Colorado River Basin and their designated critical habitat would continue to be protected under the ESA. Reclamation has consulted with the Service under Section 7 of the ESA on the operation of Glen Canyon and Hoover dams. The resulting biological opinions will remain in effect. Reservoir operations remain within historical ranges, and efforts to protect, recover, and monitor the species status would continue.

The main effort to protect and conserve bonytail in the Lower Basin is the reintroduction of fingerling bonytail from the Dexter National Fish Hatchery, New Mexico that have been reared in predator-free ponds into Lake Mohave by the NFWG. The primary limiting factor for bonytail under existing habitat conditions is predation of early life stages by non-native species. This program is designed to address predation and maintain genetic stocks of bonytail. The main efforts to protect and conserve bonytail in the Upper Basin are conducted through the Upper Colorado Recovery Implementation Program (UC-RIP). This program is designed to recover the bonytail in the Upper Basin by 2010.

Colorado pikeminnow - Under baseline conditions, it is anticipated that Colorado pikeminnow would continue to be restricted to the Upper Basin. Colorado pikeminnow and their designated critical habitat would continue to be protected under the ESA. The Colorado pikeminnow is extirpated from all areas considered in this analysis except for Lake Powell. The ability of the Colorado pikeminnow to successfully reproduce in Lake Powell has not been confirmed. Successful spawning occurs in riverine habitats above Lake Powell, and larvae then drift downstream to rear in sheltered environments. Survival of larvae that drift into Lake Powell is limited by predation by non-native fish. As development of water continues to occur in the upper basin, lower lake elevations are expected to occur. This will increase the amount of sheltered riverine habitat and indirectly benefit the survival of some larvae by preventing them from drifting into open water areas of the reservoir where the risk of predation is greater. The main efforts to protect and conserve Colorado pikeminnow in the Upper Basin are conducted through the UC-RIP, plus the San Juan River Basin Recovery Implementation Program (SJ-RIP). This program is designed to recover the pikeminnow in the Upper Basin by 2010.

Flannelmouth sucker - Under baseline conditions, it is anticipated that flannelmouth sucker populations in the project area would continue to be found in riverine habitats and tributaries. The species is not well adapted to reservoir habitats and are seldom found there. The low survival of eggs and larvae in the reservoirs may be attributed to impacts from cold water temperatures or predation by non-native species. These conditions would continue to limit the reproductive success of flannelmouth sucker in the reservoirs. For flannelmouth sucker that spawn in rivers upstream of Lake Mead and Lake Powell or other inflow areas, survival of larvae that drift into the reservoirs is limited by cold water temperatures and predation of non-native fish. Lower lake elevations may increase the amount of sheltered riverine habitat and indirectly benefit the survival of some larvae by preventing them from drifting into open water areas of the reservoir where the risk of predation is greater. Efforts to improve habitat conditions under the UC-RIP, SJ-RIP, Glen Canyon Dam AMP and the Lower Colorado MSCP will benefit the flannelmouth sucker.

Humpback chub - Under baseline conditions, it is anticipated that humpback chub populations would continue to be restricted to riverine and tributary habitats in the Colorado River in the Grand Canyon. The humpback chub and its designated critical habitat would continue to be protected under the ESA, the 1996 ROD, flow regimes and other activities as prescribed under the 1995 biological opinion and the Glen Canyon Dam AMP. In addition to the populations of the Grand Canyon, there are five stable populations in the Upper Basin. The UC-RIP and SJ-RIP are making progress toward recovery of the species. The humpback chub is considered extirpated from all other areas within the lower Colorado River Basin.

Razorback sucker - Under baseline conditions, it is anticipated that razorback sucker populations in the Lower Basin would continue to be limited primarily to Lake Mead and Lake Mohave and designated critical habitat would continue to be protected under the ESA. Spawning success has been limited by predation of eggs and larvae by non-native fish. Efforts are currently being made by the NFWG to supplement adult breeding populations of razorback suckers by stocking lakes and the river with young reared in predator free ponds. Operations at Lake Mohave are conducted in an effort to conserve and protect razorback sucker by controlling the amount of lake fluctuation during the spawning season. A five-year study of the remnant razorback sucker population in Lake Mead is scheduled to be completed by 2002. These practices are expected to continue under baseline conditions and all the interim surplus criteria alternatives.

3.8.4.3.2 Effects of the Alternatives

Potential effects on the five special-status fish species discussed above would be similar to baseline conditions. Each alternative would result in Lake Powell and Lake Mead surface elevations that would vary from those under baseline conditions, with the Flood Control Alternative resulting in slightly higher reservoir elevations, and the Basin States, Six States, California and Shortage Protection alternatives having lower reservoir elevations as compared to baseline projections. (Section 3.3 discusses the modeling results concerning potential future reservoir elevation trends in detail.) Efforts toward protection and recovery of these species would continue under each of the alternatives in the same manner as describe above for baseline conditions. Potential changes in BHBF and low steady summer flow frequencies are discussed in Section 3.6 of this FEIS, and Reclamation has determined that these effects would not be likely to adversely affect special-status fish species.

3.9 RECREATION

3.9.1 INTRODUCTION

The Colorado River, Lake Mead and Lake Powell provide water-based recreation opportunities that are of local, regional and national significance, as well as international interest.

This recreation analysis addresses five specific recreation-related issues associated with potential effects that could result from implementation of the interim surplus criteria alternatives considered in this document. The issues addressed are potential effects to:

- Reservoir marinas and boat launching and shoreline access for Lake Powell and Lake Mead;
- Lake Mead and Lake Powell boating and navigation;
- River and whitewater boating;
- Sport fishing in Lake Powell, Lake Mead and the Colorado River below Hoover Dam; and
- Recreational facilities operational costs.

The interim surplus alternatives would not change the current and projected operations of Lakes Mohave and Havasu and thus would not affect recreation on those reservoirs.

3.9.2 RESERVOIR MARINAS, BOAT LAUNCHING AND SHORELINE ACCESS

This section considers potential effects of the interim surplus criteria alternatives on Lake Powell and Lake Mead marinas, boat launching facilities and other important shoreline access areas.

3.9.2.1 METHODOLOGY

Information in this section was compiled after review of available published and unpublished sources, and through personal communication with Reclamation, NPS and resource specialists. Thorough review of existing literature on the Colorado River provided information on reservoir recreation use for both Lake Powell and Lake Mead. Where available, the number of facilities at each marina, boat launching ramp and shoreline access area are included.

From the information compiled, representative threshold pool elevations were selected for 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, communications with NPS personnel, or from comments received regarding the DEIS. Discussions of the probabilities of these thresholds occurring is detailed in the Environmental Consequences Section (Section 3.9.2.3). The probability of reservoir elevations occurring below these levels under baseline conditions and the action alternatives was identified using river system modeling as described in Section 3.3.

Data generated from the river system model include the probability (represented graphically in the Environmental Consequences section) that the water level related to each alternative would be above the specified "threshold" pool elevations for each year during the period of analysis. The graphs indicate the general trend of elevation probabilities and present the incremental differences in probabilities for baseline conditions and each of the alternatives.

3.9.2.2 AFFECTED ENVIRONMENT

Recreational boating on Lake Mead and Lake Powell is dependent upon access to the water via shoreline facilities such as marinas, docks and launch ramps. Fluctuation in water levels is a normal aspect of reservoir operations, and facilities are designed and operated to accommodate it. However, decreased pool elevations or increased variations or rates in pool elevation fluctuation could result in increased operation costs, temporary closures or possibly permanent closures.

Reservoir pool elevations at Lake Powell and Lake Mead depend on annual inflow from the Colorado River upstream, and outflow from the respective dam to the Colorado River downstream for water deliveries. Operation of the Colorado River generally results in the highest pool elevations in Lake Powell in mid-summer and in Lake Mead, early winter. In general, pool levels in Lake Powell and Lake Mead tend to fluctuate on an annual cycle rather than on a monthly or seasonal cycle. Lake Powell historical pool fluctuations have normally ranged from 20 to 25 feet per year (Combrinks and Collins, 1992). Since operation of Glen Canyon Dam began in 1966, Lake Mead pool fluctuation has normally ranged from 5 to 25 feet per year.

3.9.2.2.1 Lake Powell Recreation Resources

Lake Powell is located in the Glen Canyon National Recreation Area (GCNRA) in southern Utah and northern Arizona. Typical recreation activities that occur at Lake Powell include swimming and sunbathing, power boating, fishing, off-beach activities associated with boat trips (such as hiking and exploring ruins), house boating, personal water craft use, canoeing, kayaking, sailing, and other activities (USBR, 1995b). A carrying capacity study (NPS, 1991) provided information on the potential limits of boater use on Lake Powell. The study also showed that the average length of stay at the GCNRA is 4.5 days.

Visitation numbers for the entire GCNRA between 1990 and 1999 are provided in Table 3.9-1. The data indicate that there are seasonal variability in recreation use. The majority of use occurs in the summer months of June, July and August. The visitation numbers shown for 1995 through 1999 are considerably lower than visitation between 1990 and 1994 due to changes in NPS methods for calculating visitation. However, the seasonal pattern of visitation does not change; use remains highest in summer months. The majority of visitors to the GCNRA travel either less than 30 miles to visit (29.1 percent) or travel 121 to 240 miles (28.9 percent). This indicates that the area is used predominantly by local and regional visitors.

Table 3.9-1
Glen Canyon National Recreation Area Visitation

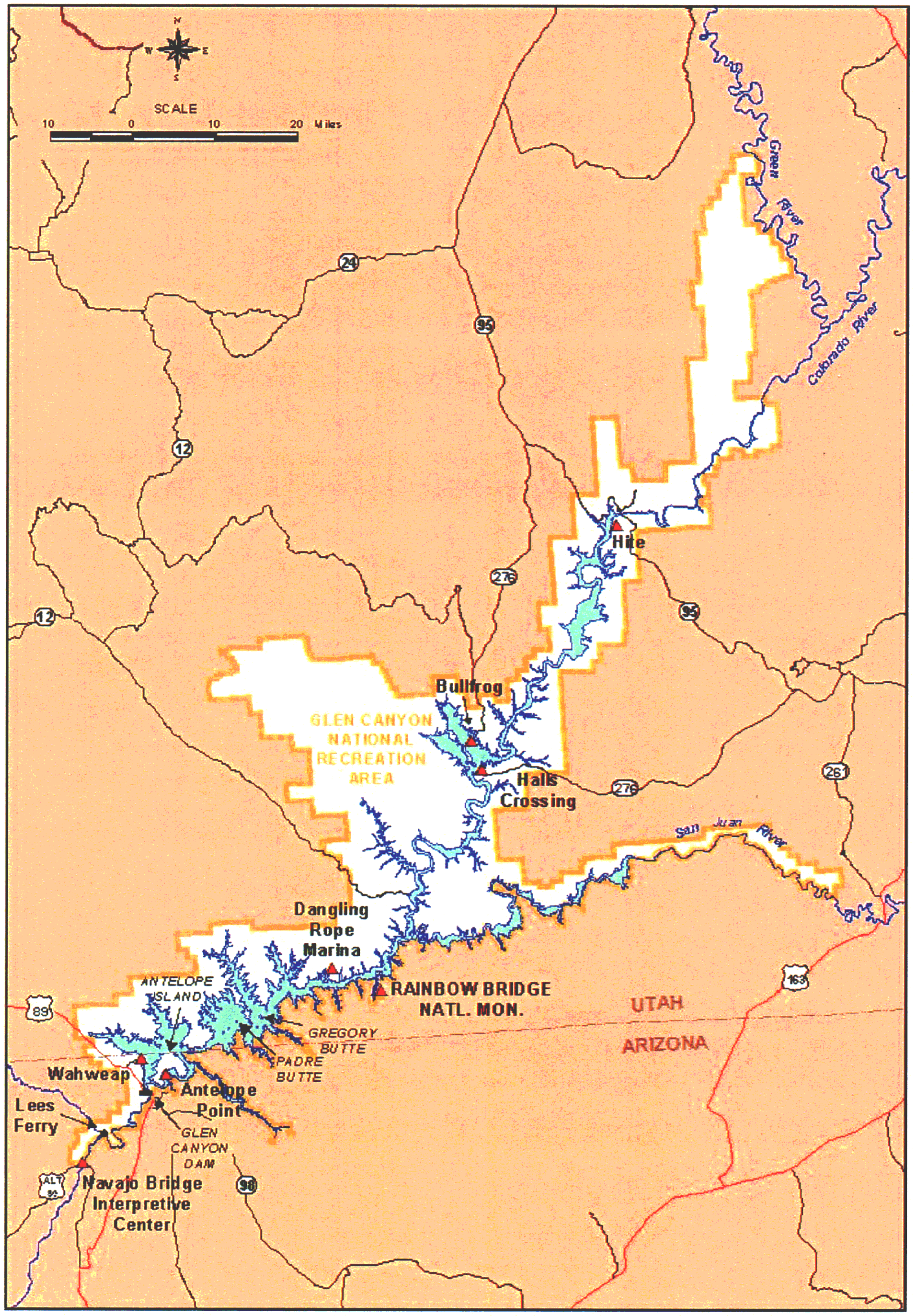
Year	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec	Total
1990	77,617	109,042	135,039	253,638	289,993	501,288	467,981	483,023	350,026	227,061	129,691	78,750	3,103,129
1991	81,875	97,120	118,182	199,462	346,764	451,674	503,752	568,030	396,785	247,982	120,822	78,442	3,210,890
1992	83,044	114,889	139,787	246,993	346,727	525,610	572,869	659,809	478,032	245,565	122,386	82,847	3,620,558
1993	60,927	83,903	123,836	201,141	372,425	526,202	624,549	644,534	530,550	259,119	111,607	76,031	3,470,194
1994	69,663	120,307	174,272	264,265	364,826	576,355	665,583	439,177	321,961	212,729	99,097	63,607	3,371,842
1995*	35,814	66,553	88,414	151,369	196,905	410,610	435,840	461,431	285,118	192,597	94,508	50,362	2,469,521
1996	41,303	50,553	96,296	209,243	231,655	419,288	447,417	442,180	268,266	187,949	89,670	48,269	2,532,087
1997	49,954	54,401	115,523	157,249	245,000	288,742	420,927	437,846	266,992	187,467	85,595	48,507	2,458,203
1998	39,241	55,538	89,971	171,234	267,509	389,167	445,423	398,776	285,105	197,673	77,247	50,315	2,467,199
1999	44,755	51,657	118,141	155,831	261,931	426,744	515,641	441,791	305,006	200,457	89,799	55,503	2,667,249

Source: Based on NPS data.

* NPS methods for calculating visitation numbers changed in 1995. This resulted in significant reductions in visitation numbers compared to prior years.

Recreation boating is the largest type of boating activity on Lake Powell, with an estimated 1.5 million boater nights per year in 1988. Although use at some of the major marinas, such as Wahweap, Hall's Crossing and Bullfrog, decreased during a low water period in 1989, the total number of boats on Lake Powell was reported to have increased 14.5 percent by July 31, 1989, compared to the same period in 1988 (USBR, 1995b). Specific facilities and reservoir elevations important to their operation are discussed in the following sections. Map 3.9-1 depicts Lake Powell and the locations of shoreline facilities.

Map 3.9-1
Lake Powell and Associated Shoreline Recreation Facilities



3.9.2.2.2 Shoreline Public Use Facilities

Public use facilities at Lake Powell that include water-based recreation activities are Wahweap, Dangling Rope Marina, Halls Crossing, Bullfrog, Hite, and Antelope Point. The GCNRA Proposed General Management Plan (NPS, 1979) describes the estimated capacity and development at these areas; these estimates are based on general concepts only and further detailed planning was proposed to begin after the plan's acceptance in 1979. Table 3.9-2 summarizes the activities at each of the sites. If the actual number of improvements (boat slips, mooring buoys, houseboats, etc.) at a facility are known, it is listed in Table 3.9-2; otherwise, the presence of an improvement is indicated with a bullet (•). If an improvement does not exist, it is denoted with "N/A." Below is a description of the shoreline public use facilities at Lake Powell.

Wahweap – The facilities at Wahweap are the closest to Glen Canyon Dam, located off Interstate 89 at the mouth of Wahweap Bay. According to a study that addressed fluctuating lake levels and recreation use, the Stateline Launching Ramp at Wahweap became inoperable in 1989 when the lake elevation decreased to below 3677 feet msl (Combrink and Collins 1992). In 1993, NPS extended the Wahweap and Stateline boat ramps down to an operable level of 3612 feet msl (Henderson, 2000).

Dangling Rope Marina – The facilities at Dangling Rope Marina were proposed to replace the facilities at Rainbow Marina in Forbidding Canyon. All the facilities float, and they are only accessible by boat (NPS, 1979). In addition to the facilities, tour boats depart from Dangling Rope Marina for visits to Rainbow Bridge National Monument during the recreation season (NPS, 1993). There are no known reservoir surface elevations that would impair operation of this facility.

Halls Crossing – The facilities at Halls Crossing are located off Utah Highway 276 on the east shore of Lake Powell, across the bay from Bullfrog Marina. According to a study that addressed fluctuating lake levels and recreation use, the Halls Crossing Ferry Ramp became inoperable in 1989 when the lake elevation decreased to below 3675 feet msl (Combrink and Collins, 1992). In 1993, NPS extended the boat ramp down to an operable level of 3612 feet msl (Henderson, 2000).

Bullfrog – The facilities at Bullfrog are located midway up Bullfrog Bay, off of Utah Highway 276 and across the bay from Halls Crossing. According to a study that addressed fluctuating lake levels and recreation use, the Bullfrog Ferry Ramp became inoperable in 1989 when the lake elevation decreased to below 3675 feet msl. In addition, the Bullfrog Utility Service became inaccessible when the lake elevation decreased to below 3670 feet msl (road access was also unavailable at the slips) (Combrink and Collins, 1992). In 1993, NPS extended the boat ramp down to an operable level of 3612 feet msl (Henderson, 2000).

Table 3.9-2
Lake Powell Shoreline Public Use Facilities

Facility	Wahweap	Dangling Rope Marina	Halls Crossing	Bullfrog	Hite	Antelope Point *
Lodging (rooms)	375	N/A	20	56	5	200-225
Restaurant/Snack Bar	2/1	N/A/1	•/1	1/1	N/A	•
Tour boats	9	N/A	N/A	1	N/A	2
Boat slips	870	N/A	165	254	6	250-300
Mooring buoys	180	N/A	141	220	54	N/A
Rental houseboats	175	N/A	89	112	21	60
Rental small boats	150	N/A	44	50	27	60
Dry storage	450	N/A	230	750	109	•
RV park (spaces)	120	N/A	32	24	N/A	150
Marina campstore	1	1	1	1	N/A	1
Store	•	•	1	1	1	1
Boat repair	•	•	•	•	N/A	N/A
Service station	•	•	gas	•	gas	•
Parking (spaces)	2,500	N/A	300	1,575	150	220
Campground (sites)	215	N/A	64	100	6	•
Picnic (sites)	124	N/A	20	50	N/A	N/A
Day use beaches/trails	N/A	N/A	N/A	N/A	N/A	•
Launching ramps	2	N/A	1	1	1	1
Airstrip	N/A	N/A	N/A	3,500-foot, paved	2,100-foot, paved	N/A
Visitor center, cultural center	•	N/A	N/A	N/A	N/A	•
Ranger station	•	N/A	•	•	N/A	•
Employee housing	•	•	•	N/A	•	•
Concessionaire quarters	80	N/A	30	40	10	N/A
Dorm units	119	6	24	96	0	N/A
Capacity (use per day)	7,800-10,100	2,400-3,100	3,400-4,400	7,900-10,300	2,500-3,300	N/A

Source: NPS 1979. Proposed General Management Plan and personal communication, Norm Henderson, NPS, 2000.

• indicates presence of an improvement.

N/A not applicable – indicates no improvement.

* Facilities shown are proposed. Existing facilities include an entrance station, gravel parking area, two permanent toilets, and a boat ramp. The Navajo Nation and NPS are in the process of developing the site.

Hite – The facilities at Hite are located off of Utah Highway 95. According to a study that addressed fluctuating lake levels and recreation use, the Hite Launching Ramp became inoperable in 1989 when the lake elevation decreased to below 3677 feet msl (Combrink and Collins 1992). In 1993 NPS extended the boat ramp down to an operable level of 3612 feet msl. However, the ramp area is known to be useable down to 3630 feet msl (Henderson, 2000).

Antelope Point – The facilities at Antelope Point are located off of Arizona Highway 98 on the southern side of Lake Powell. Development of Antelope Point only began recently, and data on visitation has not been collected on a formal basis. Existing facilities at the site consist of an entrance station where fees are collected, two permanent toilets, a large gravel parking area that can accommodate 220 vehicles, and a public boat ramp. The Navajo Nation, in conjunction with NPS, has plans to develop the site as a resort destination, and is in the process of selecting a master developer for the project. Facilities proposed for the site in the Development Concept Plan are listed in Table 3.9-2, above.

The existing boat ramp at Antelope Point currently extends down to 3677 feet msl. NPS provided Reclamation with construction drawings for extending the boat ramp down to 3620 feet msl as water elevation declines. The extended boat ramp would allow houseboats and other watercraft to launch down to elevations around 3625 feet msl, assuming about 5 feet of free board (Bishop, Personal Communication, 2000). NPS also provided Reclamation with a preliminary Antelope Point Marina layout drawing for reservoir elevation of 3600 feet msl, but it has not been established that a marina would be operable at this level.

Rainbow Bridge National Monument – The Rainbow Bridge National Monument is located on the south shore of Lake Powell and is bounded on three sides by the Navajo Reservation near the Utah/Arizona border. The facilities at the 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 below the full-pool elevation of 3700 feet msl, and the other is used when the reservoir is at full-pool elevation. The docks and trail system are designed to accommodate lake level fluctuations allowed in the operation of Glen Canyon Dam and powerplants (from 3490 feet msl to 3700 feet msl) (NPS, 1993). If the lake levels fall below 3650 feet msl, the dock facilities would be moved and the old land trail through Bridge Canyon (submerged at full pool) would be hardened and used for access. The floating walkway and interpretive platforms would be removed and stored. The courtesy docks would be connected to the land trail with a short walkway (NPS, 1990). However, large quantities of silt that have been deposited where Bridge Creek flows into Lake Powell could create access problems at low water surface elevations. The large silt flats are difficult to cross with floating walkways; special construction techniques may be required to bridge these areas. At some lake elevations, it may be infeasible to maintain water access to the monument (NPS, 1993); however, the specific elevation is not known.

When Lake Powell is operated below 3700 feet msl, some of the Rainbow Bridge National Monument is within a high hazard flash flood area. The 100- and 500-year flood elevations in Bridge Creek are estimated to be 7.5 feet and 10 feet above the creek channel, respectively. For the area well upstream of Lake Powell, the trail follows the creek and is above both the 100- and 500-year floodplains. However, the trail route in the transition zone between the reservoir and creek, along the lake's edge, could be subject to water surface elevation increase, surface turbulence, and significant velocities, depending on the lake elevation at the time of flooding and the magnitude of the flood. For the lake itself, there would be little or no discernable water surface increase and the turbulence would be limited. When Lake Powell is at full operating pool, flash flood areas are well upstream of the reservoir, in the Bridge Creek Canyon drainage outside the monument.

The General Management Plan for Rainbow Bridge includes a Flash Flood Mitigation Plan. In the event of combined low pool elevations and flash flood conditions, there are four components of the mitigation plan that would be put in place. These components include: 1) a wayside exhibit with information to inform visitors of possible flash flood hazards; 2) additional signage in the flood hazard zones to alert visitors where to move in case of a flood; 3) identification of evacuation and emergency measures, including chain of command responsibilities, emergency supply locations, and support facilities; and 4) installation of a warning system that would alert visitors to evacuate.

Prior to the construction of Glen Canyon Dam, access to the area was primarily by foot. Since the creation of Lake Powell, access is now primarily by water, although the area is also accessible by trails through Navajo Mountain. Access to the monument is restricted during the recreation season in accordance with the monument's carrying capacity of 200 people at one time. In addition, access is limited daily during certain times of the day. Boat tours to the monument are allowed during the busier time of the day and originate at Dangling Rock Marina. All tours have an NPS interpreter on board to convey the monument's significance. Access during quieter times of the day is limited to five to eight private boats. During the off-season, access to the monument is unrestricted except that boat tours are managed to ensure that only one tour boat at a time is present at the monument (NPS, 1993).

3.9.2.2.2.1 Threshold Elevations

From the information presented above on reservoir pool elevations, three elevations, 3677 feet msl, 3626 feet msl and 3612 feet msl, were identified as representative threshold elevations below which shoreline facilities at Lake Powell could be affected.

The existing boat ramp at Antelope Point extends down to elevation 3677 feet msl. This elevation is identified as one of the threshold elevations for the analysis of marinas and boat ramps at Lake Powell. As discussed above, the extended boat ramp would be operable down to 3625 feet msl. The elevation of 3626 feet msl is discussed in the boating navigation and safety section (Section 3.9.3.3.1) and is considered to be representative of the threshold elevation for the extended boat ramp. Since the minimum reservoir elevation at which the Antelope Point Marina would be operable has not yet been established, the threshold elevations of 3626 feet msl (discussed above) and 3612 feet msl (discussed below) are assumed to apply to a future marina at Antelope Point.

As discussed above, the boat ramps at Wahweap, Halls Crossing, Bullfrog, and Hite are designed to operate down to 3612 feet msl. It is not known what adjustments and capital improvement costs would be required if elevations were to decline to below 3612 feet msl. As such, 3612 feet msl is used in this analysis as the lower threshold elevation for marinas and boat ramps at Lake Powell.

The threshold elevations of 3677 feet msl, 3626 feet msl and 3612 feet msl are used to evaluate baseline conditions and the effects of interim surplus criteria alternatives on shoreline facilities at Lake Powell in the Environmental Consequences section (Section 3.9.2.3.1). The threshold elevation of 3626 feet msl is evaluated in Section 3.9.3.3.1.

3.9.2.2.3 Lake Mead Recreation Resources

Lake Mead, the reservoir created by the construction of Hoover Dam, is located in the Lake Mead National Recreation Area (LMNRA) in southern Nevada and northern Arizona. The LMNRA contains 1.5 million acres and encompasses the 100-mile-long Lake Mead, 67-mile-long Lake Mohave, the surrounding desert, and the isolated Shivwits Plateau in Arizona. At a full pool elevation of approximately 1210 feet msl, Lake Mead's surface area is 153,235 acres, the storage capacity is 25.9 maf and there are 695 miles of shoreline (USBR, 1996b). Lake Mead is the largest man-made lake in the Western Hemisphere.

LMNRA receives approximately ten million visitors annually. Typical water-based recreation activities that occur on Lake Mead include: swimming, boating, houseboating, fishing, sailboarding, paddlecraft use, scuba diving (USBR, 1996b). On average, the majority of boats are personal watercraft. There may be as many as 6000 boats combined on Lake Mead and Lake Mohave during a peak recreation use weekend. At Boulder Beach, which is located near the urbanized area of Las Vegas and surrounding communities, the personal watercraft percentage may be as high as 50 percent.

3.9.2.2.4 Shoreline Public Use Facilities at Lake Mead

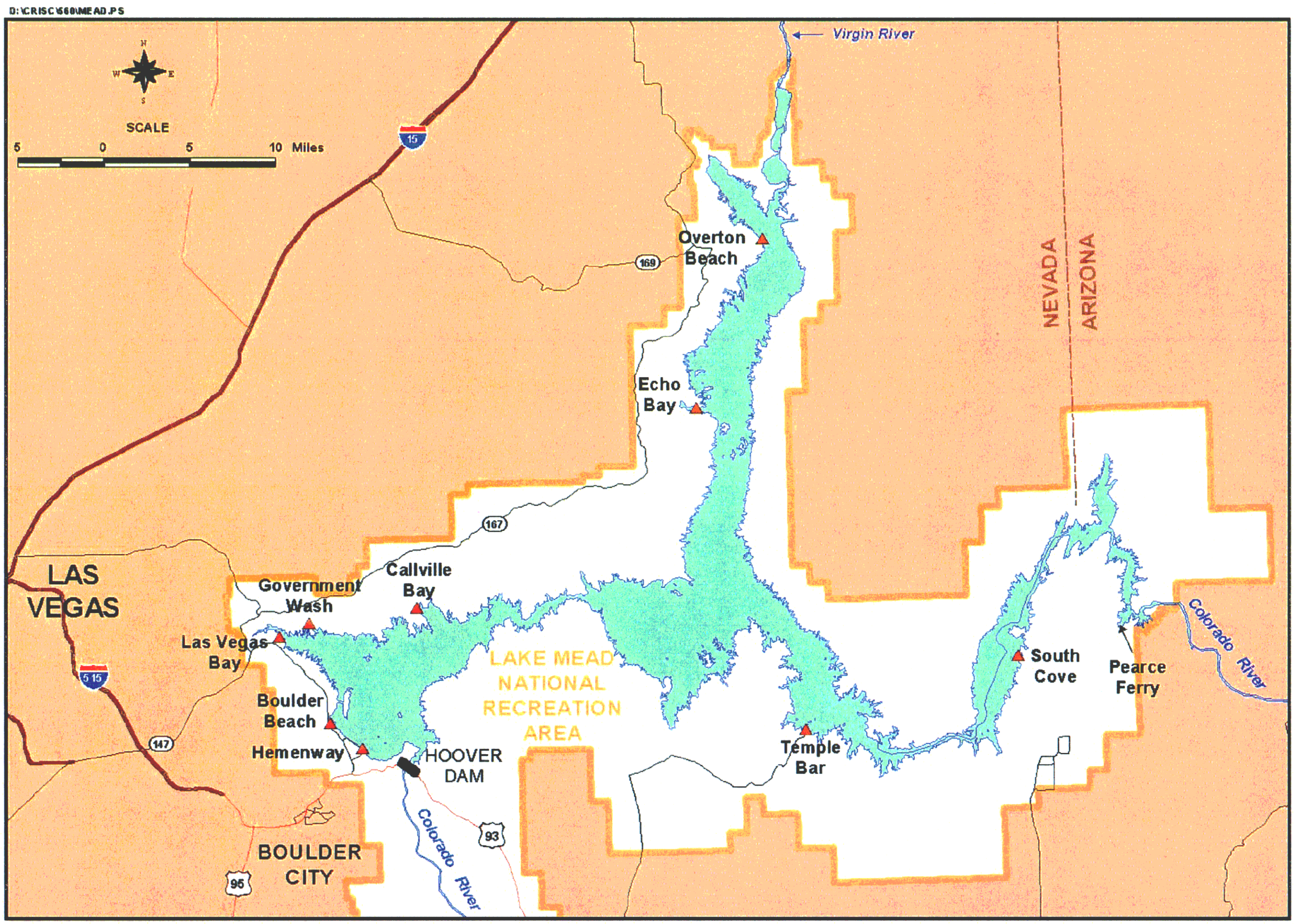
Six marinas at Lake Mead provide boat launching facilities as well as slips and storage, fuel and boat launches. In addition, there are three boat ramps without associated marinas and one site without a boat ramp. The marinas include Boulder Beach, Las Vegas Bay, Calville Bay, Echo Bay, Overton Beach and Temple Bar. The boat ramps are located at Hemenway, Government Wash and South Cove. Pearce Ferry has no boat ramp and is used as a take out by private and commercial boaters that kayak and raft the Colorado River into Lake Mead. Facilities at the six marinas are summarized in Table 3.9-3, and all of the sites are described below. If the actual number of improvements (boat slips, etc.) at the facility is known, it is included in the table; otherwise, the presence of an improvement is indicated with a bullet (•). If there are no facilities at a location, this is indicated with an "N/A" for "not applicable." Map 3.9-2 shows the locations of both developed and undeveloped sites on Lake Mead.

Table 3.9-3
Lake Mead Marina Public Use Facilities

Facility	Boulder Beach/ Lake Mead Marina	Las Vegas Bay	Calville Bay	Echo Bay	Overton Beach	Temple Bar
Lodging	•	N/A	N/A	•	N/A	•
Restaurant	•	•	•	•	•	•
Tour boats	•	N/A	N/A	N/A	N/A	N/A
Marina (boat slips)	750	•	650	320	•	•
Mooring buoys	N/A	N/A	N/A	N/A	N/A	N/A
Rental houseboats	N/A	N/A	•	•	N/A	N/A
Rental small boats	•	N/A	N/A	•	N/A	•
Dry storage	•	•	•	•	•	•
RV Park (spaces)	N/A	N/A	N/A	58	N/A	7
Trailer village	•	N/A	•	69	•	111
Trailer sewage dump	•	N/A	•	•	•	•
Grocery/gift store	•	•	•	•	•	•
Gasoline/Propane	•	N/A	•	•	•	•
Boat sewage dump	•	•	•	•	•	•
Parking (spaces)	N/A	N/A	N/A	N/A	N/A	N/A
Campground (sites)	154	89	80	166	N/A	153
Picnic (sites)	•	•	•	N/A	N/A	N/A
Showers	•	N/A	•	•	•	•
Launching ramps	•	•	•	•	•	•
Airstrip	N/A	N/A	N/A	•	N/A	•
Ranger station	•	•	•	•	•	•
Self-service laundry	•	N/A	•	•	•	•
Capacity (use per day)	N/A	N/A	N/A	N/A	N/A	N/A

Source: NPS, 1995
• indicates presence of an improvement
N/A not applicable – indicates no improvement

Map 3.9-2
Lake Mead and Associated Shoreline Recreation Facilities



Recreation boating is very popular at Lake Mead, and the shoreline public use facilities are associated with boating use. Most of the facilities shown in the Table 3.9-3 were designed to operate at full pool. However, NPS has determined costs associated with adjusting facilities based on lowered lake elevations. These facilities are out of their normal operating range at pool elevations of 1180 feet msl, requiring sizable capital expenditures to restore them to working order. In addition, there are additional costs associated with any 20-foot drop below this level.

Hemenway – The boat ramp facility at Hemenway is the closest to Hoover Dam and is located off Nevada Highway 166. There is one courtesy dock and a parking area (Henderson, 2000). In addition, campgrounds and a group campground are located at Hemenway. The group campground is for self-contained vehicles, such as trailers and motor homes. There are no restrooms or tables.

Boulder Beach – The facilities at Boulder Beach are located off of Lakeshore Scenic Drive, just off of Nevada Highway 167 outside of Boulder City, Nevada, and include restrooms, tables and grills. There is also a group campground at Boulder Beach for tent camping only with limited vehicle parking.

Las Vegas Bay – The facilities at Las Vegas Bay are located off Lakeshore Scenic Drive, just off Lake Mead Drive (Nevada Highway 167). According to a marina worker, when the lake elevation drops below 1190 feet msl, the boat ramps and floats have to be readjusted.

Government Wash – The boat ramp facility at Government Wash is located off Nevada Highway 167. There is one courtesy dock and a parking area (Henderson, 2000).

Calville Bay – The facilities at Calville Bay are located off Nevada Highway 167 on the north shore of Lake Mead, midway up Calville Bay.

Echo Bay – The facilities at Echo Bay are located off Nevada Highway 167, midway up Overton Arm.

Overton Beach – The facilities at Overton Beach are located off Nevada Highway 169, near the top of Overton Arm.

South Cove – The boat launching facilities at South Cove are located off Aztec Wash, which is off Interstate 93 in Arizona. There is one courtesy dock, picnic facilities, and unpaved parking (Henderson, 2000). In addition, there is an airstrip approximately four miles from the facilities at South Cove (Henderson, 2000).

Temple Bar – The facilities at Temple Bar are located on the south shore of Lake Mead at the end of an unnamed road off Interstate 93 in Arizona.

Pearce Ferry - This area is located near Aztec Wash, which is off Interstate 93 in Arizona at the eastern end of the LMNRA. The area is a large, gravel wash with a gentle slope down to the water. Vehicles are driven down to the water's edge to load rafts and other small boats. There is parking and a year-round portable toilet, and primitive camping is allowed. There are no ramps, docks or other developed facilities at the site.

The Hualapai River Runners are one of the commercial guide services that use Pearce Ferry as a take out. The River Runners conduct guided whitewater trips that put in at Diamond Creek, and float trips that put in at Quartermaster Canyon. All of these trips take out at Pearce Ferry.

Comments from the Hualapai Tribe on the Draft EIS identified a Lake Mead pool elevation of 1183 feet msl as a threshold elevation for accessing the Pearce Ferry takeout. At this elevation and below, the river subdivides into smaller channels and large areas of silt and mud are exposed, prohibiting access to the take out.

When Pearce Ferry is inaccessible as a takeout, 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). For commercial boaters, the additional travel time to South Cove can also result in lost business by preventing guides from meeting river tour schedules.

3.9.2.2.4.1 Threshold Elevations

The description of facilities above identifies several pool elevations where facilities or access to facilities would be affected. At Las Vegas Bay, 1190 feet msl was identified as an elevation at which facilities would require adjustment, but would continue to be operable. Elevation 1180 feet msl was identified by the NPS as the elevation at which most other developed facilities would require capital expenditures, rather than just an adjustment, in order to maintain operation. Elevation 1183 feet msl was identified by the Hualapai Tribe in their comments on the DEIS as a threshold elevation for using the undeveloped Pearce Ferry site as a takeout for rafts and other whitewater boats.

The DEIS evaluated the consequences of elevation 1180 feet msl for facilities at Lake Mead (Section 3.9.2.3.2). In response to the Hualapai Tribe's comment on the DEIS regarding the threshold elevation of 1183 for Pearce Ferry, this FEIS evaluates the consequences of 1183 feet msl instead of 1180 feet msl. Therefore, 1183 feet msl is used as a representative threshold elevation for shoreline facilities and public access at Lake Mead and is used in the Environmental Consequences section (Section 3.9.2.3.2) to evaluate the effects of baseline conditions and interim surplus criteria alternatives on shoreline facilities and public access at Lake Mead.

3.9.2.3 Environmental Consequences

Recreational boating on Lake Mead and Lake Powell is dependent upon access to the water via public shoreline facilities such as marinas, docks and boat ramps, as well as undeveloped launch areas. Some fluctuation in water level is a normal aspect of reservoir operations, and facilities are designed and operated to accommodate it. However, decreased pool elevations or increased variations or rates in pool elevation fluctuation could result in increased operation costs, facility improvements, temporary closures, or possibly permanent closure of shoreline facilities.

As lake levels fluctuate, developed facilities must be adjusted accordingly. This could require moving and relocating docks, extending utility lines associated with shoreline facilities, increasing sewage pump capacity, reducing pressure on water supply lines to boats, adjusting and relocating buoys, moving breakwater barriers and channel markers, and extending launch and dock ramps (Combrink and Collins, 1992). If lake fluctuations exceed 25 feet, special adjustments to lake facilities would be necessary, including the relocation of anchors and the extension or reduction of utility lines and cables that provide utility service to floating facilities (Combrink and Collins, 1992).

In addition, if developed facilities are temporarily or permanently closed or relocated, or undeveloped sites are no longer accessible, there may be associated increases in reservoir boating congestion or longer wait times at sites that remain open. This could have an effect on boating satisfaction. The cost of relocating developed facilities in response to changes in reservoir pool elevations is discussed in Section 3.9.6.

3.9.2.3.1 Lake Powell

As discussed in the Affected Environment section above, pool elevations of 3677 feet msl and 3612 feet msl were identified as representative thresholds that are problematic for shoreline facilities at Lake Powell. Elevation 3677 feet msl was identified as a threshold elevation for the existing Antelope Point, and the NPS identified 3612 feet msl as a threshold for several other facilities. These are elevations below which facility adjustments or capital improvements would be required.

There are two other threshold elevations not treated directly below. Elevation 3626 feet msl has also been defined as a threshold elevation for the design boat ramp at Antelope Point. This elevation is discussed in Section 3.9.3.3.1. Facilities at Rainbow Bridge would be affected by pool elevations of 3650 feet msl or below, as described above in Section 3.9.2.2. Although specific probabilities of remaining above elevation 3650 feet msl were not determined, the probabilities that lake elevations would remain above 3650 feet msl would be between the probabilities for the threshold elevations of 3677 and 3612 feet msl, which are discussed below.

Figure 3.9-1 provides an overview of the differences in end-of-July water surface elevation trends under baseline conditions and the action alternatives over the period of analysis.

Figure 3.9-2 and Table 3.9-4 indicate the probability of Lake Powell elevation exceeding the threshold of 3677 feet msl in July. The probability would decrease the

Figure 3.9-1
Lake Powell End of July Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
90th, 50th and 10th Percentile Values

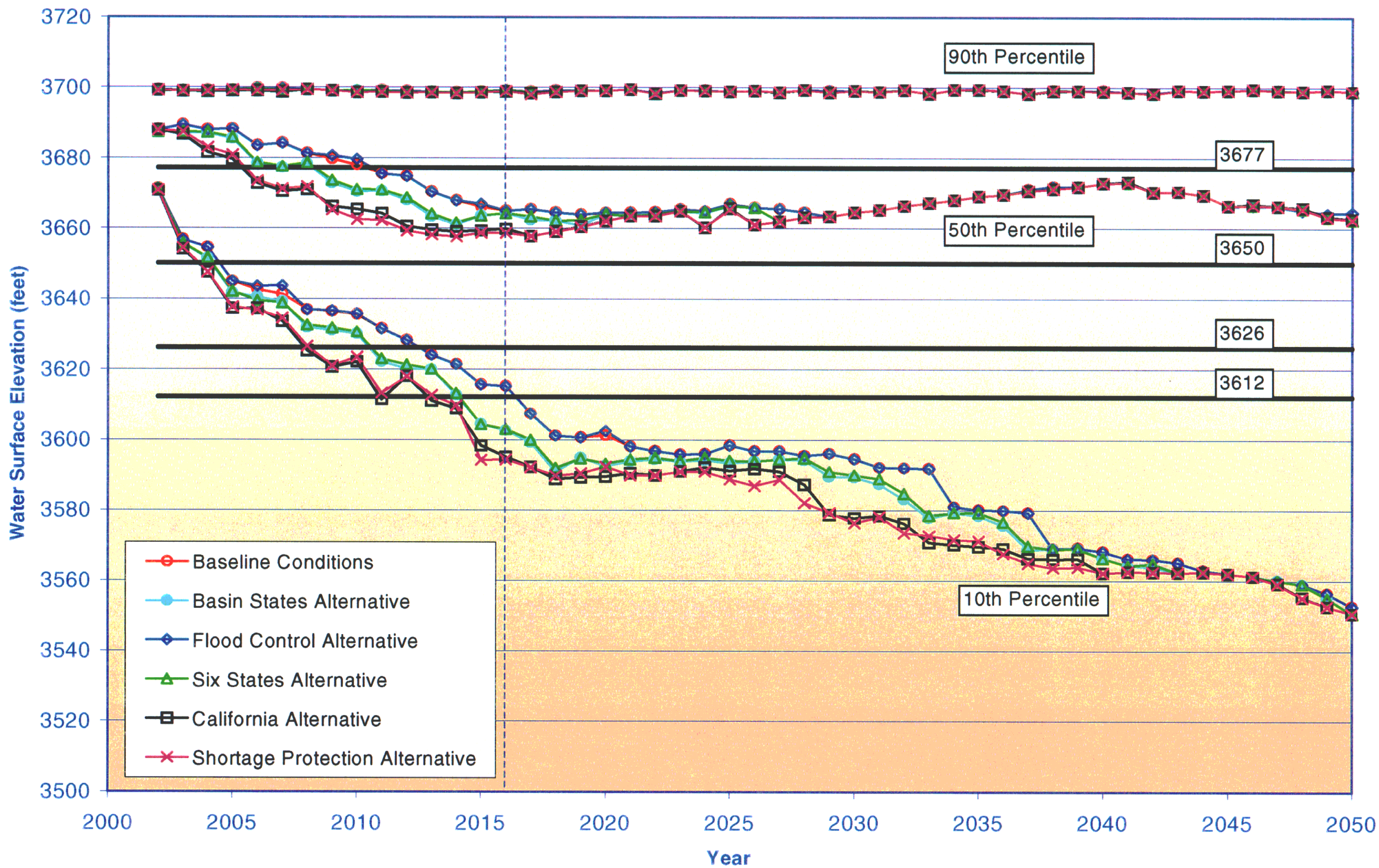
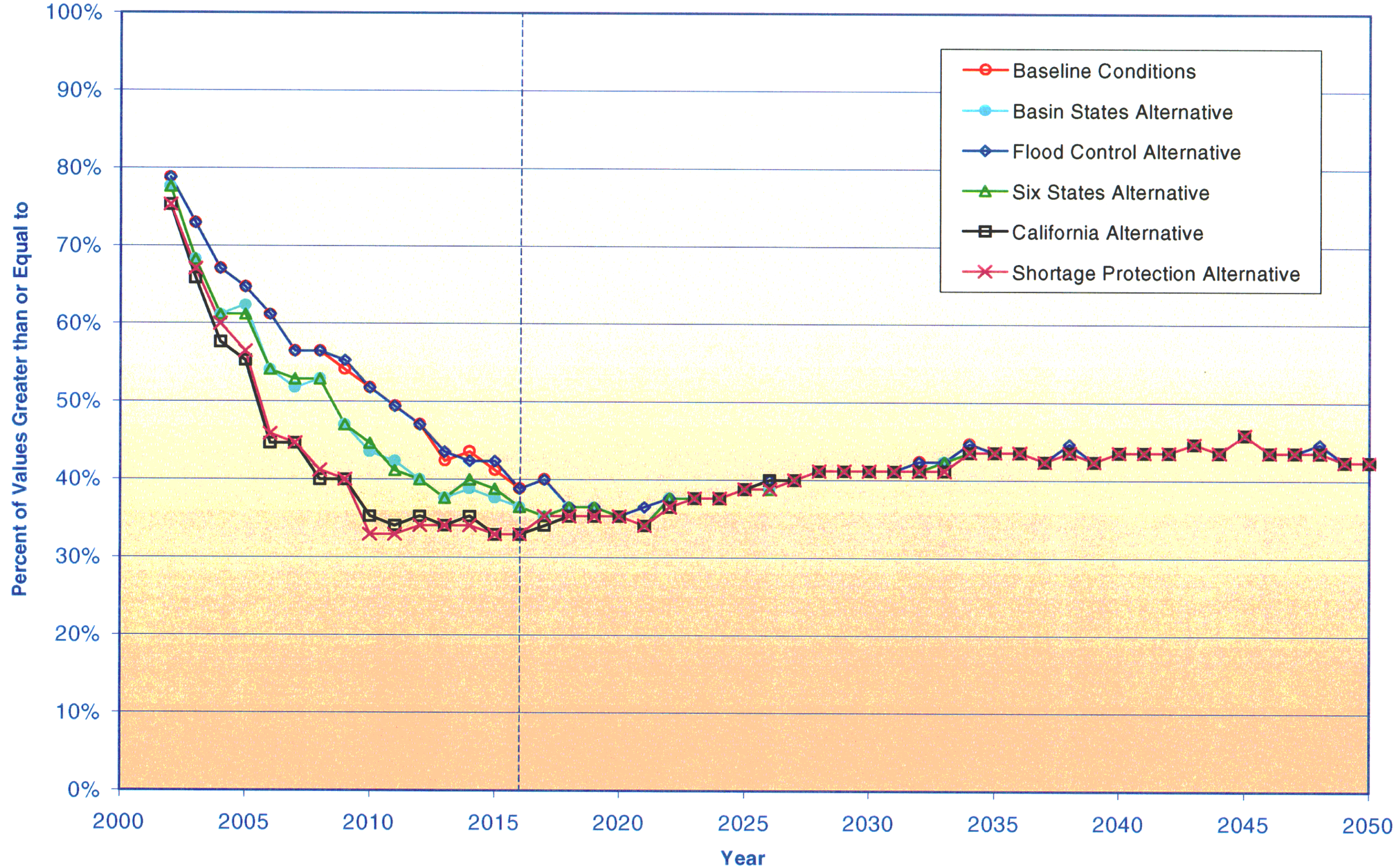


Figure 3.9-2
Lake Powell End of July Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
Percent of Values Greater than or Equal to 3677 Feet msl



most over the initial 15 years of the period of analysis. During this time, the probability would decline from nearly 80 percent to less than 40 percent under baseline conditions and the alternatives. During years 16 through 25 the effects of the alternatives would diminish, although the probability of exceeding elevation 3677 feet msl would remain low (roughly 30-40 percent). After year 25 there would be no discernable effect of the alternatives for the remainder of the analysis period; the probability of exceeding elevation 3677 feet msl would remain fairly low at around 40 to 45 percent.

The differences between the alternatives would be most apparent during the first 15 years. The greatest difference occurs in year nine, when the difference between baseline conditions and the Shortage Protection Alternative is 19 percent. The Flood Control Alternative, with results that are nearly identical to those of baseline conditions, has the lowest probability of pool elevations dropping below 3677 feet msl, whereas the Shortage Protection and California alternatives have the highest probability. The Basin States and Six States alternatives have probabilities between the baseline conditions and the Shortage Protection Alternative.

Table 3.9-4
Probabilities of Lake Powell Elevation Exceeding 3677 feet in July

Alternative	Range of Probability		
	Years 1-15	Years 16 - 25	Years 26 – 49
Baseline Conditions	79%-39%	40%-34%	46%-40%
Basin States Alternative	78%-36%	39%-34%	46%-40%
Flood Control Alternative	79%-39%	40%-35%	46%-40%
Six States Alternative	78%-36%	39%-34%	46%-40%
California Alternative	75%-33%	40%-34%	46%-40%
Shortage Protection Alternative	75%-33%	39%-34%	46%-40%

The probability of Lake Powell pool elevation exceeding the threshold of 3612 feet msl in July under baseline conditions and each of the alternatives is shown in Figure 3.9-3 and Table 3.9-5. The probability is greater than 70 percent throughout the period of analysis. The probability begins at 100 percent, due to the relatively full initial elevation, and declines gradually throughout the period of analysis. In general, probabilities decrease within a 10 to 15 percent range during the initial 15-year period, followed by an additional 10 to 15 percent decrease from years 16 through 34. For the remainder of the analysis period, decreases are around 5 percent.

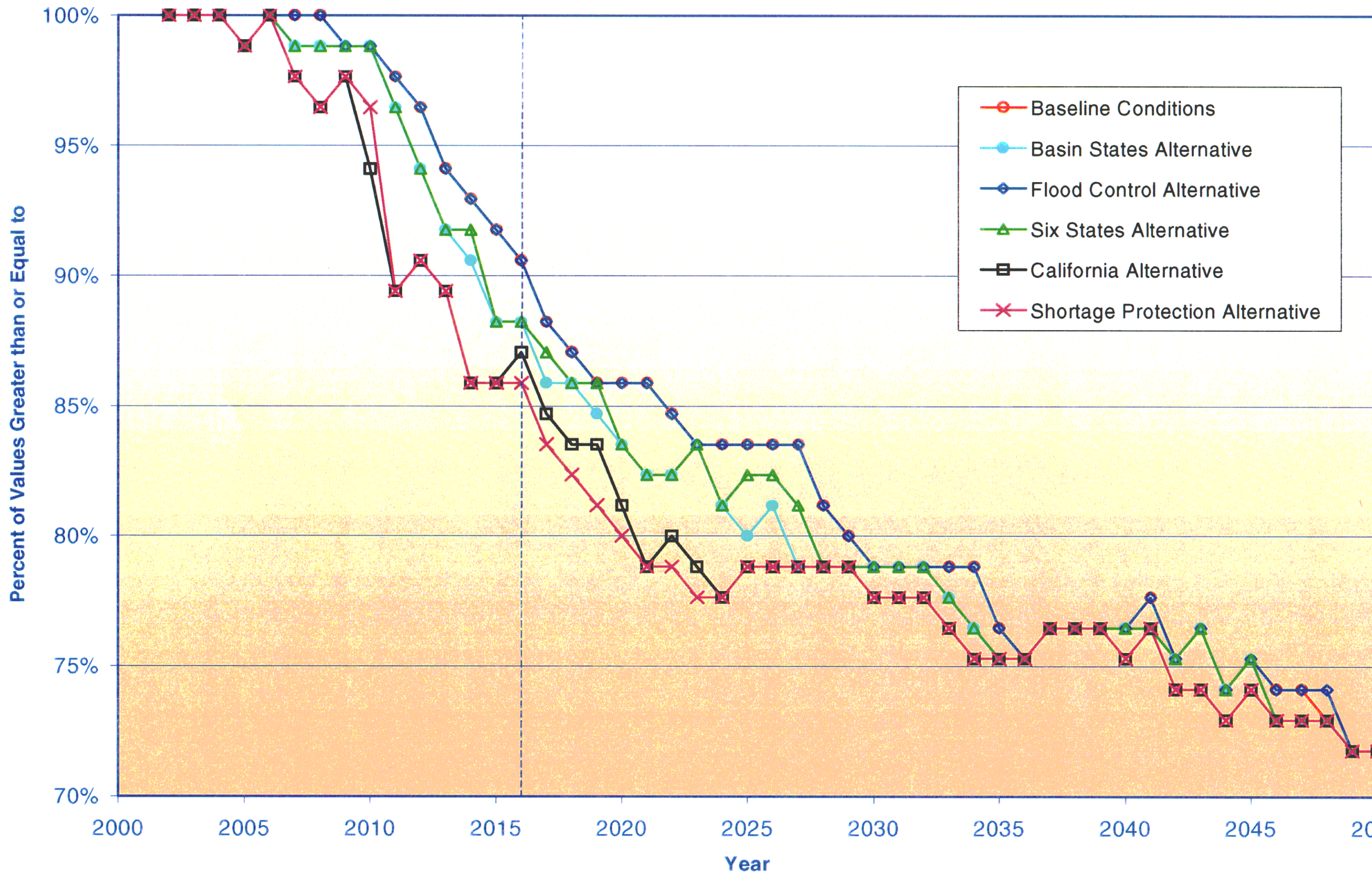
The differences between the alternatives is slight, with the greatest difference in probabilities being about eight percent. The Flood Control Alternative has the same probabilities as baseline conditions and therefore would have no effect. The other alternatives have probabilities less than or equal to baseline conditions. The Shortage Protection and California Alternatives have effects similar to each other and result in the greatest departure (maximum eight percent) from baseline conditions. The Six States and Basin States alternatives are between the Shortage Protection Alternative and baseline conditions, and have a maximum departure of five percent from baseline conditions.

Each of the alternatives is discussed below in more detail with respect to the patterns indicated on Figures 3.9-2 and 3.9-3 and Tables 3.9-4 and 3.9-5.

Table 3.9-5
Probabilities of Lake Powell Elevation Exceeding 3612 feet in July

Alternative	Range of Probability		
	Years 1-15	Years 16-34	Years 35-49
Baseline Conditions	100%-91%	88%-76%	78%-72%
Basin States Alternative	100%-88%	86%-75%	76%-72%
Flood Control Alternative	100%-91%	88%-76%	78%-72%
Six States Alternative	100%-88%	87%-75%	76%-72%
California Alternative	100%-87%	85%-75%	76%-72%
Shortage Protection Alternative	100%-86%	84%-75%	76%-72%

Figure 3.9-3
Lake Powell End of July Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
Percent of Values Greater than or Equal to 3612 Feet msl



3.9.2.3.1.1 Baseline Conditions

The probability under baseline conditions that Lake Powell pool elevation is above 3677 feet msl in July decreases from 79 percent in year 1 to 39 percent in year 15. In years 16 through 25, the probability ranges between 40 and 34 percent. For the remainder of the analysis period the probability ranges between 40 and 46 percent. The early declining probabilities (for baseline conditions and alternatives) can be mostly attributed to increasing consumptive use of Colorado River water in the Upper Basin. The later rise is attributed to the suspension of equalization requirements between Lake Powell and Lake Mead (see Section 1.4.2).

There is a high probability that July Lake Powell pool elevation would exceed the threshold of 3612 feet msl for the baseline condition throughout the period of analysis. Between years 1 and 15, the probability decreases from 100 percent to 91 percent. Between years 16 and 34, the probability continues to decrease gradually from 88 percent to 76 percent. For the remainder of the analysis period, the probability decreases slightly, ranging between 78 and 72 percent. The declining trend of all probabilities (baseline conditions and alternatives) can be mostly attributed to increasing consumptive use of Colorado River water in the Upper Basin.

3.9.2.3.1.2 Basin States Alternative

The probability of the Lake Powell pool elevation exceeding 3677 feet msl in July is slightly lower under the Basin States Alternative than under baseline conditions. In the first 15 years, the probability decreases from 78 percent to 36 percent under the Basin States Alternative. The probability during this period is one percent to eight percent lower than under baseline conditions. In years 16 to 25, the probability decreases to a low of 34 percent, then rises to 39 percent. During this period, the probability is generally the same as for baseline conditions. For the remainder of the analysis period, probabilities fluctuate between 40 and 46 percent, and are generally the same as under baseline conditions.

The probability of Lake Powell elevation exceeding 3612 feet msl in July under the Basin States Alternative is slightly lower than for the baseline conditions. Between years 1 and 15, the probability decreases from 100 percent to 88 percent, compared to a 91 percent probability under baseline conditions. During this period, the probability is typically up to two percent less than under baseline conditions. Between years 16 and 34, the probability continues a gradual decline to 75 percent, and ranges between zero and five percent less, but typically between zero and two percent less, than under baseline conditions. For the remaining years of analysis, the probability continues to decline to a low of 72 percent in year 2050, and is within one percent of the probability under baseline conditions.

3.9.2.3.1.3 Flood Control Alternative

The probability of Lake Powell pool elevation exceeding 3677 feet msl under the Flood Control Alternative is approximately the same as for baseline conditions. In the first 15 years, the probability decreases from 79 to 39 percent, and is within one percent of the probability under baseline conditions. From years 16 to 25, the probability fluctuates between 40 and 35 percent. The probability during this period is typically the same as under baseline conditions. By the end of the period of analysis, the probability remains fairly constant, between 40 and 46 percent. During this period, the probability is typically the same as under baseline conditions.

The probability of Lake Powell pool elevation exceeding 3612 feet msl under the Flood Control Alternative is generally the same as that described for baseline conditions throughout the period of analysis.

3.9.2.3.1.4 Six States Alternative

The probability of Lake Powell pool elevation exceeding 3677 feet msl under the Six States Alternative is very similar to the Basin States Alternative discussed above. In early years, the probability is up to seven percent less than under baseline conditions. In later years, the probability is generally the same as under baseline conditions.

The probability of Lake Powell pool elevation exceeding 3612 feet msl under the Six States Alternative is also very similar to the Basin States Alternative. In early years, the probability is up to four percent less than under baseline conditions. In later years, the probability is typically the same as under baseline conditions.

3.9.2.3.1.5 California Alternative

The probability of Lake Powell pool elevation exceeding 3677 feet msl is lower under the California Alternative than under baseline conditions. In the first 15 years, the probability declines from 75 percent to a low of 33 percent, and ranges from 4 to 16 percent less than under baseline conditions. In years 16 to 25, the probability increases slightly, ranging from 34 to 40 percent, and is typically the same as under baseline conditions. For the remainder of the analysis period, the probability increases slightly, remaining between 40 and 46 percent, and is always within one percent of baseline conditions.

The probability of Lake Powell pool elevation exceeding 3612 feet msl under the California Alternative is slightly lower than under baseline conditions. Between years 1 and 15, the probability decreases from 100 percent to 87 percent and is from zero to eight percent less than under baseline conditions. The probability continues to decrease from 85 to 75 percent in years 16 through 34, and is up to seven percent less than under baseline conditions. For the remaining years of analysis, the probability ranges between 76 and 72 percent, and is from zero to two percent less than under baseline conditions.

3.9.2.3.1.6 Shortage Protection Alternative

The probability of Lake Powell pool elevation exceeding 3677 feet msl under the Shortage Protection Alternative is not significantly different from the California Alternative discussed above. In early years, the probability is up to 19 percent less than under baseline conditions. In later years, the probability is typically the same as under baseline conditions.

The probability of Lake Powell pool elevation exceeding 3612 feet msl under the Shortage Protection Alternative is not significantly different from the California Alternative discussed above. In early years, the probability is up to eight percent less than under baseline conditions. In later years, the probability is within two percent of the probability under baseline conditions.

3.9.2.3.2 Lake Mead

As discussed in the Affected Environment section above, a pool elevation of 1183 feet msl was identified as a representative threshold that is problematic for shoreline access at Lake Mead. Figure 3.9-4 provides an overview of the difference in end-of-year water surface elevations under baseline conditions and each of the action alternatives. Although elevations would typically be lower during the summer peak-use period, the differences between baseline conditions and action alternatives would be similar to those presented herein.

Figure 3.9-5 and Table 3.9-6 indicate the probability of Lake Mead elevation exceeding the threshold of 1183 feet msl at the end of the year. As shown in Figure 3.9-5, the probability is low over the period of analysis due primarily to effects associated with baseline conditions. In the initial 15 years of analysis, the probabilities under baseline conditions and the alternatives decline by more than 20 percent. Shortly after year 15, the probabilities under baseline conditions and the alternatives converge near 35 percent. Subsequently, a probability of 28 to 36 percent is maintained until the end of the analysis period.

Table 3.9-6
Comparison of Lake Mead Elevation Exceedance Probabilities for Elevation 1183 Feet

Alternative	Year 0-15	Years 16 - 49
Baseline Conditions	65%-36%	36%-29%
Basin States Alternative	55%-32%	35%-29%
Flood Control Alternative	65%-36%	38%-29%
Six States Alternative	55%-32%	35%-29%
California Alternative	45%-25%	35%-28%
Shortage Protection Alternative	47%-26%	34%-28%

Figure 3.9-4
Lake Mead End of December Water Elevations
Comparison of Surplus Alternative to Baseline Conditions
90^{th}, 50^{th} and 10^{th} Percentile Values

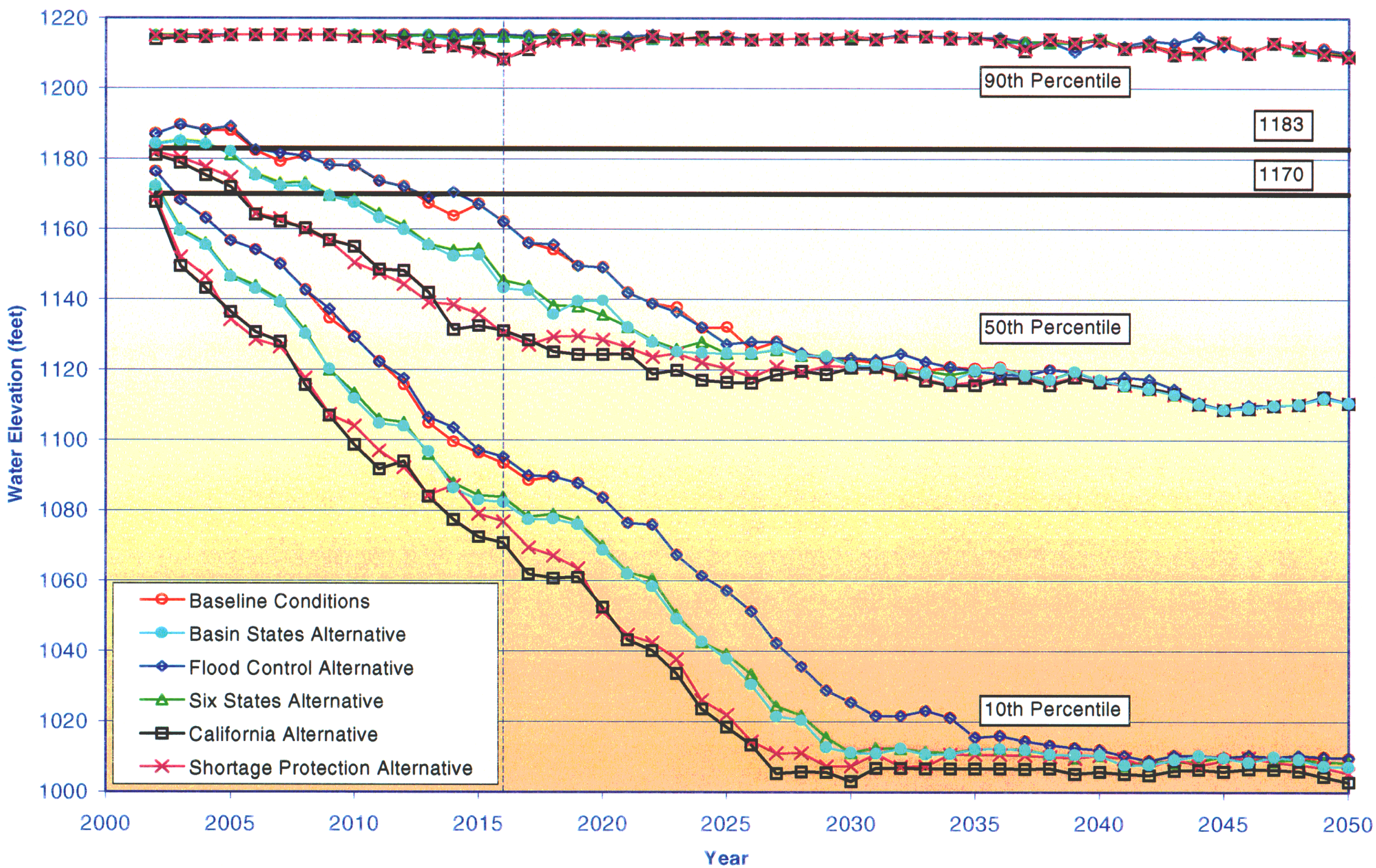
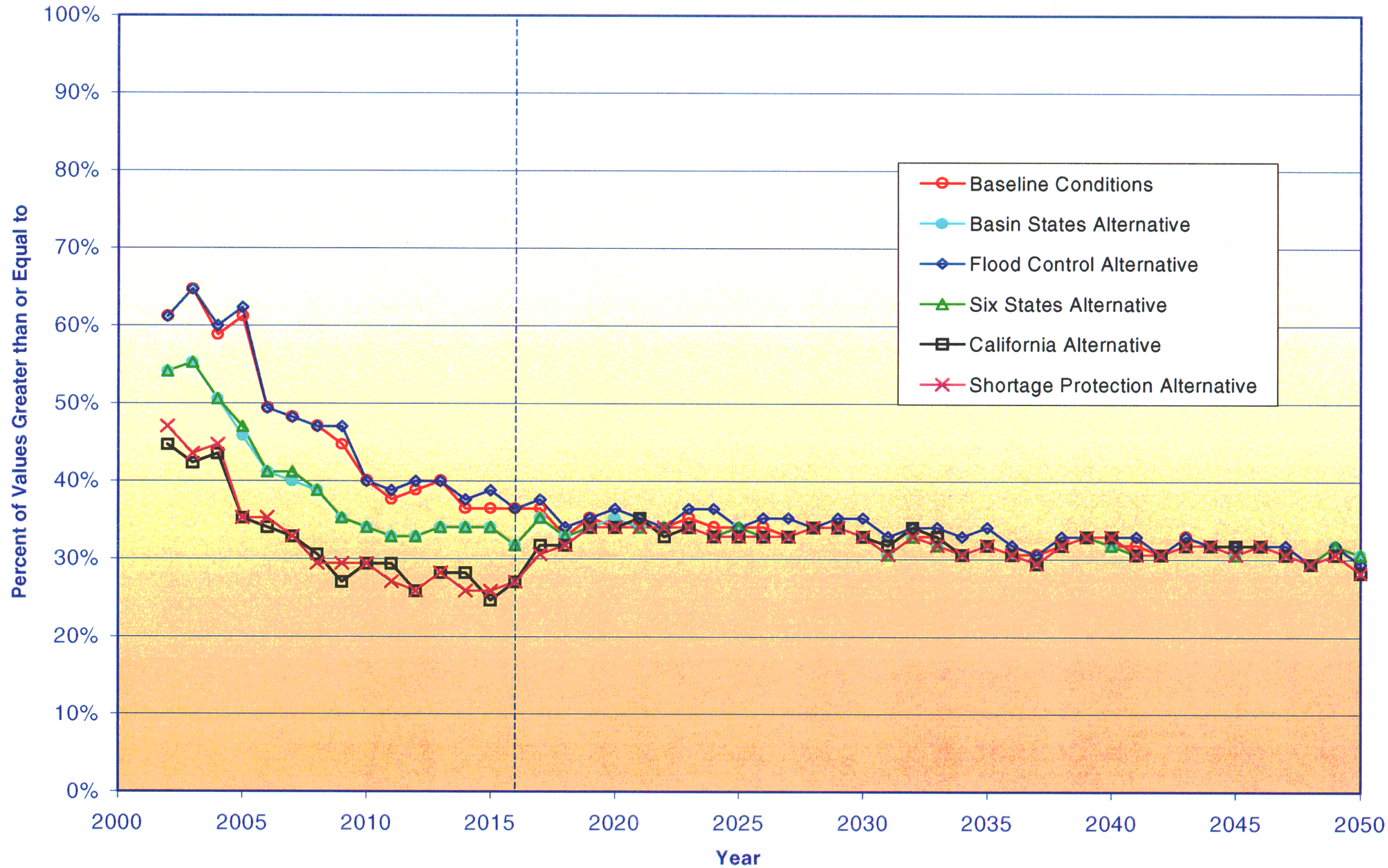


Figure 3.9-5
Lake Mead End of December Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
Percent of Values Greater than or Equal to 1183 Feet msl



3.9.2.3.2.1 Baseline Conditions

The probability of Lake Mead pool elevation exceeding 1183 feet msl declines from 65 percent to 36 percent under baseline conditions during the first 15 years of the analysis period. In the remaining years of the analysis period, the probability ranges between 36 and 29 percent. The general declining trend of Lake Mead elevations over time can be attributed to increases in Upper Basin use.

3.9.2.3.2.2 Basin States Alternative

The probability of Lake Mead pool elevation exceeding 1183 feet msl in the first 15 years of the analysis period declines from 55 percent to 36 percent under the Basin States Alternative. The probability during this period is typically up to nine percent less than under baseline conditions. In remaining years of the analysis period, the probability ranges between 35 and 29 percent. During this period, the probability is within one percent of the probability under baseline conditions.

3.9.2.3.2.3 Flood Control Alternative

The probability of Lake Mead pool elevation exceeding 1183 feet msl in the first 15 years of the analysis period declines from 65 percent to 36 percent under the Flood Control Alternative. In remaining years of the analysis period, the probability ranges between 38 and 29 percent. The probability of exceeding elevation 1183 feet msl under the Flood Control Alternative would be approximately the same as under baseline conditions throughout the entire analysis period.

3.9.2.3.2.4 Six States Alternative

The probability of Lake Mead pool elevation exceeding 1183 feet msl in the first 15 years of the analysis period declines from 55 percent to 32 percent under the Six States Alternative. In remaining years of the analysis period, the probability ranges between 35 and 29 percent. The probability is nearly identical to that for the Basin States Alternative discussed above.

3.9.2.3.2.5 California Alternative

The probability of Lake Mead pool elevation exceeding 1183 feet msl is lowest under the California Alternative in most years. In the first 15 years, the probability ranges between 45 and 25 percent. This is up to 26 percent lower than under baseline conditions. After year 16, the probability is within one percent of the probability under baseline conditions.

3.9.2.3.2.6 Shortage Protection Alternative

The probability of Lake Mead pool elevation exceeding 1183 feet msl under the Shortage Protection Alternative is nearly the same as under the California Alternative. In the first 15 years, the probability ranges between 47 and 27 percent and is up to 26 percent lower than under baseline conditions. After year 16, the probability associated with the Shortage Protection Alternative generally converges with baseline conditions and the other alternatives, similar to the California Alternative.

3.9.3 RESERVOIR BOATING/NAVIGATION

This section discusses potential effects of the interim surplus criteria on reservoir boating and navigation. This includes a discussion of areas on the reservoir that could become unsafe for boating at certain elevations due to exposed rocks or other obstructions, and safe boating densities that indicate the number of boats that can safely be accommodated on the reservoirs at one time.

Boating navigation and safe boating capacities on Lake Powell and Lake Mead are dependent upon water surface elevations. As lake levels decline, so does the available surface area. Hazards such as exposed rocks may become more evident, or changes in navigation patterns may be necessary. The area of the reservoirs available for boating is also reduced, which may affect the number of boats that can safely operate at one time. At low pool elevations, special buoys or markers may be placed to warn boaters of navigational hazards. In addition, signs may be placed in areas that are deemed unsuitable for navigation.

3.9.3.1 METHODOLOGY

Description of the affected environment is based on a literature review of published and unpublished documents and maps, and personal communications with NPS staff at the GCNRA and LMNRA. Information received includes the identification of navigation issues associated with recreational boating on Lake Powell and Lake Mead, such as navigation safety and safe boating densities. Low reservoir pool elevations identified in the literature or through discussions with NPS as being of concern for reservoir boating and navigation are discussed herein. Assessment of environmental consequences associated with implementing the interim surplus criteria alternatives is based on river system modeling and probability analyses of Lake Powell and Lake Mead pool elevations exceeding identified thresholds.

Safe boating capacity is another aspect of boating navigation and safety. Safe boating is one factor that can be used to assess the carrying capacity of a reservoir. To date, no determination of carrying capacity (number of boats at one time) has been made for either Lake Powell or Lake Mead. However, the NPS is currently developing a carrying capacity approach for managing water-based recreation on Lake Mead that is based on the U.S. Forest Service Recreation Opportunity Spectrum system. Results of the NPS study were not available for this analysis.

A safe boating density of nine acres per boat was established for the GCNRA (USBR, 1995b) at Lake Powell. The safe boating density could be used to assess the effects of the interim surplus criteria alternatives on boating safety if daily boating levels for the reservoir were available. However, there is no known 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 (as discussed below). Without information on current reservoir boat densities, it is not known whether future reductions in pool elevations at Lake Powell and Lake Mead would result in unsafe boating conditions.

3.9.3.2 AFFECTED ENVIRONMENT

3.9.3.2.1 Lake Powell Boating Navigation and Safety

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 3680 feet msl, there are several places that remain passable, although buoys are placed for safe navigation. At elevation 3626 feet msl and 3620 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 the areas is around Castle Rock, just east of the Wahweap Marina, and the other is around Gregory Butte, which is about midway to Dangling Marina from Wahweap (as shown on Map 3.9-1). At elevation 3626 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 Gregory Butte, 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 of 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 old Colorado River bed and 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 the upstream end of the reservoir, where the San Juan River enters, a delta has formed that can affect river boaters coming into Lake Powell at low pool elevations. River boaters from the San Juan River paddle 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 water surface elevations, the river boaters must travel further downstream to reach a location that is accessible to the transport company's boat.

Although this results in more miles to paddle to the takeout, there is usually enough current in the river to carry the boats. For some boaters, the added mileage is an opportunity to paddle additional rapids on the Colorado River in Cataract Canyon (Hyde, 2000). For others, the additional mileage is seen as exposure to additional navigational hazards, possibly requiring portaging of boats due to restricted channel widths and subsurface conditions.

3.9.3.2.1.1 Lake Powell 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 motor boats for multiple day excursions to explore the reservoir.

The number of boats that Lake Powell can safely accommodate at one time (i.e., safe boating capacity) is based on a 1977 Bureau of Outdoor Recreation standard of nine surface acres per boat (USBR, 1995b). The amount of water storage in Lake Powell directly influences the surface area of the reservoir and the number of boats that can safely be on the reservoir. Table 3.9-7 lists median July Lake Powell surface areas for baseline conditions and alternatives in the year 2016 and identifies the safe boating capacity of the reservoir at those elevations, based on an assumed maximum safe density of nine acres per boat. The surface area of Lake Powell is reduced by approximately 9 to 10 percent for each 20-foot drop.

Table 3.9-7
Lake Powell Safe Boating Capacity at Water Surface Elevations

Scenario	Median Elevation in July of Year 15 (feet msl)	Water Surface Area (acres)	Safe Boating Capacity[1]
Baseline Conditions	3665	134,600	14,956
Basin States Alternative	3664	134,100	14,900
Flood Control Alternative	3665	134,600	14,956
Six State Alternatives	3664	134.100	14,900
California Alternative	3660	130,800	14,533
Shortage Protection Alternative	3659	130,200	14,467

[1] Number of boats, assuming safe density of 9 acres per boat.

At full pool for Lake Powell (3700 feet msl), the surface area is 160,782 acres. Using the safe boating density of nine surface acres per boat, Lake Powell's safe boating capacity at full storage is approximately 17,865 boats. As pool elevation decreases, the surface area available for boats also decreases. While safe reservoir boating carrying capacity is reduced at lower lake elevations, there may be additional shoreline camping available due to more exposed beaches. However, boating capacity is more constrained by safe boating densities than by the availability of camping sites on Lake Powell (Combrink and Collins, 1992).

3.9.3.2.2 Lake Mead Boating Navigation and Safety

Similar to the navigation system on Lake Powell, 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.

As with Lake Powell, the main channel of the old Colorado River bed forms the primary travel corridor on Lake Mead and 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 (refer to Map 3.9-2). There are no developed facilities at South Cove or Pearce Ferry. Points of interest in the Grand Canyon include Columbine Falls, Bat Cave, Spencer Creek, and Separation Canyon. In addition to sightseeing being a popular activity, many boaters include overnight camping stays on these excursions (USBR, 1995b).

The upper arms and inflow areas of Lake Mead are considered dangerous for navigation 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, undated).

Over the years, sediment has built up in the section of the reservoir between Grand Wash and Pearce Ferry. When lake elevations drop below 1170 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 have a difficult time accessing the area because of the shifting nature of the channel (USBR, 1995b). Based on this information, 1170 feet msl is considered a threshold elevation for safe boating navigation at Lake Mead.

While the area around Pearce Ferry is an issue for navigation at 1170 feet msl, it is also inaccessible as a take out for whitewater boaters at elevation 1183 feet msl and boaters must paddle an additional 16 miles to South Cove (Henderson, 2000). Paddling to South Cove includes paddling through the section of reservoir between Pearce Ferry and Grand Wash. (Refer to Section 3.9.2.2.3 for a description of the Pearce Ferry facility, and Section 3.9.2.3.2 for an analysis of environmental consequences associated with elevation 1183 feet msl.)

In addition to the boating navigation issues summarized above, there are swimmer safety issues at Lake Mead. At Gypsum Wash (between Las Vegas Bay and Government Wash), there are cliffs that are popular with recreationists for jumping into the lake. When lake elevations are below 1180 feet msl, the water is too shallow for cliff jumping from this location. Another jumping spot that was poplar during the late 1980's when reservoir levels were down is an area called "33 Hole." This location is popular for cliff jumping when the lake elevation reaches 1165 feet msl. Cliff jumping at both locations is discouraged by the NPS for safety reasons (Burke, 2000). Since the activity is discouraged, the identified elevations were not considered as thresholds for evaluation of effects.

3.9.3.2.3 Lake Mead Safe Boating Capacity

The LMNRA receives approximately ten million visitors annually. Of those that participate in water-based recreation, most either swim, boat, fish, sailboard, use paddlecraft, or scuba dive (USBR, 1996b). Since no boating capacity has been established for Lake Mead, the safe boating density of nine acres per boat established for Lake Powell was assumed; safe boating capacities were determined based on reservoir elevation/surface area relationships. There is no daily or peak boating use information available to establish the relationship between actual boating densities and the safe boating capacity values shown below in Table 3.9-8. This table shows Lake Mead surface area under the predicted pool elevations for baseline conditions and the alternatives at the end of 2016, and identifies the safe boating capacity of the reservoir based on an assumed maximum safe density of nine acres per boat.

Table 3.9-8
Lake Mead Safe Boating Capacity at Water Surface Elevations

Scenario	Median Elevation at End of Year 15 (feet msl)	Water Surface Area (acres)	Safe Boating Capacity[1]
Baseline Conditions	1162	120,200	13,356
Basin States Alternative	1143	108,100	12,011
Flood Control Alternative	1162	120,200	13,356
Six State Alternatives	1145	109,400	12,156
California Alternative	1131	102,100	11,344
Shortage Protection Alternative	1130	101,700	11,300

[1] Number of boats, assuming safe density of 9 acres per boat.

At full pool for Lake Mead, the 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 storage is approximately 17,000 boats. As pool elevation decreases, the safe boating capacity also decreases.

3.9.3.3 ENVIRONMENTAL CONSEQUENCES

Boating navigation and safe boating densities on Lake Powell and Lake Mead are dependent upon water surface elevations. As lake levels fluctuate, hazards, such as exposed rocks at lower pool elevations or different navigational patterns at higher elevations, may become evident. At low pool elevations, special buoys or markers may be placed to warn boaters of navigational hazards. In addition, signs may be placed in areas deemed unsuitable for navigation.

Assessment of environmental consequences of the alternatives on boating navigation and safety is based on river system model output, described in detail in Section 3.3. The probability of effects under baseline conditions and the alternatives was determined through identifying the probability of exceeding a representative "threshold" pool elevation during the period of analysis. The selection of the threshold pool elevation is based on the known boating navigation issues discussed in the Affected Environment section above. The probabilities of the reservoirs remaining above the identified threshold elevations are identified for baseline conditions and the interim surplus criteria alternatives, and differences between probabilities under baseline conditions and alternatives are compared.

In addition to navigation issues that occur at low pool elevations, the number of boats that can safely be accommodated on the reservoir at one time (safe boating capacity) is also a reservoir boating issue. As discussed previously, the lack of boating use data and spatial modeling of the effects of the alternatives on shoreline conditions precludes a quantitative or qualitative assessment of the impacts associated with the alternatives. In general, as pool elevations change, so does the reservoir surface area and the number of boats that can safely be accommodated on the reservoir. Therefore, the alternatives that result in the greatest potential for lower surface elevations would tend to increase the likelihood of exceeding safe boating densities. Without current and projected boating use levels for comparison to surface areas under the alternatives, it cannot be determined whether the change in available surface area would result in an exceedance of the calculated safe boating capacities shown in Tables 3.9-7 and 3.9-8, so environmental consequences related to safe boating capacity are not analyzed further.

3.9.3.3.1 Lake Powell

For Lake Powell boating navigation, a reservoir pool elevation of 3626 feet msl was identified as a representative threshold in Section 3.9.3.2.1. Figure 3.9-1 (presented previously) shows elevation trends for baseline conditions and the alternatives over the period of analysis.

In addition, as discussed in the section on shoreline facilities (Section 3.9.2.2.2), elevation 3626 feet msl is also close to the elevation for a new proposed boat ramp at Antelope Point, which will extend down to 3620. Using an assumption of six feet for freeboard, the environmental consequences associated with elevation 3626 for navigation are applicable to the future operability of the proposed ramp at Antelope Point.

Figure 3.9-6 depicts the probability of pool elevations exceeding 3626 feet msl under baseline conditions and each of the alternatives. Table 3.9-9 presents a comparison of the probabilities associated with years 1 through 15, 16 through 28, and 29 through 49. The probability decreases (from 100 to 65 percent) during the analysis period under baseline conditions and all of the alternatives. The probability is greatest for baseline conditions and the Flood Control Alternative, and least for the California and Shortage Protection Alternatives. The Six States and Basin States alternatives have probabilities between the others.

Figure 3.9-6
Lake Powell End of July Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
Percentage of Values Greater than or Equal to 3626 Feet

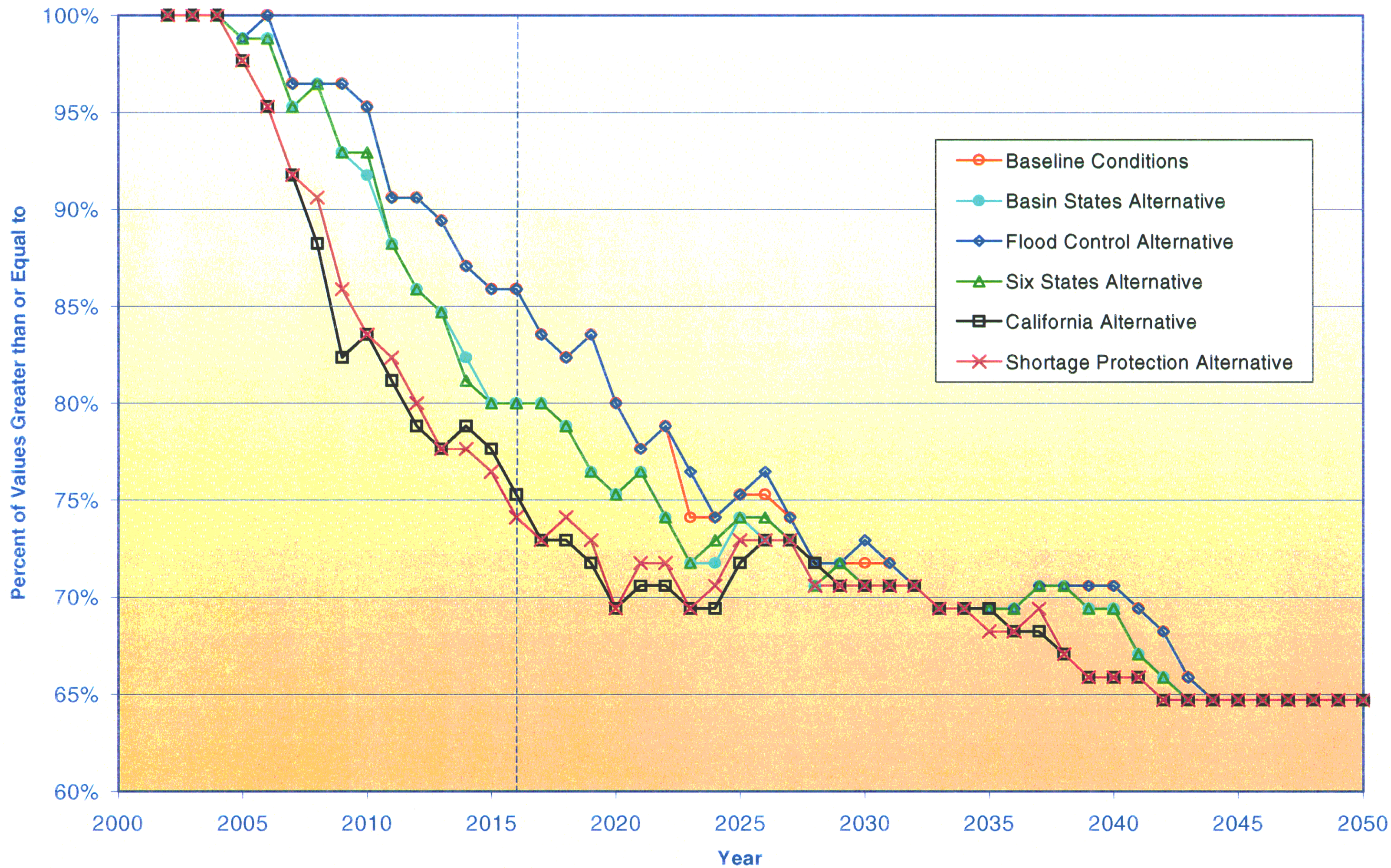


Table 3.9-9
Probabilities of Lake Powell Elevation Exceeding 3626 feet in July

Projected Condition	Range of Probability		
	Years 1 - 15	Years 16 - 28	Years 29 - 49
Baseline Conditions	100%-86%	84%-72%	72%-65%
Basin States Alternative	100%-80%	80%-71%	71%-65%
Flood Control Alternative	100%-86%	84%-72%	73%-65%
Six States Alternative	100%-80%	80%-71%	71%-65%
California Alternative	100%-75%	73%-69%	71%-65%
Shortage Protection Alternative	100%-74%	74%-69%	71%-65%

3.9.3.3.1.1 Baseline Conditions

The probability of Lake Powell pool exceeding the safe boating navigation elevation of 3626 feet msl in July gradually decreases from 100 percent to 65 percent under baseline conditions during the entire period of analysis. The probability decreases more slowly under baseline conditions and the Flood Control Alternative than under the other alternatives. In the first 15 years of the analysis period, the probability decreases from 100 to 86 percent. From years 16 to 28, the probability decreases from 84 to 72 percent. For the remainder of the analysis period, the probability continues to decrease, declining from 72 to 65 percent.

3.9.3.3.1.2 Basin States Alternative

The probability of Lake Powell pool elevation exceeding 3626 feet msl gradually decreases from 100 percent to 65 percent under the Basin States Alternative during the entire period of analysis. During the first 15 years, the probability declines more rapidly than under baseline conditions, dropping from 100 to 80 percent. The probability in year 15 is six percent less than under baseline conditions. Between years 16 and 28, the probability begins to converge with the probabilities of baseline and the other alternatives, and ranges between 80 and 71 percent. During this period, the probability is up to 7 percent less than under baseline conditions. For the remainder of the analysis period, the probability is similar to baseline conditions and the other alternatives, continuing to decline to a low of 65 percent.

3.9.3.3.1.3 Flood Control Alternative

For the Flood Control Alternative, the probability of Lake Powell pool elevation exceeding 3626 feet msl is practically the same as for baseline conditions throughout the analysis period. As shown in Figure 3.9-6, there are only three years in which the probability is different (within one to two percent) from baseline conditions.

3.9.3.3.1.4 Six States Alternative

The probability of Lake Powell elevation exceeding 3626 feet msl under the Six States Alternative is identical to the probability under the Basin States Alternative in all but four years, when there is a one percent difference.

3.9.3.3.1.5 California Alternative

The California Alternative results in the lowest probability of Lake Powell pool elevation exceeding 3626 feet msl. The probability decreases from 100 to 75 percent in the first 15 years of the analysis period. Between years 16 and 28, the probability begins to converge with the probabilities under baseline and the other alternatives, ranging between 73 and 69 percent. For the remainder of the analysis period, the probability is similar to baseline conditions and the other alternatives, continuing to decline to a low of 65 percent. During these three periods, the probability is up to 14 percent, 12 percent and 5 percent, respectively, below the probability under baseline conditions.

3.9.3.3.1.6 Shortage Protection Alternative

For the Shortage Protection Alternative, the probability of Lake Powell pool elevation exceeding 3626 feet msl is nearly the same as under the California Alternative throughout the analysis period. The probability is up to 12 percent less than under baseline conditions during the first 15 years of the analysis period. Between years 16 and 28, the probability begins to converge with the probabilities under baseline conditions and the other alternatives, and is up to 11 percent less than under baseline conditions. For the remainder of the analysis period, the probability is within 5 percent of baseline conditions.

3.9.3.3.2 Lake Mead

A reservoir pool elevation of 1170 feet msl was identified as the representative threshold for boating navigation at Lake Mead, as described in Section 3.9.3.2.2.

Figure 3.9-7 depicts the probability of Lake Mead end-of-December pool elevations exceeding 1170 feet msl for baseline conditions and the alternatives. Table 3.9-10 compares the probabilities associated with years 1 through 15, years 16-22, and years 23 through 49.

Figure 3.9-7
Lake Mead End of December Water Elevations
Comparison of Surplus Alternatives to Baseline Conditions
Percentage of Values Greater than or Equal to 1170 Feet

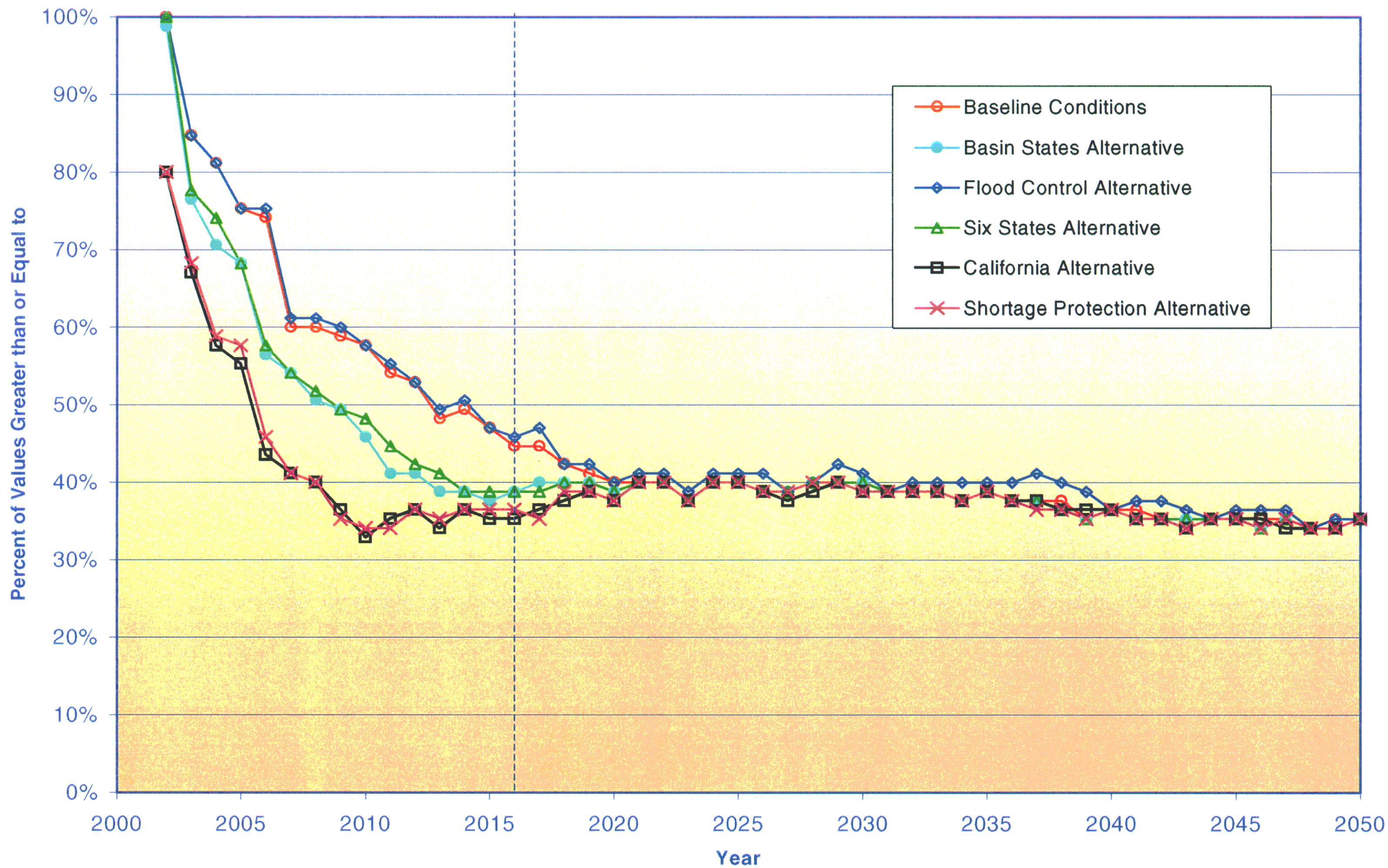


Table 3.9-10
Probabilities of Lake Mead End-of-December Elevation Exceeding 1170 feet

Projected Condition	Range of Probability		
	Years 1 – 15	Years 16 - 22	Years 23 - 49
Baseline Conditions	100%-45%	45%-38%	40%-34%
Basin States Alternative	99%-38%	40%-38%	40%-34%
Flood Control Alternative	100%-46%	47%-39%	42%-34%
Six States Alternative	100%-39%	40%-38%	40%-34%
California Alternative	80%-33%	40%-36%	40%-34%
Shortage Protection Alternative	80%-34%	40%-35%	40%-34%

Under baseline conditions and the alternatives, the probability of Lake Mead pool elevation exceeding 1170 feet msl declines during the interim period, then stabilizes for the remainder of the period of analysis. The probability is greatest for baseline conditions and the Flood Control Alternative, and least for the California and Shortage Protection Alternatives. The Basin States and Six States alternatives have probabilities between the others.

3.9.3.3.2.1 Baseline Conditions

The probability of Lake Mead pool elevation exceeding the safe boating and navigation elevation of 1170 feet msl at the end of the year declines from 100 to 34 percent under baseline conditions throughout the entire period of analysis. Probabilities decrease more slowly under baseline conditions than under all alternatives except for Flood Control. In the first 15 years of analysis, the probability declines from 100 to 45 percent. Between years 16 and 22, the probability continues to decline from 45 to 38 percent, as the alternatives converge with baseline conditions. For the remainder of the analysis period, the probability under baseline conditions is similar to the alternatives, ranging between 40 and 34 percent.

3.9.3.3.2.2 Basin States Alternative

The probability of Lake Mead pool elevation exceeding 1170 feet msl declines from 99 to 34 percent throughout the entire period of analysis for the Basin States Alternative. As with most other alternatives, the decrease occurs during the interim period and occurs more quickly than under baseline conditions. In the first 15 years of the analysis period, the probability drops from 99 percent to 39 percent and is typically up to 13 percent less than under baseline conditions. Between years 16 and 22, the probability stabilizes and converges with baseline conditions. The range of probability is from 40 to 38 percent, and is up to five percent less than under baseline conditions. For the remainder of the analysis period, the probability is within one percent of baseline conditions, ranging between 40 and 34 percent.

3.9.3.3.2.3 Flood Control Alternative

The probability of Lake Mead pool elevation exceeding 1170 feet msl under the Flood Control Alternative is typically up to two percent greater than under baseline conditions. In the first 15 years of analysis, the probability decreases from 100 to 46 percent, and is within one percent of baseline conditions. Between years 16 and 22, the probability continues to decline, ranging between 47 and 39 percent, and is typically one percent greater than under baseline conditions. For the remainder of the analysis period, the probability is up to 4 percent greater than baseline conditions, ranging between 42 and 34 percent.

3.9.3.3.2.4 Six States Alternative

The effects of the Six States Alternative would be nearly the same as those for the Basin States Alternative. In the first 15 years of the analysis period, the probability of Lake Mead elevation exceeding 1170 feet msl is typically up to 11 percent less than under baseline conditions. Between years 16 and 22, the probability stabilizes and converges with baseline conditions. The probability is typically within two percent of baseline conditions. For the remainder of the analysis period, the probability is within one percent of baseline conditions, ranging between 40 and 34 percent.

3.9.3.3.2.5 California Alternative

The probability of Lake Mead pool elevation exceeding 1170 feet msl under the California Alternative is similar to that under the Shortage Protection Alternative and less than under baseline conditions and the other alternatives. In the first 15 years, the probability drops from 80 to 33 percent, then rises to 35 percent. The probability is up to 31 percent less than under baseline conditions. Between years 16 and 22, the probability rises slightly and converges with baseline conditions and the other alternatives. The probability ranges from eight percent less than to the same as under baseline conditions. For the remainder of the analysis period, the probability is within one percent of baseline conditions.

3.9.3.3.2.6 Shortage Protection Alternative

The effects of the Shortage Protection Alternative are very similar to those described for the California Alternative. The probability of Lake Mead pool elevation exceeding 1170 feet msl is generally within one percent of the probability under the California Alternative throughout the period of analysis.

3.9.4 RIVER AND WHITEWATER BOATING

The Grand Canyon Protection Act directs the Secretary to operate Glen Canyon Dam in accordance with the additional criteria and operating plans specified in Section 1804 of the Act, and to exercise other authorities under existing law in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including but not limited to natural and cultural resources and visitor use.

The Glen Canyon Dam Adaptive Management Program (AMP) was established as a Federal Advisory Committee to assist the Secretary in implementing the Grand Canyon Protection Act. As discussed in Section 3.2.2, 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. While the interim surplus criteria could have an influence on releases from Glen Canyon Dam, such releases will be governed by the criteria in the Record of Decision, which was developed in full consideration of both the safety and quality of recreational experiences in Glen and Grand Canyons. A summary of the Glen Canyon Dam Record of Decision has been included as Attachment D of this FEIS.

The only effect that implementation of the interim surplus criteria alternatives would have on whitewater boaters would be the possibility of lowered pool elevations in Lake Powell and Lake Mead. Whitewater boaters on the San Juan River often end their trips at Lake Powell. While decreased levels in Lake Powell have effects on take out points in the Colorado and San Juan Rivers, they also may expose additional rapids in Cataract Canyon, which would expand whitewater rafting opportunities. Section 3.9.3.2.1 discusses boaters entering Lake Powell.

Whitewater boaters on the Colorado River often end their trips in Lake Mead. Pearce Ferry is the preferred Lake Mead take out for boaters, but it may not be accessible when the reservoir pool elevation is below 1183 feet msl. An analysis of this elevation is presented in Section 3.9.2.2. A take out is also available at Diamond Creek, upstream of Lake Mead at the Hualapai Reservation. The Hualapai Tribe maintains the take out area and road and charges a fee for take out. The Hualapai Tribe also conducts river trips from Diamond Creek (on the Colorado River) to Pearce Ferry. This concession may be affected if trips encounter changes in availability of the Pearce Ferry take out.

3.9.5 SPORT FISHING

This section considers potential effects of the interim surplus criteria alternatives on recreational opportunities associated with sport fishing at Lake Powell, Lake Mead and Lake Mohave (between Hoover and Davis Dam). Sport fishing in the Colorado River between Glen Canyon Dam and Lake Mead will not be affected by the interim surplus criteria action due to the protection afforded by the Adaptive Management Program (see

Section 3.9.4). Fluctuations in flows between Hoover Dam and the SIB under the alternatives would be within the historical operating range of the river. Therefore, changes in flows under the alternatives would not affect recreation within these areas. Adverse effects on sport fisheries from potential changes in water temperature below Hoover Dam would not be expected, as discussed in Section 3.7.3.

3.9.5.1 METHODOLOGY

The discussion of the affected environment for reservoir fishing is based on a review of published documents. Much of this information was derived from the following sources: for Lake Powell, the *Fish Management Plan, Glen Canyon National Recreation Area* (NPS, 1996); and for Lake Mead, the *Desert Lake View Newspaper, Fall/Winter 1999*. In addition, creel information and angler fishing data has been obtained from state agencies in Utah, Arizona, and Nevada responsible for managing the fisheries resources at Lake Mead, Lake Powell, and Lake Mohave.

Assessment of potential impacts on sport fishing in Lake Powell, Lake Mead and Lake Mohave is based on information presented in other sections of the document regarding sport fishery populations (Section 3.7), reservoir shoreline facilities (Section 3.9.2) and reservoir navigation (Section 3.9.3). There were no specific reservoir pool elevation thresholds related to sport fishing identified from the literature reviewed. Catch rates for reservoir fishing are assumed to be directly related to reservoir habitat discussed in Section 3.7, Aquatic Resources. Fishing satisfaction is assumed to be directly related to the general recreation issues of boating access to the water via shoreline facilities, and boating navigation potential for hazards or reservoir detours due to low pool elevations. As discussed in Section 3.7, catch rates are not expected to be affected by fluctuations in pool elevations.

3.9.5.2 AFFECTED ENVIRONMENT

3.9.5.2.1 Sport Fishing in Lake Powell

As discussed in Sections 3.7 and 3.8, native Colorado River species have not done well in the reservoir environment. While some native species may spawn in the reservoir, it is believed that the majority of young are eliminated by sport fish predators. The predominant sport fishery in Lake Powell revolves around striped bass. The striped bass depend on threadfin shad as a food source, so it is critical to maintain a balanced shad population for the striped bass. The threadfin shad in Lake Powell are at the northernmost portion of their range and are very sensitive to fluctuations in water temperature. In addition to striped bass, Lake Powell supports largemouth and smallmouth bass, walleye, channel catfish, bluegill, and black crappie. Lake Powell has been stocked with fish almost annually, beginning in 1963 (NPS, 1996).

Lake Powell is a popular fishing destination. Over three million people visit the GCNRA annually, and those that fish spend a total of close to two million angler hours in pursuit of a variety of sport fish.

Nearly all anglers fish by boat due to the cliff-like canyon walls of the reservoir. Shore angling is rare. Annual angler use, based on boat fishing, is estimated to average 72,608 days. The majority of anglers (42 percent) come from Utah, followed by Colorado (24 percent) and Arizona (23 percent). California and other states make up the remaining 11 percent (Gustaveson, 2000).

Currently, the catch rate is 0.3 fish per hour, a number that has declined in recent years due to angling pressure. Approximately one-half of the fish caught are harvested, which results in an average annual harvest of 300,000 fish (NPS, 1996). Fishing catch rates and harvest rates differ at Lake Powell due to changing public attitudes towards catch and release. Most anglers release smallmouth bass and harvest striped bass. In 1997, 86 percent of the smallmouth bass caught were returned, compared to only 28 percent of the 396,000 striped bass caught (Gustaveson, 2000).

Most Lake Powell anglers seek a fishing opportunity and would rather catch any fish, compared to a targeted individual species. However, when asked for a species preference, most anglers prefer to catch black bass or striped bass. Most anglers tend to target species they expect to catch most readily. (Gustaveson, 2000).

Recent studies have indicated a trend of increasing biocontaminant concentration in aquatic organisms near the dam. Selenium has been found in plankton and in striped bass. Although there have not yet been any apparent negative impacts on striped bass reproduction, selenium can pose a health risk to anglers from consumption. If the presence of selenium continues, educating the anglers and performing risk assessment studies may be necessary (NPS, 1996).

3.9.5.2.2 Sport Fishing in Lake Mead

Fishing is a favorite activity at Lake Mead. Largemouth bass, striped bass, channel catfish, rainbow trout, bullhead catfish, sunfish, crappie, and bluegill can be found in Lake Mead.

Lake Mead is famous for its striped bass, with an occasional catch weighing over 40 pounds, although weights of three to five pounds are more common. Angler survey results from NDOW indicate that since 1984, striped bass have been the species most sought after by anglers by a wide margin (62.7 percent) (NDOW, 2000). Fishing for striped bass or largemouth bass is good throughout the entire lake, but panfish and catfish are more prevalent in the upper Overton Arm.

The Nevada Division of Wildlife (NDOW) stocks rainbow trout from late December through the spring months. The razorback sucker, a protected fish species, must be returned to the water immediately and carefully, if caught. 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.

To fish from shore, a valid license is required from the state where the fishing occurs. If fishing from a boat or other flotation device, a use stamp from the other state is required. Rainbow trout fishing also requires an additional stamp. Children under 14 are not required to have a license.

The NDOW conducts annual creel and angler use surveys of Nevada licensed anglers (resident and non-resident). While Arizona licensed anglers also fish in Lake Mead, it is estimated that roughly 80 percent of the fishing use on the reservoir is represented in the NDOW surveys (Sjöberg, 2000). NDOW's annual statewide angler questionnaire is mailed out to 10 percent of all Nevada licensed anglers, resident and non-resident. Table 3.9-11 presents data from 10 years of questionnaires.

Table 3.9-11
Nevada Division of Wildlife Annual Angler Questionnaire Results for Lake Mead

Year	Anglers	Angler Days	Fish Harvest (all species)	Days per Angler	Fish per Angler	Fish per Angler Day
1989	44,444	476,543	940,608	10.72	21.16	1.97
1990	41,012	488,381	934,807	11.91	22.79	1.91
1991	47,873	792,883	1,532,481	16.56	32.01	1.93
1992	46,460	558,301	1,314,508	12.02	28.29	2.35
1993	46,649	697,117	1,699,816	14.94	36.44	2.44
1994	45,507	648,928	1,710,412	14.26	37.59	2.64
1995	47,630	574,972	1,590,413	12.07	33.39	2.77
1996	42,715	554,625	1,410,440	12.98	33.02	2.54
1997	43,747	505,892	1,239,840	11.56	28.34	2.45
1998	43,831	612,551	1,568,676	13.98	35.79	2.56
Average	44,987	591,019	1,394,200	13.10	30.88	2.36

Source: NDOW, Statewide Angler Questionnaire Database, 1989 through 1998, cover letter dated 5 October, 2000.

The Arizona Department of Game and Fish estimated the Arizona licensed angler use for Lake Mead (based on Nevada survey results) to be 118,422 days in 1995. Combined with Nevada's use estimate for the same year, there were 693,394 angler days on Lake Mead in 1995 (83 percent from Nevada, and 17 percent from Arizona).

3.9.5.2.3 Sport Fishing in Lake Mohave

This section discusses sport fishing in Lake Mohave, below Hoover Dam. Table 3.9-12 shows the developed access sites and facilities at Lake Mohave.

Table 3.9-12
Lake Mohave Developed Recreation Facilities

Facilities	Willow Beach	Cottonwood Cove	Katherine
Ranger Station	•	•	•
Lodging	N/A	•	•
Trailer Village (fee)	N/A	•	•
Campground	N/A	•	•
Marina	•	•	•
Food Service	•	•	•
Grocery/Gift Shop	•	•	•
Gasoline	•	•	•
Picnic Area	•	•	•
Shower (fee)	N/A	•	•
Trailer Sewage Dump	•	•	•
Boat Sewage Dump	•	•	•
Self-service laundry	N/A	•	•
Propane Service	•	•	•
Houseboat Rentals	N/A	•	•

Source: NPS, 1995.
• indicates presence of improvement
N/A indicates no improvement

In Lake Mohave there are largemouth bass, striped bass, channel catfish, rainbow trout, bullhead catfish, sunfish, crappie and bluegill. Because Lake Mohave is within the LMNRA, the same fishing rules and requirements described above for Lake Mead apply to Lake Mohave. NDOW stocks rainbow trout in the lake from late December through the spring months. The USFWS stocks rainbow trout throughout the year, with concentrated stocking October through May.

Three protected species, including razorback sucker, Colorado squawfish, and bonytail chub, are the last of the native Colorado River fish and can be found in Lake Mohave.

When caught, these fish must be released. 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.

Fishing on Lake Mohave can be exceptional. Bass and trout often run three pounds, with some trout weighing as much as 10 or more pounds. Anglers fish for big trout at Willow Beach, while Cottonwood Cove and Katherine Landing offer both bass and trout fishing. Within the last few years, striped bass fishing has become very popular.

The NDOW conducts annual creel surveys at Cottonwood Cove and Willow Beach. In 1998, angler use for Lake Mohave was estimated at 155,654 angler days, about the same as in 1997. The 1998 lake-wide harvest was estimated at 414,954 fish. Of the species caught, 80 percent were striped bass and 12 percent were rainbow trout. Other species included largemouth bass, channel catfish, and sunfish.

3.9.5.3 Environmental Consequences

3.9.5.3.1 Sport Fishing in Lake Powell, Lake Mead and Lake Mohave

Reduced reservoir surface elevations could affect recreational reservoir fishing by decreasing the number of fishing days and angler satisfaction. The lower pool elevations could cause temporary or permanent closure or relocation of shoreline facilities, thus requiring the boat angler to either travel to another launch site, fish from the bank, or possibly forego fishing that day. Also, navigational issues, such as the closure of areas of the reservoirs, could increase travel times to desired fishing locations and result in reduced angler satisfaction. Lower pool elevations may make some shoreline fishing areas inaccessible. In addition, as discussed in Section 3.9.3.2, as pool elevations lower, the surface area available for boats and safe boat capacity decreases. The boat angler may need to call ahead for reservoir conditions. Lake Mohave surface elevations will not be affected by any of the alternatives.

No direct information on angler success rates or angler satisfaction in relationship to reservoir pool elevations is available. Therefore, potential effects were determined indirectly through consideration of potential effects on sport fishery production and water access for boat and shore anglers. The effects of the alternatives on sports fishery production are discussed in detail in Section 3.7.4. The effects on boating access, including shoreline facilities that provide access to the water for boat angling and navigational constraints on boating, are discussed in Sections 3.9.2 and 3.9.3.

As discussed in Section 3.7.4, Sport Fisheries, potential reductions in surface elevations associated with the interim surplus criteria alternatives are not expected to affect sport fishery composition or quantities within the reservoirs. As such, angler success rates at Lake Powell and Lake Mead would not be reduced.

3.9.6 RECREATIONAL FACILITIES OPERATIONAL COSTS

In order to keep reservoir marinas, boat launching, public use beaches and shoreline access operational, facility owners/operators and agencies providing utility connections must respond to fluctuating pool elevations. This section focuses on the operational and capital costs of keeping recreational facilities in operation as reservoir surface elevations change.

Potential revenue effects from changes in recreation use are not considered. As discussed above, it is not expected that baseline conditions or interim surplus criteria would result in facility closures, as most facilities can be relocated to maintain operation at lower reservoir elevations.

3.9.6.1 METHODOLOGY

Information in the affected environment section was compiled after review of available published and unpublished sources and through personal communication with NPS specialists. Available data do not cover all facilities. Furthermore, the analysis is generally based on professional judgment, extrapolating from limited historical data. However, the analysis provides a useful approximation of the order of magnitude of costs to recreational facilities that may be incurred under projections for each of the alternatives.

Using data associated with facility relocation costs, projections of the costs associated with declines were made using results of the river system modeling discussed in Section 3.3. Calculations of potential costs use model projections associated with the 50 percent exceedence probability elevations for years 2002 through 2016. This simplified methodology addresses multi-year changes in elevation, and does not consider costs associated with facility adjustments to accommodate monthly fluctuations.

3.9.6.2 AFFECTED ENVIRONMENT

The following sections discuss costs associated with relocation of reservoir marinas and boat launching facilities at Lake Powell and Lake Mead. Many of the facilities at Lake Powell and Lake Mead were constructed when the reservoirs were near their maximum pool elevations of 3700 feet msl and 1210 feet msl, respectively.

3.9.6.2.1 Lake Powell

The costs of fluctuating pool elevations on Lake Powell marinas and boat-launching facilities were calculated by Combrink and Collins (1992). The study calculated operating costs for one-foot fluctuations (termed "normal adjustments") and for adjustments when the pool fluctuation exceeds 25 feet (termed "special adjustments"). The normal adjustments are adjustments made within the range of regular operations and are done routinely as water levels change during the year. Special adjustments include relocations of anchors and extensions of cables and utilities. The study found that major capital investments would be needed; cost estimates were developed based on a 50-foot decline in pool elevations.

Additional data for the Antelope Point Marina has been provided by the Navajo Nation and National Park Service. Construction drawings have been prepared to allow extension of the ramp from 3677 to 3620 feet msl, with a reported capital cost estimate of approximately $500,000 (Bishop, Personal Communication, 2000). This cost has been included in NPS planning for Antelope Point.

Table 3.9-13 presents the costs incurred per adjustment in the form that the data was collected. In order to use the data to compare different alternatives, it has been converted into a cost per foot of fluctuation. Data collected in 1989 has been updated to 2000 price levels.

Table 3.9-13
Costs Associated with Adjustments to Lake Powell Recreation Facilities

Adjustment Cost Category[1]	Cost per Adjustment		Cost per Foot
	1989 Price Level[2]	2000 Price Level[3]	
Operating Cost for a Normal Adjustment (based on one-foot fluctuation)	$1,275	$1,721	$1,721
Operating Cost for a Special Adjustment (fluctuations exceeding 25 feet)	$33,460	$45,171	$1,807
Capital Cost for each 50-foot drop	$2,000,000	$2,700,000	$54,000
Total Cost per Foot			**$57,528**
Additional Capital Cost for drop below 3677 water surface elevation[4]		$500,000	

[1]. Operating costs are the cost of adjusting the existing facilities for fluctuations and consist of labor hours. Capital costs consist of construction of ramp extensions, utility line extensions and relocations.
[2] Combrink and Collins (1992).
[3] Consumer Price Index-All Urban Consumers. 1989 average is 124.0. March 2000 is 167.8. Adjustment factor: 167.8/124.0 = 1.35
[4] Capital cost to extend the toe of the existing Antelope Point Marina from 3677 to 3620 feet msl (Bishop, Personal Communication, 2000).

Table 3.9-13 indicates there are costs associated with even minor changes in pool elevations. However, the cost of capital improvements required to extend utilities and access below the range of elevations that can be accommodated by existing infrastructure is much larger than the operating costs incurred within the capacity of the existing infrastructure.

It should be noted that many of the Lake Powell shoreline facilities were extended in 1992/93 to accommodate reduced Lake Powell surface elevation down to 3612 feet msl. Due to these extensions, the actual costs of relocating facilities in the event of future

Lake Powell surface elevation declines may be lower than those indicated in the analysis.

3.9.6.2.2 Lake Mead

NPS provided information on costs associated with relocation of facilities at Lake Mead. The operating levels range between full pool elevation (1210 feet msl) and 1180 feet msl. When Lake Mead declines to 1180 feet msl, adjustments need to be made to the major facilities. Costs to make these adjustments for each of the major facilities at year 2000 price levels range from $560,000 to $970,000. NPS has also determined that additional incremental drops of 20 feet in elevation will incur additional costs, ranging from $480,000 to $800,000 (Henderson, 2000).

Costs associated with fluctuating pool elevations are available for federally-owned facilities at LMNRA from unpublished data assembled by the Resource Management Office, Lake Mead NRA (Henderson, Burke and Vanderford, April 17 and 18, 2000). In addition, Overton Beach Marina (letter dated March 29, 2000) and Lake Mead Resort (letter dated April 11, 2000) provided information to Reclamation indicating the costs associated with fluctuating reservoir elevations. Table 3.9-14 presents these costs.

Table 3.9-14
Costs Incurred to Recreational Facilities from Lake Mead Pool Fluctuations
(Year 2000 Price Level)

Line No.	Fluctuation	Cost per Increment
1	Cost to LMNRA facilities of surface elevation occurrence below 1180 feet msl [1]	$ 6,011,000
2	Cost to LMNRA facilities at 1160 feet msl and at each additional 20-foot drop [1]	$ 5,080,000
3	Cost to Lake Mead Resort Marina from a 20-foot drop in elevation [2]	$ 91,400
4	Cost to Overton Beach Marina facilities from a fluctuation from 1212 feet msl to 1150 feet msl (62 feet) [3]	$ 60,000
5	Cost to Overton Beach Marina Facilities from a fluctuation from 1150 feet msl to 1130 feet msl (20 feet) [3]	$ 425,000
6	Cost to Temple Bar Resort from a 10-foot drop [4]	$ 12,500
7	Cost to Echo Bay Resort from a 20-foot drop from 1213 feet msl to 1193 feet msl [5]	$ 38,400

[1] Unpublished data from Lake Mead NRA.
[2] Letter dated April 11, 2000, from Lake Mead Resort to Reclamation. The letter quantifies cost for a drop from current pool elevations. It also notes that a drop below 1150 would, in the NPS's judgement, require abandonment of the basin within which the resort is located.
[3] Letter dated March 29, 2000, from Overton Beach Marina to Reclamation.
[4] Letter dated March 27, 2000, from Temple Bar Resort. Midpoint of range ($10,000 to $15,000) is used. Letter further notes that a drop below 1125 feet msl would require a complete relocation of the marina, including buildings located on land.
[5] Letter dated March 16, 2000, from Echo Bay Resort to Reclamation.

3.9.6.3 ENVIRONMENTAL CONSEQUENCES

3.9.6.3.1 Lake Powell

As discussed in the methodology section, an estimate can be made of the cost impacts of the alternatives on Lake Powell recreational facilities under some basic conditions. Estimates in this section are for aggregate relocation costs associated with all identified Lake Powell shoreline facilities.

Table 3.9-15 shows estimated incremental costs that would be incurred from Lake Powell surface elevation decreases associated with the median elevation projections for baseline conditions and each alternative from 2002 through 2016 (Figure 3.9-1 presents these elevations graphically). These impacts are based on a cost of $57,528 per foot change in elevation, developed based on the information shown in Table 3.9-12.

Table 3.9-15
Costs Associated with Potential Relocation of Lake Powell Recreational Facilities Under Alternatives Compared to Baseline Conditions[1]
(Year 2000 Price Level)

Alternative	Median Elevation in Year 2016 (feet msl)[2]	Elevation Below Baseline Conditions (feet)	Incremental Cost during 15-Year Period[3]
Baseline Conditions	3665	0	---------
Basin States Alternative	3664	1	$ 747,864
Flood Control Alternative	3665	0	$ 0
Six States Alternative	3664	1	$ 747,864
California Alternative	3660	5	$1,208,088
Shortage Protection Alternative	3659	6	$1,438,200

[1] Assumes pool elevation decreases constantly over time, following 50% probability of exceedence elevation.
[2] Based on 50 percent probability of exceedence elevation projected from modeling on July 31 of each year.
[3] Table 3.9-13. $57,528 per foot for each facility. No incremental cost is included for extending the ramp at the Antelope Point Marina..

By 2050, the median elevation of all alternatives is within a two-foot range (3662.5 to 3664.6) and the difference in costs is small.

3.9.6.3.2 Lake Mead

As discussed in the methodology section, an estimate can be made of the cost impact of the alternatives on Lake Mead recreational facilities using certain assumptions.

Table 3.9-16 shows estimated incremental costs that would be incurred from Lake Mead surface elevation decreases associated with the median elevation projections for each alternative as compared to baseline conditions from 2002 through 2016 (Figure 3.9-4 presents the median elevations graphically).

Table 3.9-16
Costs Associated with Potential Relocation of Lake Mead Recreational Facilities Under Alternatives Compared to Baseline Conditions[1]

Alternative	Elevation in Year 2016 (feet msl)[2]	Elevation Below Baseline Conditions	Incremental Cost during 15-Year Period
Baseline Conditions	1162	N/A	NA
Basin States Alternative	1143	19	$ 5,243,900[3]
Flood Control Alternative	1162	0	0
Six States Alternative	1146	16	$ 5,243,900[3]
California Alternative	1131	31	$ 10,348,900[4]
Shortage Protection Alternative	1130	32	$ 10,773,900[5]

1 Assumes pool elevation decreases constantly over time, following 50% probability of exceedence elevation.
2 Based on 50 percent probability of exceedence elevation on December 31 of each year projected from river system modeling.
3 Lines 2, 3, 4 and 6 from Table 3.9-14.
4 Two times Line 2, one times Line 3 and 4, and three times Line 6 from Table 3.9-14.
5 Two times Line 2, one times Lines 3, 4 and 5, and three times Line 6 from Table 3.9-14

By 2050, the median elevation under all alternatives is the same (1110.6 feet msl), and no differences in cost would occur.

3.10 ENERGY RESOURCES

3.10.1 INTRODUCTION

The analyses in this section consider two specific issues associated with energy resources. The first issue considered is potential changes in hydropower production from Hoover Dam and Glen Canyon Dam; the second is potential increases in energy requirements of the Southern Nevada Water System (SNWS) Lake Mead intake, Navajo Generating Station cooling water intake in Lake Powell and the City of Page potable water intake in Lake Powell.

3.10.2 HYDROPOWER

This section discusses potential changes in power production that could occur as a result of the interim surplus criteria under consideration. The analysis focuses on changes in production from Glen Canyon Dam and Hoover Dam for each alternative compared to baseline conditions.

3.10.2.1 METHODOLOGY

In order to determine the effects of the interim surplus criteria alternatives, the information produced from the river system modeling described in detail in Section 3.3 has been used. This model simulates operation of Glen Canyon and Hoover powerplants under baseline conditions and the interim surplus criteria alternatives. The output quantities of the model that are important in determining the effects of the alternatives on power generation are:

- Annual average Lake Powell Elevation;
- Annual average Glen Canyon Powerplant Energy Production;
- Annual average Lake Mead Elevation;
- Annual average Hoover Powerplant Energy Production;
- Annual average Lake Mohave Elevation (constant at an elevation of 647 feet msl throughout the period of analysis).

These quantities, derived from the model runs, are shown in Tables 1, 2, 5 and 7 in Attachment P. In addition, powerplant capability curves for Glen Canyon and Hoover powerplants showing powerplant capacity as a function of lake elevation (or net effective head) are required to determine how the capacity varies for each alternative throughout the study period. Powerplant capability curves used for the analysis are presented in Tables 3 and 4 in Attachment P.

Table 3 of Attachment P uses discharge multipliers to determine the maximum operable capacity of the Glen Canyon Powerplant. The maximum water release of 25,000 cfs (restricted except during power system emergencies) is divided by the discharge multiplier to calculate the capacity. Table 4, for Hoover Powerplant, uses the theoretical turbine curve data for heads from 560 feet to 590 feet. Below 560 feet of head, a ratio of 2062/2074 has been applied to the turbine curve data to reflect recent downratings of units A3, A4, and A8 as reported in a letter dated July 2000, from the Area Manager of Reclamation to Western.

As used herein, powerplant capacity refers to the load that a generator or facility can achieve at a given moment. Energy is a measure of electric capacity generated over time. Comparing the projected amount of powerplant generating capacity and energy production available under the various alternatives with baseline projections produces a probabilistic measure of the effects of the alternatives on power production if the assumptions contained in the forecasts covering water supply materialize.

The methodology for determination of the effects of the alternatives is to compare the change in capacity and energy production, on an annual basis, between baseline conditions and each alternative. Annual average generating capacity and energy available from Glen Canyon and Hoover powerplants was determined using the reservoir elevation and energy output quantities from system modeling discussed in Section 3.3, and the powerplant capability curves. Modeling of energy production is based on aggregate turbine production curves. Annual average capacity and energy production for baseline conditions and the alternatives are shown in Tables 5 and 7 in Attachment P. Annual average energy production is also shown in Figures 3.10-1 and 3.10-2. Comparisons of the annual average energy production associated with each alternative and the annual average energy production of baseline conditions are shown in Tables 6 and 8 in Attachment P.

3.10.2.2 AFFECTED ENVIRONMENT

The energy resources that could be affected by changes in Colorado River operation are Glen Canyon Powerplant and Hoover Powerplant electrical power output. The reservoirs behind these facilities are operated to store Colorado River water for delivery in the Lower Colorado River Basin below Glen Canyon Dam, and water to meet delivery obligations to Arizona, California, Nevada and Mexico downstream of Hoover Dam.

3.10.2.2.1 Factors of Power Production

In general, the two factors of a hydroelectric system, excluding machinery capability, that are directly related to power production are 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 water surface elevations of the forebay behind a dam and in the tailwater below the dam. The head determines the maximum capacity, measured in MW, that is available from the powerplant. The nameplate capacity of Glen Canyon Powerplant is 1296 MW. However, the maximum operating capacity of Glen Canyon Powerplant generators is approximately 1200 MW due to turbine restrictions (Western, 1998). Because the maximum allowable water release has been limited to 25,000 cfs, the maximum operable capacity for Glen Canyon is limited to 1048 MW, except during a power system emergency. The maximum operating capacity of Hoover Powerplant is 2074 MW. The net effective head on the powerplant is influenced by the reservoir surface elevations and operating strategies for both the upstream and downstream reservoirs.

The quantity of water flowing through the turbines (water releases) determines the amount of energy produced, measured in gigawatt-hours (GWh). The net energy generated during fiscal year 1998 from Glen Canyon Powerplant and Hoover Powerplant was 6626 GWh and 5768 GWh, respectively (Western, 1998 and Reclamation, 2000).

The turbines at a powerplant are designed to produce maximum efficiency at a design head. At design head, the plant 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 design head because of reduced forebay (upstream reservoir) elevation, the power output of the turbine is reduced, the electrical capacity of the generator attached to the turbine is reduced, and the efficiency of the turbine is 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 may become entrained in the water, and/or vortices may appear in the forebay.

3.10.2.2.2 Power Marketing and Customers

The effects of any surplus or deficit in power generation are incurred by the customers to whom the power from Glen Canyon and Hoover powerplants is allocated. The contracts for power from Glen Canyon Dam terminate in 2025. The contracts for power from Hoover Dam terminate in 2017. The identity of the recipients of power from these resources is not known for about two-thirds of the period of analysis for Hoover Dam and about one-half of the period of analysis for Glen Canyon Dam. Therefore, an analysis of the effects of the alternatives compared with those of baseline conditions will consider the general effects in the overall areas served by the resources, although a future group of power customers would be impacted similarly to current customers.

The states that would be affected by changes in energy and capacity at Glen Canyon and Hoover powerplants are Arizona, California, Nevada, Utah, Wyoming, New

Mexico and Colorado. These states make up the Rocky Mountain, Arizona-New Mexico-Southern Nevada, and California-Mexico areas of the Western Systems Coordinating Council (WSCC). Electrical energy produced in each of these areas is derived from a variety of sources. The power from Glen Canyon Powerplant and Hoover Powerplant contributes a small, but significant portion of the energy produced in these areas. The total generation capability of the areas as of January 1, 1999, is 86,348 MW. The generation capability of each WSCC area is:

- Rocky Mountain 10,584 MW
- Arizona-New Mexico-Southern Nevada 22,272 MW
- California-Mexico 53,492 MW

Glen Canyon and Hoover powerplants contribute approximately 3.6 percent of the total generating capability of these three areas of WSCC (WSCC, 1999). The maximum capacity available from Glen Canyon Powerplant at elevation 3700 feet msl has been restricted to approximately 1200 MW. However, as stated above, the maximum operable capacity at Glen Canyon Powerplant is limited to 1048 MW due to water release restrictions, except during power system emergencies. Therefore, for the purposes of this analysis, the operable capacities of Hoover and Glen Canyon powerplants are 2074 MW and 1048 MW, respectively, for a total of 3122 MW.

3.10.2.3 ENVIRONMENTAL CONSEQUENCES

The environmental consequences of a change in river operations that impacts power production can be measured by the increase or decrease in capacity and energy available from the powerplants. The power production under the alternatives is compared with power production under baseline conditions to determine the incremental effects of each alternative, using annual average modeled reservoir levels and downstream releases. Reductions in capacity, energy, and generation ancillary services from Glen Canyon and Hoover powerplants under baseline conditions would ultimately need to be replaced by either types of generation. Additional incremental reductions under each alternative would also ultimately need to be replaced.

The replacement of Glen Canyon and Hoover powerplant generation could be accomplished through a number of different strategies. If capacity loss can be expected for long periods of time, construction of new generation would likely occur. If capacity loss is intermittent throughout the period of analysis, purchases from the short-term market would be expected. If energy loss can be expected for a long period of time, either construction of new generation or operation of higher-cost generation for longer periods of time during the day would be expected. If energy loss is intermittent throughout the period of analysis, replacement from the short-term market would be anticipated.

3.10.2.3.1 Baseline Conditions

3.10.2.3.1.1 Glen Canyon Dam

The annual average capacity and energy production at Glen Canyon Dam under baseline projections are shown in Table 5 in Attachment P; the annual average energy production is shown in Figure 3.10-1. The powerplant capacity begins at 1020 MW in 2002 and is reduced to 960 MW in 2016 because of reductions in lake elevation. Subsequently, the capacity increases to 990 MW in 2041, then decreases to 975 MW in 2050. From 2002 through 2016, the greatest annual decrease in capacity is 13 MW between 2012 and 2013. The annual reduction throughout the early years is from two to six MW, representing less than a one percent decline in capacity from the powerplant per year. The output varies cyclically between 2017 and 2050, with annual increases or decreases in capacity of two to six MW.

Under baseline conditions, the energy available from Glen Canyon Dam averages 4532 GWh from 2002 through 2016, and 4086 GWh through the rest of the period of analysis. Energy production increases the first year of the study. Thereafter, annual reductions in energy production are generally less than 50 GWh per year through 2016. Annual reductions in energy from 2017 through 2050 are generally less than 40 GWh.

3.10.2.3.1.2 Hoover Dam

The annual capacity and energy production at Hoover Powerplant under baseline conditions are shown in Table 7 of Attachment P; the annual average energy production is shown in Figure 3.10-2. The powerplant capacity begins at 2062 MW in 2002 and is reduced to 2033 MW in 2016 because of reductions in lake elevation. Capacity decreases to 1865 MW in the year 2050. From 2002 through 2016, the greatest annual decrease in capacity is nine MW. This reduction represents less than a one percent per year decline in capacity from the powerplant through 2016. From 2017 through the remainder of the period of analysis, the annual capacity reductions are generally less than 10 MW.

The energy available from Hoover Powerplant averages 4685 GWh from 2002 through 2016, and 3903 GWh through the rest of the period of analysis. Energy production increases during the first three years of the period of analysis, with annual reductions from 2004 through 2016 of generally less than 50 GWh. Annual reductions in energy from 2017 through 2050 are predominantly less than 60 GWh.

Figure 3.10-1
Glen Canyon Powerplant
Annual Average Energy Production

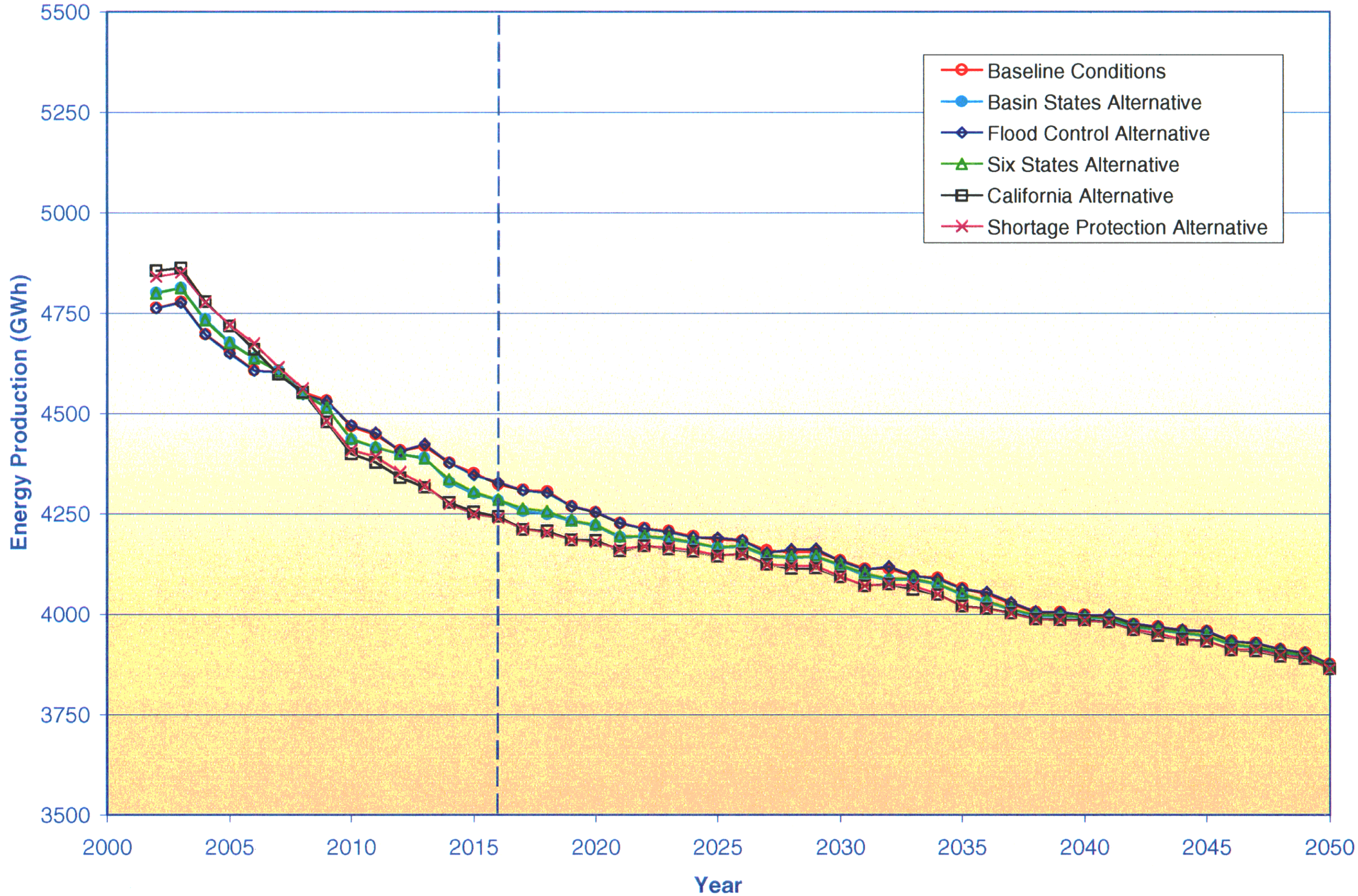
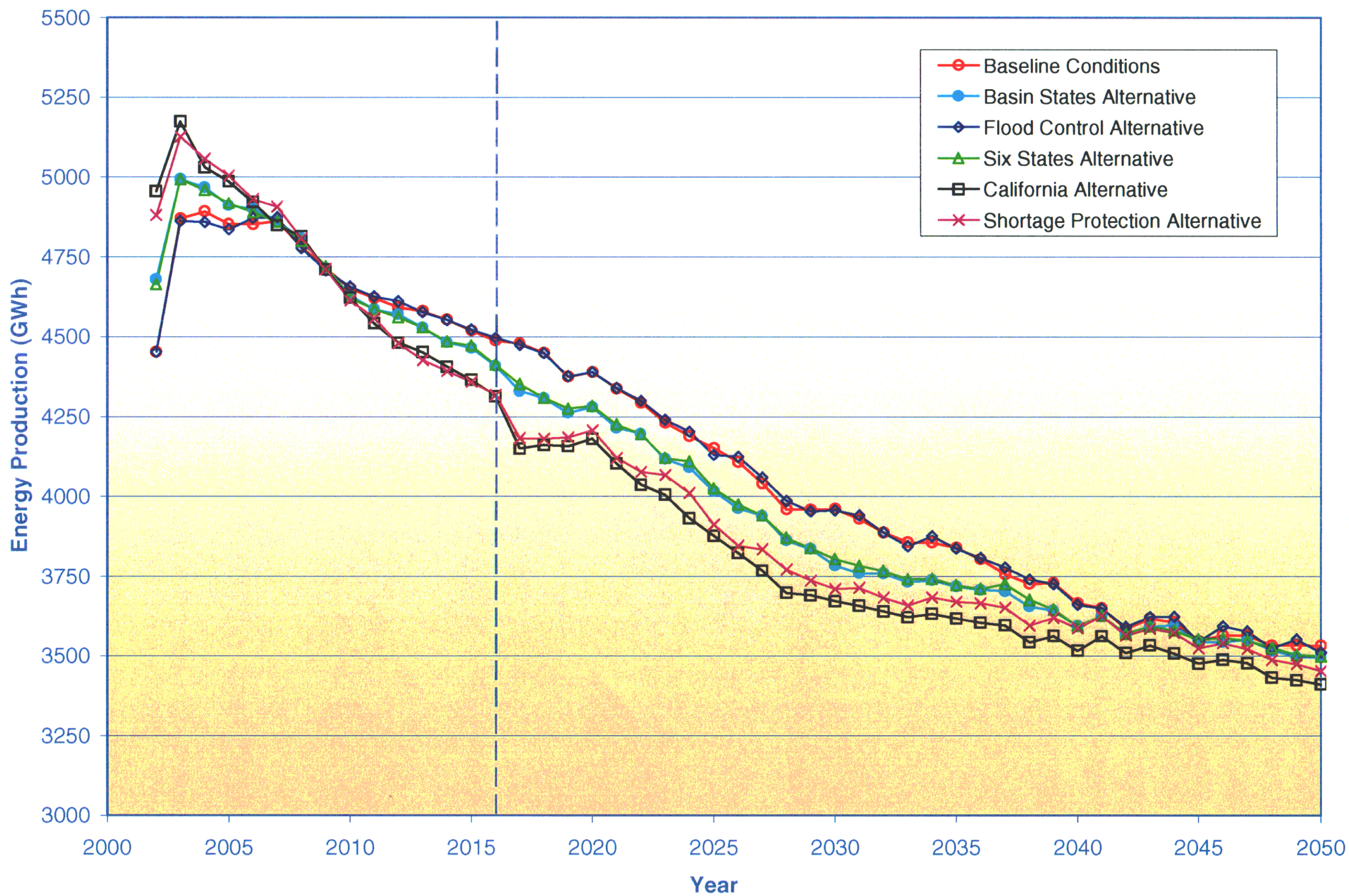


Figure 3.10-2
Hoover Powerplant
Annual Average Energy Production



3.10.2.3.1.3 Combined Capacity and Energy Reduction Under Baseline Conditions

The combined capacity reduction from Glen Canyon and Hoover powerplants through 2016 is 89 MW under baseline conditions. The combined energy production in 2016 is 403 GWh less than year 2002 energy production. In 2050, the capacity reduction is 242 MW less than 2002 levels, and the energy available is reduced 1807 GWh from year 2002 production. Under baseline conditions, power customers can expect a reduction in production from present levels in the future. Because of the gradual withdrawal over time, the deficit is expected to be replaced by short-term purchases made by either the power customers or Western, at the power customer's option, in accordance with contract terms.

3.10.2.3.2 Basin States Alternative

3.10.2.3.2.1 Glen Canyon Dam

The average capacity available from Glen Canyon Powerplant under the Basin States Alternative is shown in Table 5 of Attachment P. The powerplant capacity begins at 1014 MW in 2002 and is reduced to 960 MW in 2016. The capacity varies two to four MW each year until 2050, at which time powerplant capacity is at 975 MW. The average annual capacity available through the period of analysis is 987 MW.

The annual energy available averages 4527 GWh in the early years through 2016, and 4209 GWh throughout the period of analysis. Annual energy production in 2050 is 3875 GWh.

3.10.2.3.2.2 Hoover Dam

The average capacity available from Hoover Powerplant is shown in Table 7 of Attachment P. The powerplant capacity begins at 2061 MW in 2002 and is reduced to 1971 MW in 2016. The capacity either increases or decreases in consecutive years by up to 44 MW, with the capacity in 2050 being 1865 MW. The average capacity available throughout the period of analysis is 1935 MW.

The average annual energy available is 4701 GWh through 2016, and 4087 GWh throughout the period of analysis. Annual energy production in 2050 is 3496 GWh.

3.10.2.3.3 Flood Control Alternative

3.10.2.3.3.1 Glen Canyon Dam

The average capacity and energy available from Glen Canyon Powerplant under the Flood Control Alternative are shown in Table 5 of Attachment P. The powerplant capacity begins at 1020 MW in 2002 and is reduced to 962 MW in 2016. The decline continues to 975 MW in the year 2050. From 2002 through 2016, the greatest annual decrease in capacity is 12 MW. This reduction represents less than a one percent average decline in powerplant capacity per year through 2016. The capacity either increases or decreases in consecutive years through the remainder of the period of analysis. Capacity changes from the period 2016 through 2050 are predominantly in the two to six MW range each year, either increasing or decreasing.

Annual energy production from Glen Canyon averages 4532 GWh in the early years through 2016 and averages 4223 GWh throughout the period of analysis. Annual energy production in 2050 is 3875 GWh.

3.10.2.3.3.2 Hoover Dam

The annual capacity and energy available from Hoover Powerplant under the Flood Control Alternative are shown in Table 7 of Attachment P. The powerplant capacity begins at 2062 MW in 2002 and is reduced to 2033 MW in 2016. Powerplant capacity continues on a declining trend, until the capacity reaches 1865 MW in 2050. The greatest declines in the period from 2002 through 2016 are five and 13 MW, with the annual decline in capacity being predominantly one to two MW.

Under the Flood Control Alternative, the annual energy available from Hoover Powerplant averages 4686 GWh during the period 2002 through 2016. The average for the period from 2017 through 2050 is 3908 GWh. The average for the entire study period is 4146 GWh.

3.10.2.3.4 Six States Alternative

3.10.2.3.4.1 Glen Canyon Dam

The capacity available from Glen Canyon Powerplant under the Six States Alternative begins at 1014 MW in 2002 and decreases to 960 MW in 2016. The capacity then follows a generally increasing trend through 2043, after which annual reductions lead to a capacity of 975 MW in 2050. The capacity available averages 980 MW throughout the period of analysis. Annual changes of between two and five MW are predominant in the Six States Alternative.

The annual energy production averages 4527 GWh through 2016, and 4211 GWh throughout the period of analysis. Annual energy reductions throughout the period of analysis are predominantly less than 50 GWh.

3.10.2.3.4.2 Hoover Dam

The capacity available from Hoover Powerplant under the Six States Alternative begins at 2061 MW in 2002 and decreases to 2005 MW in 2016. The capacity then follows a decreasing trend until the output reaches 1865 MW in 2050. The predominant annual capacity reductions throughout the study period are less than 10 MW.

The average annual energy production is 4698 GWh through 2016. The average annual energy production throughout the period of analysis is 4091 GWh. Annual energy production reductions in successive years are predominantly less than 50 GWh.

3.10.2.3.5 California Alternative

3.10.2.3.5.1 Glen Canyon Dam

The capacity available from Glen Canyon Powerplant under the California Alternative begins at 1007 MW in year 2002, and is reduced to 958 MW in 2016. The capacity follows a generally increasing trend from 2016 through the end of the period of analysis. In 2050, the capacity is 975 MW. Annual changes in plant capacity are generally between two and five megawatts.

Energy production at Glen Canyon averages 4516 GWh through 2016, and 4193 GWh throughout the entire period of analysis. Annual changes in energy production are generally less than 30 GWh.

3.10.2.3.5.2 Hoover Dam

The capacity available from Hoover Powerplant under the California Alternative begins at 2061 MW in year 2002, and is reduced to 1907 MW in 2016. The capacity follows a generally downward trend from 2016 through the end of the period of analysis. In 2050, the capacity of Hoover is 1867 MW. Annual changes in plant capacity are generally less than 10 megawatts.

Annual energy production at Hoover averages 4709 GWh through 2016, and 4016 GWh throughout the period of analysis. Annual changes in energy production are predominantly less than 20 GWh.

3.10.2.3.6 Shortage Protection Alternative

3.10.2.3.6.1 Glen Canyon Dam

The capacity available from Glen Canyon Powerplant under the Shortage Protection Alternative begins at 1009 MW in 2002 and is reduced to 958 MW in the year 2016. The capacity generally increases to 988 MW in the early 2040s, then is reduced to 975 MW in the year 2050. Annual capacity variations are generally from two to six megawatts.

Energy production averages 4518 GWh through 2016, and 4193 GWh throughout the entire study period. Annual energy production variations are generally less than 30 GWh.

3.10.2.3.6.2 Hoover Dam

The capacity available from Hoover Powerplant under the Shortage Protection Alternative begins at 2061 MW in 2002 and is reduced to 1904 MW in 2016. The capacity follows a generally decreasing trend from 2016 through 2050, when the capacity reaches 1865 MW. Annual capacity reductions are predominantly in the two to five megawatt range.

Annual energy production averages 4733 GWh from the beginning of the period of analysis to 2016, and 4047 GWh throughout the entire period of analysis. Annual variation throughout the period of analysis is generally less than 100 GWh.

3.10.2.4 COMPARISON OF ALTERNATIVES

As discussed above, the amounts of capacity and energy available as a result of each alternative operating strategy vary on an annual basis. The important measurement of the effects of each alternative is their comparison with the baseline conditions. As indicated, the resources available from Glen Canyon and Hoover powerplants can be expected to be reduced over time, due primarily to increased depletions in the Upper Basin states. This effect is included in model runs for baseline conditions.

Table 3.10-1 summarizes the differences between hydropower capacity and energy generation under each alternative and under baseline conditions. Values under the Flood Control Alternative are typically slightly greater than under baseline conditions. Values under the California and Shortage Protection Alternatives are the furthest from baseline conditions, while values under the Six States and Basin States alternatives are closer to baseline conditions.

The capacity and energy differences (reductions) between each alternative and baseline conditions would be replaced by power available from the market. The greatest single-year difference in energy generation at Glen Canyon Powerplant under any of the alternatives as compared to baseline conditions is 102 GWh, under the California and Shortage Protection Alternatives (see Table 6 of Attachment P) or about 2.5 percent of the modeled average annual generation of Glen Canyon. The effects of interim surplus alternatives are greater at Hoover Powerplant. The greatest single-year difference in annual energy generation under any of the alternatives as compared to baseline conditions is 328 GWh under the California Alternative (see Table 8 of Attachment P), or about eight percent of the modeled average annual energy generation. The average annual generation during the period of analysis under the Preferred (Basin States) Alternative is 0.8 percent (0.3 percent at Glen Canyon and 1.3 percent at Hoover) less than under baseline conditions. The quantities of capacity needed to replace reductions, while not significant when compared to the total capacity installed in the three WSCC regions, may be significant to the entity losing the capacity.

Table 3.10-1
Hydropower Capacity and Energy – Comparison of Alternatives to Baseline Conditions[1]
(Difference between baseline conditions and each alternative[2])

Alternative	2002 – 2016 Average Annual Capacity (MW)	2002 – 2016 Average Annual Energy (GWh)	2017 – 2050 Average Annual Capacity (MW)	2017 – 2050 Average Annual Energy (GWh)	2002 – 2050 Average Annual Capacity (MW)	2002 – 2050 Average Annual Energy (GWh)
Glen Canyon Powerplant						
Basin States Alternative	-10	-5	-1	-16	-4	-13
Flood Control Alternative	0	0	0	1	0	1
Six States Alternative	-10	-5	-1	-15	-4	-12
California Alternative	-21	-16	-1	-35	-8	-30
Shortage Protection Alternative	-21	-14	-1	-36	-7	-29
Hoover Powerplant						
Basin States Alternative	-14	15	-14	-87	-14	-56
Flood Control Alternative	1	0	1	5	1	3
Six States Alternative	-11	13	-12	-80	-12	-51
California Alternative	-47	24	-23	-193	-30	-127
Shortage Protection Alternative	-45	20	-20	-147	-28	-96
Total						
Basin States Alternative	-24	10	-15	-103	-18	-69
Flood Control Alternative	1	0	1	6	1	4
Six States Alternative	-21	8	-13	-95	-16	-63
California Alternative	-68	8	-24	-228	-38	-157
Shortage Protection Alternative	-66	6	-21	-183	-35	-125

[1] Appendix P, Tables 8 and 10 compare each alternative to baseline conditions.
[2] Positive (negative) value indicates that cost is higher (lower) under the alternative.

At Glen Canyon, the greatest single-year difference in capacity compared to baseline conditions is 36 MW under the Shortage Protection Alternative (see Table 6 of Attachment P). This amount represents a decrease of 3.5 percent from baseline conditions and approximately 0.3 percent of the installed capacity in the Rocky Mountain Area. At Hoover, the greatest single-year difference in capacity compared to baseline conditions is 137 MW under the California Alternative (see Table 8 of Attachment P). This amount represents a decrease of 6.7 percent from baseline conditions and about 0.2 percent of the installed capacity in the three-state marketing area for Hoover.

Additional water releases resulting from four of the five alternatives (all but the Flood Control Alternative) under consideration will increase the energy available from the powerplants during the first two to seven years of the interim period. This can be expected to reduce energy purchases by the customers from alternate, higher priced resources. Future reductions in power production can be expected to necessitate increased purchases of capacity to meet peak loads and reserves. Purchases of replacement power by power customers would result in changes in costs and increased exposure to market volatility.

3.10.3 SOUTHERN NEVADA WATER SYSTEM LAKE MEAD INTAKE ENERGY REQUIREMENTS

This section discusses potential increases in operating costs of the SNWS Lake Mead intakes that could occur as a result of implementation of the interim surplus criteria alternatives. Increased pumping costs could occur if the alternatives cause lower Lake Mead water surface elevations than baseline conditions.

3.10.3.1 METHODOLOGY

River system modeling, described in detail in Section 3.3, provided the average monthly elevation of Lake Mead for each year during the study period for baseline conditions and each of the alternatives. These elevations are shown in Table 2 of Attachment P. Increases or decreases in net effective pumping head correspond to decreases or increases in Lake Mead Surface elevations. The net effective pumping head differences between the baseline and the alternative strategies are also shown in Table 2 of Attachment P. Using an estimate prepared by SNWA (Johnson, 2000) for incremental pumping costs of $28,000 per year associated with each foot of increased pumping head, the increased cost of each alternative is shown in Table 2 of Attachment P.

3.10.3.2 AFFECTED ENVIRONMENT

The State of Nevada, through the SNWA, diverts most of its allocation of Colorado River water from Lake Mead through the SNWS into the Las Vegas Valley and adjacent areas. The power-consuming features of this system are the pumping plants from Lake Mead to the water treatment facility. The energy required to provide this lift is a function of the net difference in elevation between the Lake Mead water surface and the water treatment facility. Any increase in the net effective pumping head would increase the amount of energy required to pump each acre-foot of water from Lake Mead. The net effective pumping head will increase as the Lake Mead elevation falls. Water users in Clark County, Nevada and possibly others would absorb increased costs associated with water supply.

3.10.3.3 ENVIRONMENTAL CONSEQUENCES

The difference in net effective pumping head between each alternative and baseline projections is used to determine the effects of each alternative on pumping cost. The following analysis uses the estimate of $28,000 per year per foot increase in net effective pumping head furnished in the aforementioned letter. Baseline pumping costs were not calculated.

3.10.3.3.1 Baseline Conditions and Alternatives

Under baseline conditions, the average elevation of Lake Mead declines from 2002 through 2050. These results indicate that under baseline conditions and each of the alternatives, SNWA can expect pumping costs to increase due to the increase in net effective pumping head. Table 3.10-2 summarizes potential differences between pumping costs under the alternatives and baseline conditions.

Table 3.10-2
Southern Nevada Water System Lake Mead Intake Energy Requirements
Average Annual Power Cost – Comparison of Alternatives to Baseline Conditions[1]
(Differences between baseline conditions and each alternative)

Alternative	2002-2016	2017 - 2050	2002 - 2050
Basin States Alternative	$ 229,395	$ 94,352	$ 135,691
Flood Control Alternative	$ -32,685	$ -21,025	$ -24,594
Six States Alternative	$ 214,779	$ 88,027	$ 126,829
California Alternative	$ 544,843	$ 205,652	$ 309,486
Shortage Protection Alternative	$ 532,635	$ 170,314	$ 281,229

[1] $28,000/per year per foot increase in net effective pumping head at year 2000 price level
[2] Positive (negative) value indicates that cost is higher (lower) under the alternative.

The Flood Control Alternative, when compared to baseline conditions, results in reduced costs for SNWA to pump Colorado River water into its system. The Basin States and Six States alternatives result in average pumping cost increases of about $130,000 per year over the entire period of analysis. The California Alternative and the Shortage Protection Alternative result in average pumping cost increases of about $300,000 per year over the entire period of analysis.

3.10.4 INTAKE ENERGY REQUIREMENTS AT LAKE POWELL

This section discusses potential changes in pumping costs for two entities that pump water from Lake Powell: the Navajo Generating Station which obtains cooling water from Lake Powell, and the City of Page which obtains municipal water from Lake Powell. Incremental differences in pumping costs are associated with differences in modeled average Lake Powell surface elevations between baseline conditions and alternatives.

3.10.4.1 METHODOLOGY

River system modeling, described in detail in Section 3.3, provided the average elevation of Lake Powell for each year during the study period for baseline conditions and for each of the alternatives. Increases or decreases in net effective pumping head correspond with decreases or increases in Lake Powell surface elevations. Lake Powell elevations and the net effective pumping head differences between baseline conditions and the alternatives are shown in Table 1 of Attachment P. Estimates of the differences in pumping costs were calculated using these changes in pumping head, as well as estimates of annual water use, unit energy costs and pump efficiency.

The formula for calculating energy requirements (E) as a function of pump lift (H) is:

$$E = V * 1.024 * (H/e)$$

Where V is the volume of water pumped and e is pump efficiency.

3.10.4.2 Affected Environment

The Navajo Generating Station is a 2250 MW, coal-powered plant jointly owned by Reclamation, Salt River Project, Los Angeles Department of Water and Power, Arizona Public Service Company, Nevada Power and Tucson Electric Power. The Salt River Project (SRP) operates the plant. The SRP projects that water use will be approximately 29,000 afy in the future. Power for the intake pumps is obtained from auxiliary power units at the Generating Station at a cost of $0.0104 per kWh. Pump efficiency is estimated by SRP at 75 percent. (Weeks, 2000)

The City of Page provides municipal water to approximately 7800 residents from Lake Powell. The intake pump station is operated by Reclamation using power produced at the Glen Canyon Power Plant. Municipal water use in Page is dominated by residential use with substantial residential landscape irrigation. A negligible amount of treated water is delivered by the city to Reclamation for use at the dam. Presuming 275 gallons per day per resident, annual use would be approximately 2400 afy. An overall efficiency of 75 percent for the pump station was used as a reasonable estimate. A cost of $0.03 per kWh was estimated as the cost of the electricity.

3.10.4.3 Environmental Consequences

The difference in net effective pumping head between each alternative and baseline projections was used to determine the effects of each alternative on pumping cost. Baseline pumping costs were not calculated.

Under baseline projections, the average elevation of Lake Powell declines from elevation 3685 feet msl in year 2002 to elevation 3661 feet msl in year 2050 (Appendix P, Table 1). Table 3.10-3 compares the annual power costs of each alternative to baseline conditions.

As Lake Powell water elevations are within hundredths of a foot for baseline conditions and for the Flood Control Alternative, no change in pumping costs would occur. For all other alternatives, Lake Powell water elevations average less than under baseline conditions. Average pumping costs would be higher for both the Navajo Generating Station (average increase of $808 per year over the period of analysis for the Basin States Alternative) and for the Reclamation-operated raw water intake serving the City of Page. (Average increase of $193 per year over the period of analysis for the Basin States Alternative).

Table 3.10-3
Intake Energy Requirements at Lake Powell
Average Annual Power Cost – Comparison of Alternatives to Baseline Conditions (Difference between baseline conditions and each alternative)

Alternative	2002–2016	2017–2050	2002–2050
Navajo Generating Station Intake Energy Requirements[1]			
Basin States	$ 2,216	$ 186	$ 808
Flood Control	0	0	0
Six States	2,129	172	771
California	4,651	303	1,634
Shortage Protection	4,660	312	1,643
City of Page Municipal Water Supply[2]			
Basin States	$ 529	$ 44	$ 193
Flood Control	0	0	0
Six States	508	41	184
California	1,110	72	390
Shortage Protection	1,112	74	392

[1] E(kWh) = 1.024 * 29,000 * (H/0.75). Cost = E(kWh) * $ 0.0104
[2] E(kWh) = 1.024 * 2,400 * (H/0.75). Cost = E(kWh) * $ 0.03
Estimates are annual averages for the indicated time periods.

3.11 AIR QUALITY

3.11.1 INTRODUCTION

Adoption of interim surplus criteria would not involve new construction or physical activities that would result in air emissions within the area of potential effect considered in this FEIS. Air quality effects discussed in this FEIS are limited to changes in fugitive dust emissions that could result from changes in exposed reservoir shoreline as a result of potential changes in Lake Mead and Lake Powell water surface elevations.

3.11.2 FUGITIVE DUST FROM EXPOSED SHORELINE

This air quality analysis provides an overview of ambient air quality in the project area, as well as a qualitative review of the potential changes in fugitive dust emissions associated with the project alternatives when compared to fugitive dust emissions that may occur under baseline projections.

3.11.2.1 METHODOLOGY

Variations in fugitive dust emissions can result from changes in the area of exposed shoreline due to changes in water operating levels. The amounts of fugitive dust generated per acre of exposed shoreline vary depending upon soil characteristics and other factors such as moisture content, wind speed, direction, and local topography. In developing a methodology for reviewing fugitive dust emission potential from exposed shoreline around Lake Powell and Lake Mead, the following assumptions were made:

- The incremental changes in exposed shoreline area are related to incremental changes in water surface elevation as indicated by existing reservoir area - elevation data. However, the true area of exposed shoreline terrain is also affected by the slope of the terrain along the shoreline. To account for sloping terrain, an average shoreline slope of 30 degrees and 45 degrees from horizontal was assumed for Lake Mead and Lake Powell, respectively.

- Incremental changes in fugitive dust emissions are directly proportional to the changes in exposed shoreline area. Although some portions of exposed area would have varying potential to generate fugitive dust, it is assumed that these areas are distributed proportionally throughout the potential range of reservoir surface elevations. Therefore, exposed areas were assumed to have a similar emission rate for a given amount of exposed shoreline. It should be noted, however, that estimated fugitive dust emissions were not calculated for this analysis, and it is likely that certain areas of the exposed shoreline would be expected to have higher emission rate factors than others. For example, delta areas with high amounts of fine sediment deposit would be a more likely source of fugitive dust generation than more compact or rocky soils at other exposed locations.

Based on these assumptions and using modeling results associated with projected median surface elevations for Lake Powell and Lake Mead, potential changes in shoreline exposure under baseline conditions and the interim surplus criteria alternatives were identified.

3.11.2.2 AFFECTED ENVIRONMENT

Ambient conditions in the Las Vegas (Lake Mead) area are characterized by low annual precipitation and generally light winds. Windrose data for the Las Vegas area for the period 1992 through 1996 indicate the predominant wind directions to be from the west, southwest, and south (i.e., away, rather than toward the Las Vegas metropolitan area) throughout the year. Wind speeds are less than five miles per hour (mph) for approximately 25 percent of the year and greater than 25 mph for less than one percent of the year. The average wind speed is approximately nine mph. Ambient conditions are similar for the Lake Powell area. Windrose data for Page, Arizona for the period 1992 through 1996 indicates there is no predominant wind direction. Rather, wind direction is somewhat evenly distributed, with the exception of winds from the southeast occurring less frequently. Wind speeds are less than five mph for more than 65 percent of the year and greater than 20 mph for less than one percent of the year. The average wind speed is less than five mph.

Lake Mead is located on the Nevada (Clark County)/Arizona (Mohave County) border. Air quality regulations, including implementation of the federal Clean Air Act, in the Lake Mead area are administered by the Clark County Air Pollution Control Division (Nevada) and the Arizona Department of Environmental Quality (ADEQ). Air quality regulations in the Lake Powell area, which is located on the Arizona/Utah border, are administered by the ADEQ and the Utah Department of Environmental Quality, Division of Air Quality.

Pursuant to the federal Clean Air Act, as amended in 1990, the EPA has established National Ambient Air Quality Standards (NAAQS) for a number of air pollutants, which are considered harmful to public health or the environment. There are two types of NAAQS, primary and secondary. Primary standards are designed to set limits for the protection of public health, including the health of sensitive populations (receptors) such as asthmatics, children and the elderly. Secondary standards are designed for the protection of the public welfare, including visibility as well as damage to animals, crops, vegetation and buildings. The EPA has established annual average and 24-hour average NAAQS for particulate matter of less than 10 microns in diameter (PM_{10}) and particulate matter of less than 2.5 microns in diameter ($PM_{2.5}$). Although the PM_{10} standards have been in effect for some time, the $PM_{2.5}$ standards are more recent (1997). Because development of baseline data for the latter is an ongoing effort and final implementation of the $PM_{2.5}$ standards may not occur for years, the discussion of fugitive dust emissions focuses on PM_{10}, which are more commonly understood and encompass $PM_{2.5}$ emissions in any event.

Fugitive dust emissions such as those from exposed reservoir shorelines can contribute to PM_{10} concentrations. To the extent that exposed shoreline is characterized by relatively fine or light soils, fugitive dust emissions can result. However, given the apparent nature of the reservoir shorelines (more gravel surface than soil) and the relatively low average winds in the reservoir areas, soil materials from exposed shoreline areas do not appear to result in significant fugitive dust emissions.

Another possible source of particulate emissions is from the deposition of dried plant material left along the shoreline as the water level recedes. Given the nature of the lakes' bottom compositions and the relatively slow rate of reservoir water level decreases, it is unlikely that this type of emissions source would be significant. The lakes do not appear to contain high levels of algae, and the water levels are projected to decline by a few feet per year (relative to baseline conditions). At this rate, algae or other forms of plant matter would be likely to recede with the water rather than be deposited along the shoreline.

Particulate emissions in the Lake Mead and Lake Powell areas do not appear to be a significant problem. While some urban areas (including Las Vegas, North Las Vegas and Henderson) within Clark County are not in attainment of the NAAQS for PM_{10}, the rest of the county, including Lake Mead, is in attainment of the standard. The portion of Mohave County adjacent to Lake Mead is also in attainment of the PM_{10} standard. The northern central Arizona and southern Utah area, including Lake Powell, is also in attainment of the PM_{10} standard. This attainment status corresponds with windrose information for both areas (i.e., relatively low average wind speeds implying low wind blown dust emissions on average) and the relatively low levels of dust generated from human activities.

Since both lake areas are used primarily for recreational purposes, there are limited sensitive receptor population concentrations such as asthmatics, children or elderly living in these areas.

3.11.2.3 Environmental Consequences

Based on modeled median surface elevations, baseline conditions will likely result in decreased reservoir water levels and increases in exposed shoreline for both Lake Mead and Lake Powell over the period of analysis. Median elevations under each of the alternatives indicate a similar potential for increased shoreline exposure over time. Tables 3.11-1 and 3.11-2 indicate Lake Mead and Lake Powell median surface elevations identified through modeling (described in Section 3.3), as well as reservoir surface area and exposed shoreline (based on shoreline slope estimates discussed in Section 3.11.2.1) associated with these elevations. The greatest difference in exposed shoreline between baseline conditions and each of the alternatives would generally occur in the first half of the modeled period, as indicated under years 2016 and 2026 in Tables 3.11 and 3.11-2. By year 2036, there are relatively minor variations in exposed shoreline associated with the median elevations under the alternatives as compared with baseline projections.

Specifically, modeling results indicate an increased potential for fugitive dust emissions under the Basin States, Six States, California and Shortage Protection alternatives when compared with baseline projections throughout the initial, approximately 35 to 40 years of the projections, with the greatest differences in shoreline exposure potential occurring at or near the end of the interim period, in the year 2016. The Flood Control Alternative would have a slightly decreased potential for fugitive dust emission over the entire period of analysis when compared with baseline conditions.

Table 3.11-1
Median Lake Mead Surface Elevation, Surface Area and Exposed Shoreline Area Under Baseline Conditions and Alternative Projections

Scenario	Surface Elevation[1] (feet msl)				Reservoir Surface Area (acres x1000)				Exposed Shoreline Area[2] (acres x1000)			
	2016	2026	2036	2050	2016	2026	2036	2050	2016	2026	2036	2050
Baseline Conditions	1162	1126	1121	1111	120.2	99.8	97.6	93.6	42.3	65.9	68.4	73.0
Basin States Alternative	1143	1125	1120	1111	108.1	99.3	97.4	93.6	56.3	66.4	68.6	73.0
Flood Control Alternative	1162	1128	1119	1111	120.2	100.7	96.8	93.6	42.3	64.8	69.3	73.0
Six States Alternative	1145.5	1124.7	1120.4	1110.6	109.4	99.3	97.5	93.6	54.8	66.4	68.5	73.0
California Alternative	1131.2	1116.4	1117.6	1110.6	102.1	95.9	96.3	93.6	63.2	70.4	69.9	73.0
Shortage Protection Alternative	1130.2	1117.9	1117.6	1110.6	101.7	96.5	96.3	93.6	63.7	69.7	69.9	73.0

[1] Based on modeled median reservoir surface elevations.
[2] Area of exposed shoreline represents the area that would be exposed below the full pool elevation of Lake Mead for the various water surface elevations indicated, assuming an average shoreline slope of 30 degrees. Lake Mead's water surface area is 156,845 acres at water surface elevation of 1219.6 feet msl.

Table 3.11-2
Median Lake Powell Surface Elevation, Surface Area and Exposed Shoreline Area Under Baseline Conditions and Alternative Projections

Scenario	Surface Elevation[1] (feet msl)				Reservoir Surface Area (acres x1000)				Exposed Shoreline Area[2] (acres x1000)			
	2016	2026	2036	2050	2016	2026	2036	2050	2016	2026	2036	2050
Baseline Conditions	3665	3666	3670	3663	134.6	135.2	138.0	132.6	37.0	36.2	32.2	39.9
Basin States Alternative	3664	3666	3670	3663	134.1	135.2	138.0	132.6	37.7	36.2	32.2	39.9
Flood Control Alternative	3665	3666	3670	3665	134.6	135.2	138.0	134.2	37.0	36.2	32.2	37.6
Six States Alternative	3664	3666	3670	3663	134.1	135.2	138.0	132.6	37.7	36.2	32.2	39.9
California Alternative	3660	3661	3670	3663	130.8	131.6	138.0	133.0	42.4	41.3	32.2	39.3
Shortage Protection Alternative	3659	3661	3670	3663	130.2	131.6	138.0	132.6	43.2	41.3	32.2	39.9

[1] Based on modeled median surface elevations.
[2] Area of exposed shoreline represents the area that would be exposed below the full pool elevation of Lake Powell for the various water surface elevations indicated, assuming an average shoreline slope of 45 degrees. Lake Powell's water surface area is 160,782 acres at water surface elevation of 3700 feet msl.

3.12 VISUAL RESOURCES

3.12.1 INTRODUCTION

This visual resource analysis addresses the scenic resources at Lake Mead and Lake Powell. The analysis centers on the potential effects of increased shoreline exposure that could result from implementation of the interim surplus criteria alternatives considered in this document.

3.12.2 METHODOLOGY

The evaluation of the effects of the alternatives on the visual resources is based on an assessment of the changes in reservoir shorelines caused by potential decreases in reservoir water surface elevations. More precisely, the modeling indicates the increased range of water level swings between the highs when reservoirs are full and the lows that could occur when the Colorado River Basin natural runoff is low. The potential water level lows have been described in Section 3.3 in terms of probability of occurrence, based on operation model output. Consequently the visual effects are also presented in terms of the probabilities of shoreline changes. Owing to the subjective nature of visual qualities, this analysis is presented as a qualitative assessment of potential visual effects.

Changes in water elevation have differing effects on the amount of exposed shoreline depending on topography; the analysis relates the changes in lake levels to shoreline topography. The shoreline changes were interpreted from existing topographic maps. The description of the affected environment is derived from NPS documents and commercial maps and literature describing scenery in the LMNRA and the GCNRA.

3.12.3 AFFECTED ENVIRONMENT

Both Lake Mead and Lake Powell are situated in desert areas of the Colorado River Basin. While the desert vistas at the reservoir sites have a certain scenic attractiveness of their own, the reservoirs have added a contrasting visual element that increases the visual attractiveness of the areas, which are now dedicated as national recreation areas. The uniqueness of the reservoirs with their contrasting surroundings has been widely illustrated in travel and vacation literature, and has formed well known visual images which help to draw multi-day visitors seeking water related recreation, and touring motorists making day visits.

The reservoir water levels fluctuate both yearly and, to a lesser degree, seasonally. During high runoff years reservoir inflows exceed the required releases and water is stored, causing the water level to rise. During lower runoff years, when releases are greater than inflows, water levels decline. The effects of water level changes on visual qualities in the GCNRA and LMNRA depend greatly on the distance from which the shoreline is viewed, and the type of topography forming the shoreline.

3.12.3.1 LAKE POWELL

Glen Canyon National Recreation Area is located in the Canyonlands area of the Colorado Plateau. The plateau includes parts of Utah, Colorado, New Mexico, and Arizona and is drained by the Colorado River and its many tributaries. The primary attraction of the GCNRA is Lake Powell, a 186-mile-long reservoir on the Colorado River that is formed by Glen Canyon Dam. Lake Powell extends along what was once the Colorado River, through Glen Canyon and numerous side canyons to form more than 1960 miles of reservoir shoreline. Recreationists enjoy exploring the endless side channels and canyons of the reservoir by boat, often spending several days on the water in houseboats or camping in remote areas. The combined qualities of visual attractiveness and branching waterways create an attraction for many recreationists.

3.12.3.1.1 Landscape Character

In "carving" out the canyon landforms, the Colorado River and its tributaries formed a labyrinthine pattern of deep twisted canyons whose towering walls exhibit the geological history of the region. The sedimentary rock formations show multihued sandstone and limestone layers and change color under differing sun angles occurring during the day. Much of the land surface is bare rock with no soil cover. With little soil cover or moisture, there is minimal vegetation and little relief from the sun and the winds that blow across the vast plateau. Consequently, the terraced plateau landscape above the canyon walls displays the vast expanse of red sandstone and limestone. These red, orange and beige rock formations result in a dramatic landscape of towering rock spires, undulating plateaus of slick rock and steep-sided canyons. Since the filling of Lake Powell several decades ago, a dramatic contrast to this arid red rock environment evolved in the form of the deep blue waters of Lake Powell, with their erratic patterns on the landscape likened to a blue lightening bolt in the red-orange desert. Secluded side canyons support cottonwoods and poplars because of the shelter from the wind provided by the canyon walls, and presence of water from tributaries. Tamarisk, a non-native, invasive species, thrives along the lakeshore and in stream bottoms, wherever it can find abundant water, forming a ring of green vegetation along the less steep slopes of the reservoir. The reservoir and its protected surroundings in the GCNRA form a valued recreation resource.

3.12.3.1.2 Sensitive Viewing Locations

The shoreline of Lake Powell and its adjacent landscape can be viewed from the surrounding land at Glen Canyon Dam and its vicinity and from limited areas of the canyon rim, notably the recreation-oriented area extending upstream of the lake from the west end of the dam.

Access by boat permits the greatest amount and variety of scenic vistas; boaters generally look forward to viewing canyon scenery during their visit to the area. The vistas are relatively short in relation to the surface area of the lake, because of the sinuous shape of the lake, and the fact that much of the area lies in side canyons and isolated basins along the meandering course of the former Colorado River corridor.

When Lake Powell water level declines, a white band of calcium carbonate appears on rock surfaces where cliffs or rocky slopes form the reservoir rim. In areas where the lakeshore consists of sand and gravel, an exposed beach belt emerges.

3.12.3.2 LAKE MEAD

3.12.3.2.1 Landscape Character

Lake Mead is situated in the northern part of the Mojave Desert and is surrounded by an austere desert landscape. The lake extends about 66 miles upstream from Hoover Dam and has about 695 miles of irregular shorelines with large bays and small coves.

Lake Mead is framed by low mountains with jagged rocky faces and profiles. Intervening canyons and washes provide variation to the terrain, with the combination presenting an interesting rugged type of scenery for many visitors. While the landscape at midday is relatively subdued in terms of color, the contrast with the blue water of the lake provides an appealing scenic area for visitors. Moreover, the contrasting "moods" of the surrounding desert visible between sunrise and sunset create memorable scenic experiences.

3.12.3.2.2 Sensitive Viewing Locations

The portion of the Colorado River corridor where Lake Mead is located consists of alternating narrow rocky canyons and wide alluvial basins. Most of the lake and its shoreline is visible only to people at widely scattered access points and from boats on the lake. The major exceptions are the broad Hemenway Wash area on the west side of the Boulder Basin of the lake, the Las Vegas Bay area on the west side of Boulder Basin and Hoover Dam.

The Hemenway Wash area is a broad colluvial fan extending upslope from the lake to the River Mountains on the west, with one contiguous area named Hemenway Valley extending upslope southward and forming the northern part of Boulder City. At the lake shore, the broad expanse of gradually sloping desert terrain has been developed into a series of water-based recreation areas, consisting of, in a northward direction, Hemenway boat launching area and water craft area (boating area with launching ramps, docks, and shoreline areas designated for personal water craft use), the Boulder Beach area, a largely unimproved gravel beach area for recreation including swimming, windsurfing and sunbathing, with an adjacent overnight campground and a mobile home community, and then the Lake Mead Marina, providing a boat berthing area, restaurant and boat launching and docking facilities.

Westerly of the shoreline area, up the sloping desert terrain, is the boundary between the LMNRA and the beginning of the Hemenway Valley section of Boulder City. This area has been extensively developed with condominiums and homes ranging in price up to millions of dollars, with much of the area having been developed to take advantage of lake vistas and views of the surrounding hills and desert landforms.

Las Vegas Bay to the north is a relatively narrow area of Lake Mead that is the initial vista presented to people driving to the lake from the Las Vegas Valley. Vistas of the lake are distant because the roads serving the area tend to be on benches above the lake from which direct views of the shoreline are distant and intermittent. Hoover Dam is at the south end of a narrow, steep-walled canyon, which is visible only from the dam and the Arizona abutment and visitor parking areas.

When Lake Mead water level declines, two elements of the area's vista are readily visible. One element is the exposed beach belt around the perimeter of the reservoir where the bottom consists of sand and gravel. The other element is a white band of calcium carbonate on rock surfaces where cliffs or rocky slopes form the reservoir rim.

3.12.4 ENVIRONMENTAL CONSEQUENCES

3.12.4.1 BASELINE CONDITIONS

3.12.4.1.1 Lake Powell

The water surface elevation of Lake Powell under baseline conditions would fluctuate between full level and lower level, with the amount and duration of fluctuation depending on natural runoff in the Colorado River system. Moreover, the potential range of fluctuations would increase with the passage of time as the Upper Divisions states increase their use of river water. An annual fluctuation of approximately 20 feet is projected, in step with the seasonal runoff cycle. Considering the annual fluctuation, the "average full" Lake Powell elevation for this analysis is considered to be an average of approximately 3690 feet msl.

While the timing of major water level variations can not be predicted, nor the length of time the water level would remain at the full level or at any other specific level, the probable range of future baseline water levels has been estimated by the model. As shown on Figure 3.3-6, the median water level decline would be 25 feet below the average full level by the end of 15 years, after which the median level would remain at or above that decline to 2050. There is also a 10 percent probability that the water level would decline as much as 75 feet below the average full level by the end of 15 years, and as much as 135 feet by 2050. However, as noted above, these lows would be temporary, with a likelihood that the reservoir level would fluctuate up to full level when high natural runoff conditions occur. The declines cited above represent the average water levels under an annual 20-foot variation.

The visual consequences of such water level declines would affect boaters viewing two types of shoreline. First, colorful sandstone canyon walls could show a white band of calcium carbonate deposit between the full water level and the lower water level, which would detract from the visual contrast of rock and water. Second, the shoreline areas consisting of sandy or gravelly desertscapes with their unique desert vegetation would be altered by the interposition of a beach belt of sand and gravel between the full water level and the lower water level. This could also alter the contrasting contact between the blue water and the natural desert, and in some cases, distance boaters from the natural terrain.

3.12.4.1.2 Lake Mead

As described in Section 3.3, the water surface elevation of Lake Mead under baseline conditions would fluctuate between a full pool and increasingly lower lake levels, with the amount and duration of fluctuations depending on natural runoff in the Colorado River system. The potential range of fluctuations would increase with the passage of time as the Upper Division states increase their use of river water. While the timing of major water level variations can not be predicted, nor the length of time the water level would remain at the full level or at any other specific level, the probable range of water levels has been estimated by the model. An annual fluctuation of 10 to 20 feet is projected, in step with the seasonal runoff cycle. Considering the annual fluctuation, the "average full" Lake Mead elevation for this analysis is considered to be an average of approximately 1215 feet msl.

As shown on Figure 3.3-13, the median water level would decline 50 feet below the average full level by the end of 15 years, after which the median decline would continue to 105 feet by 2050. There is also a 10 percent probability that the median water level would decline as much as 120 feet below the average full level by the end of 15 years, 180 feet by the end of 30 years, and then continue a gradual decline to 200 feet by 2050. However, as noted above, these lows would be temporary, with the probability that the level of Lake Mead level would fluctuate up to full level when high natural runoff conditions occur.

The visual effect of such a decline perceived by the public would vary depending on the proximity to the reservoir. Persons close to, or on, Lake Mead would perceive that the water level had dropped greatly. However, along most of the alluvial shoreline the exposed bottom would exhibit expanses of gravel. Boaters viewing cliff shorelines would see a band of white calcium carbonate deposits that would probably detract from their appreciation of the rock walls. Persons outside the LMNRA could notice a reduction in reservoir level, depending on their distance from the lake and the degree of visibility of the lake shore. However, beyond the alteration of the water shoreline and the increased prominence of islands and outcrops in the lake, no degradation of the viewshed would be anticipated.

3.12.4.2 BASIN STATES ALTERNATIVE

3.12.4.2.1 Lake Powell

Under this alternative the median water level would decline 25 feet below the average full level by the end of 15 years, after which the median decline would be virtually the same as under baseline conditions to 2050. There is also a 10 percent probability that water level would temporarily decline as much as 85 feet below the average full level by the end of 15 years, and continue a gradual decline to 140 feet by 2050. However, as noted above, these lows would be temporary, with a likelihood that the reservoir level would fluctuate up to full level when high natural runoff conditions occur. The declines cited above represent the average water levels under an annual 20-foot variation.

The visual consequences would involve the same scenic changes described above for baseline conditions.

3.12.4.2.2 Lake Mead

Under this alternative the median water level would decline 70 feet below the average full level by the end of 15 years, after which the median decline would reach 105 feet by 2050. There is also a 10 percent probability that water level would temporarily decline as much as 135 feet below the average full level by the end of 15 years, and 205 feet by the end of 30 years and during the remaining period to 2050. However, as noted above, these lows would be temporary, with a likelihood that the reservoir level would fluctuate up to full level when high natural runoff conditions occur.

The visual consequences would involve the same scenic changes described above for baseline conditions.

3.12.4.3 FLOOD CONTROL ALTERNATIVE

3.12.4.3.1 Lake Powell

Under this alternative the Lake Powell water levels would be virtually the same as under baseline conditions. The visual consequences would involve the same scenic changes described above for baseline conditions.

3.12.4.3.2 Lake Mead

Under this alternative Lake Mead water levels would be virtually the same as under baseline conditions. The visual consequences would involve the same scenic changes described above for baseline conditions.

3.12.4.4 SIX STATES ALTERNATIVE

3.12.4.4.1 Lake Powell

Under this alternative the median water level would decline 25 feet below the average full level by the end of 15 years, after which the median decline would be virtually the same as under baseline conditions to 2050. There is also a 10 percent probability that water level would temporarily decline as much as 85 feet below the average full level by the end of 15 years, and continue a gradual decline to 140 feet by 2050. However, as noted above, these lows would be temporary, with a likelihood that the reservoir level would fluctuate up to full level when high natural runoff conditions occur. The declines cited above represent the average water levels under an annual 20-foot variation.

The visual consequences would involve the same scenic changes described above for baseline conditions.

3.12.4.4.2 Lake Mead

Under this alternative the median water level would decline 70 feet below the average full level by the end of 15 years, after which the median decline would reach 105 feet by 2050. There is also a 10 percent probability that water level would temporarily decline as much as 130 feet below the average full level by the end of 15 years, and 205 feet by the end of 30 years and during the remaining period to 2050. However, as noted above, these lows would be temporary, with a likelihood that the reservoir level would fluctuate up to full level when high natural runoff conditions occur. The visual consequences would involve the same scenic changes described above for baseline conditions.

3.12.4.5 CALIFORNIA ALTERNATIVE

3.12.4.5.1 Lake Powell

Under this alternative the median water level would decline 30 feet below the average full level by the end of 15 years, after which the median decline would be virtually the same as under baseline conditions. There is also a 10 percent probability that the water level would decline as much as 95 feet below the average full level by the end of 15 years, and continue a gradual decline to 140 feet by 2050. However, as noted above, these lows would be temporary, with a likelihood that the reservoir level would fluctuate up to full level when high natural runoff conditions occur. The declines cited above represent the average water levels under an annual 20-foot variation.

The visual consequences would involve the same scenic changes described above for baseline conditions.

3.12.4.5.2 Lake Mead

Under this alternative the median water level would decline 85 feet below the average full level by the end of 15 years, after which the median decline would reach 105 feet by 2050. There is also a 10 percent probability that water level would temporarily decline as much as 145 feet below the average full level by the end of 15 years, and 210 feet by the end of 30 years and during the remaining period to 2050. However, as noted above, these lows would be temporary, with a likelihood that the reservoir level would fluctuate up to full level when high natural runoff conditions occur.

The visual consequences would involve the same scenic changes described above for baseline conditions.

3.12.4.6 SHORTAGE PROTECTION ALTERNATIVE

3.12.4.6.1 Lake Powell

Under this alternative the median water level would decline 30 feet below the average full level by the end of 15 years, after which the median decline would be virtually the same as under baseline conditions to 2050. There is also a 10 percent probability that the water level would decline as much as 95 feet below the average full level by the end of 15 years, and continue a gradual decline to 140 feet by 2050. However, as noted above, these lows would be temporary lows, with a likelihood that the reservoir level would fluctuate up to full level when high natural runoff conditions occur. The declines cited above represent the average water levels under an annual 20-foot variation.

The visual consequences would involve the same scenic changes described above for baseline conditions.

3.12.4.6.2 Lake Mead

Under this alternative the median water level would decline 85 feet below the average full level by the end of 15 years, after which the median decline would reach 105 feet by 2050. There is also a 10 percent probability that the water level would temporarily decline as much as 140 feet below the average full level by the end of 15 years, and 210 feet by the end of 30 years and during the remaining period to 2050. However, as noted above, these lows would be temporary, with a likelihood that the reservoir level would fluctuate up to full level when high natural runoff conditions occur.

The visual consequences would involve the same scenic changes described above for baseline conditions.

3.13 CULTURAL RESOURCES

3.13.1 INTRODUCTION

Cultural resources include prehistoric and historic districts, sites, buildings, structures, objects and landscapes. Historic properties are cultural resources that meet one or more of the Secretary's criteria of significance found at 36 CFR 60.4 and are listed on, or have been found eligible for inclusion, in the National Register of Historic Places (NRHP). The term also includes sites of traditional religious and cultural significance to an Indian Tribe that meet one or more of the NRHP criteria – traditional cultural properties. Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, requires all federal agencies to take into account the effects of their actions on historic properties.

3.13.2 APPROACH TO ANALYSIS

The first step in the Section 106 process, as set forth at 36 CFR 800.3(a), is for the Agency Official to determine if a proposed action meets the definition of an undertaking. An "undertaking" is defined at 36 CFR 800.16(y) as "a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a federal agency, including those carried out by or on behalf of a federal agency; those carried out with federal financial assistance; those requiring a federal permit, license or approval; and those subject to State or local regulation administered pursuant to a delegation or approval by a federal agency." The Secretary has the authority to declare surplus conditions with reference to the LROC developed pursuant to the Colorado River Basin Project Act, and to make surplus determinations during the AOP development process. Using the existing LROC and AOP process, the Secretary has declared the existence of surplus conditions every year since 1996 and could continue to do so in the absence of interim criteria. Reclamation has determined development and implementation of interim surplus criteria for use in conjunction with the LROC and AOP process has the potential to temporarily change the way in which surplus is determined for the period 2000-2015. Development and implementation of interim surplus criteria can thus be construed as a temporary change in an ongoing activity that is part of an existing program, the latter being the delivery of Colorado River water. Thus, it meets the definition of an undertaking for the purposes of complying with Section 106 of the NHPA.

The second step in the Section 106 process is to determine if the undertaking has the potential to cause effects to historic properties. If an undertaking "does not have the potential to cause effects on historic properties," pursuant to 36 CFR 800.3(a)(1), the Agency Official has no further obligations under Section 106. *Effect* is defined at 36 CFR 800.16(i) as "alteration to the characteristics of a historic property qualifying it for inclusion in or eligibility for the National Register." Reclamation has determined development of interim surplus criteria is an undertaking, but one without potential to affect historic properties. Reclamation's rationale for this determination is outlined below.

3.13.3 AFFECTED ENVIRONMENT

The term *area of potential effects* (APE) is defined at 36 CFR 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 "the area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects cause (*sic*) by the undertaking." For the purposes of evaluating the potential for development and implementation of interim surplus criteria to affect historic properties, the APE has been differentially defined for Lake Powell, Lake Mead, the Grand Canyon, and the reservoirs and river corridor from below Hoover Dam to the SIB. This is to address the effects of changes in lake elevations and mean monthly flow rates predicted by the hydrological modeling runs presented earlier in this EIS, and other factors. The APE definitions used in this analysis are as follows:

Lake Powell: That area around the margin of the lake extending from the historic maximum pool elevation of 3708 feet msl, to the 3595-foot contour. The 3595-foot contour has been selected as the low elevation cutoff point, as hydrological modeling runs indicate there is a 10 percent probability the surface elevation of the lake could drop to this level by 2016 for the Shortage Protection Alternative.

Lake Mead: That area around the lake margin extending from its historic high water level of 1225.5 to 1083 feet msl. The 1083-foot contour has been selected as the low elevation cutoff point as this represents the minimum pool level necessary for continued power generation. The maximum flood pool elevation is 1229 feet msl.

Colorado River through the Grand Canyon: As discussed in Section 1.4.2, the Glen Canyon EIS analyzes the effects of operation of Glen Canyon Dam on downstream resources of the Grand Canyon, including cultural resources. The Record of Decision (ROD) for this EIS provides for monitoring and management of affected cultural resources. Section 106 compliance for existing operations and implementation of surplus criteria are and will be subject to the Cultural Resources Programmatic Agreement prepared with respect to the operation of Glen Canyon Dam. Thus it will not be considered further in this analysis.

Colorado River from Hoover Dam to SIB: Downstream from Hoover Dam, the Colorado River flows through a relatively narrow valley along which are located Lake Mohave and Davis Dam, Lake Havasu and Parker Dam, and a series of smaller dams that serve to impound and divert water for specific purposes. As indicated in Section 3.3.4, although Lake Mohave and Lake Havasu are located within the overall APE of the current action, implementation of interim surplus criteria will have no effect on the surface elevations or operation of these reservoirs. As a consequence, they are not considered further in this analysis. Below Davis and Parker dams, the river is fringed by riparian vegetation and marshy backwaters, and a series of levees serve to contain its flow. Because under all but the most exceptional circumstances (e.g., a catastrophic flood event, levee failure, etc.), the flow of the Colorado River is expected to be contained within its channel and the levees, and the APE for free-flowing stretches is considered to be the river channel and that area of the floodplain lying within the levees.

3.13.4 ENVIRONMENTAL CONSEQUENCES

The No Action and each of the action alternatives could result in changes in the surface elevations of Lake Powell and Lake Mead and changes in release patterns and flow of the Colorado River below Hoover Dam. These changes could result in changes in erosional and/or depositional processes that could affect historic properties, were such properties present. However, Reclamation considers the probability for the existence of cultural resources retaining qualities that would qualify them for listing on the NRHP within the interim surplus criteria APEs, as defined above, to be extremely low.

Although Hoover and Glen Canyon dams were constructed prior to passage of the NHPA in 1966, attempts were made to locate and salvage information from significant prehistoric and historic archaeological sites prior to inundation by Lake Mead and Lake Powell. As a result of these efforts, numerous kinds of sites including masonry structures, wattle and daub roomblocks, rockshelters, lithic and ceramic scatters, trails, shrines, quarry locations, salt mines, and historic towns, mills, roads, etc., are known to be submerged beneath the waters of the lakes.

Under the baseline condition for the No Action Alternative, impacts that are likely to have occurred to sites inundated by the reservoirs can be expected to vary in kind and degree, depending on a number of factors including the type of site, slope, the substrate on which the site is located, the site's elevation with respect to historic operation of the reservoir, the number of times a site has been inundated, exposed and re-inundated, etc. In areas where the lake margins make contact with unconsolidated sediments (i.e., alluvial fans, fluvial deposits, etc.), wave action and rising and falling water levels can cause cutting and bench formation, exposure and removal of finer-grained sediments, and sorting and redistribution of coarser materials in the sediment matrix along the slope of the bench or beach. If offshore currents are present, materials may be redistributed along the direction of flow. Where lake margins intersect with lenses or large exposures of poorly consolidated bedrock (e.g., carbonate cemented sandstones, formations containing large quantities of gypsum, etc.), rising and falling water coupled with wave action can, over time, result in undercutting and collapse. Lithic artifacts may suffer edge damage or become water-worn, bone items may be splintered or deteriorate completely, and entire classes of cultural materials (i.e., basketry, vegetal food remains, etc.) can be lost as a result of repeated episodes of exposure and inundation.

In general, sites within the range of a reservoir's historic high and low elevations that have been repeatedly inundated and exposed can be expected to have suffered the greatest amount of damage. Since its equalization with Lake Mead in 1974, surface elevations for Lake Powell have fluctuated between 3708 and 3627 feet msl. Sites located between these elevations can thus be expected to have suffered moderate to severe levels of inundation damage and are unlikely to have qualities that would qualify them for consideration as historic properties eligible for potential listing on the NRHP. Modeling runs indicate there is a 10 percent probability the surface level of Lake Powell will drop to 2595 feet msl by 2016. Sites situated between 3627 feet msl and the maximum low of 2595 feet msl predicted by the modeling runs can be expected to have been damaged as the waters of the lake rose, but in the absence of other factors (i.e., strong subsurface currents, landslides, etc.), damage should be less than that anticipated for sites located at higher elevations. Given this, there is a slight possibility sites located between 3627 and 2595 feet might retain some quality that would qualify them for listing on the NRHP.

Lake Mead rose to its historic high elevation of 1225.5 feet msl in 1983 and has dropped to its historic low elevation of 1083 feet on two occasions. The first drop occurred during the period extending from 1954 to 1957, while the second occurred during 1965 and 1966. Sites located between 1225 and 1083 feet msl can be expected to have suffered inundation damage. Damage to all sites is expected to be severe given the 60-plus years the reservoir has been operating, the large annual fluctuation range in reservoir elevation (from 10 to as much as 75 feet, prior to the filling of Lake Powell), and the reduction in pool elevation to the historic low on two occasions. Reclamation considers it is highly unlikely sites exist between elevations of 1225 and 1083 feet msl that will retain any qualities that would qualify them for consideration as historic properties eligible for potential listing on the NRHP.

Development and implementation of interim surplus criteria will result in changes in release patterns and mean monthly flow rates along the Colorado River below Hoover Dam. The results of the hydrological modeling runs for all interim surplus criteria alternatives indicate there will be an increase in mean monthly flow rates from Hoover Dam downstream to Parker Dam, while mean monthly flow rates below Parker Dam will decrease.

The Colorado River drains a vast watershed covering portions of seven states. Prior to construction of Hoover Dam, discharge rates along the river varied seasonally, averaging 20,000 cfs with peak flows in excess of 200,000 cfs, making the river extremely dynamic and unpredictable in its behavior. Examination of historic maps during archival work conducted in association with a series of recent cultural resource inventories in the vicinity of Yuma, Arizona (i.e., Bischoff et al., 1998; Huber et al., 1998a, Huber et al., 1998b; Sterner and Bischoff 1998), indicated the Colorado River altered its course several times between the 1840s and the 1950s, in one case meandering two miles across its floodplain. Geomorphological trenching on the floodplain in areas behind the modern levees revealed the presence of sedimentary deposits characteristic of a high energy fluvial environment. Such deposits are unlikely to contain *in situ* cultural remains. Inventory of several parcels located on the floodplain was also revealing. Only recent trash was found on parcels located inside the levee system, while the earliest cultural materials identified on parcels outside the levees did not pre-date construction of the levee. Prehistoric cultural remains were confined to locations on the first terrace above the 100-year floodplain. The site patterning observed during these studies is doubtless applicable in a general way to other valleys along the reach of the Colorado River below Hoover Dam.

Flow releases associated with development and implementation of interim surplus criteria will be within existing operational limits. Increases in flow rates for the reach of the Colorado River between Hoover and Parker dams and decreases in flow rates below Parker Dam do not have the potential to cause effects to historic properties, as the river in these areas is entrenched and confined in its channel by a system of levees. Furthermore, studies conducted in the vicinity of Yuma, Arizona, suggest that were bank erosion to occur, sediments adjacent to the current river channel would most likely reflect deposition under high-energy fluvial conditions. Sediments deposited under such conditions are unlikely to contain *in situ* cultural remains that would possess qualities that would qualify them for consideration as historic properties potentially eligible for listing on the NRHP.

No surface-disturbing activities will occur as a result of flow releases associated with development and implementation of interim surplus criteria, as such releases will not require construction of new facilities. No modification of existing facilities would be necessary; thus there is no potential for impacts to the structure or functioning of Hoover Dam (a National Historic Landmark), Parker Dam or Imperial Dam (both of which have been determined eligible for listing on the NRHP).

In conclusion, cultural resources that might exist within the APE for Lake Powell and Lake Mead have been repeatedly inundated, exposed, and re-inundated, making it highly unlikely that any retain qualities that would qualify them for consideration as historic properties eligible for listing on the NRHP. Increases and decreases in mean monthly flow rates below Hoover Dam do not have the potential to affect historic properties as flows will be confined to the river channel, which, when not confined by rocky canyon walls, is contained within levees. Were bank erosion to occur, sediments adjacent to the channel are of a type unlikely to contain cultural materials. There is virtually no chance cultural resources retaining qualities that would qualify them for consideration as historic properties potentially eligible for inclusion on the NRHP exist within the APE of the present undertaking. Reclamation thus considers development and implementation of interim surplus criteria to be an undertaking without the potential to affect historic properties. Pursuant to 36 CFR 800.3(a)(1), having determined development and implementation of interim surplus criteria to be an undertaking with no potential to affect historic properties, Reclamation has no further obligations under Section 106 or Part B of 36 CFR 800.

Reclamation has prepared a memorandum discussing this issue and has forwarded it to the Advisory Council on Historic Preservation.

3.14 INDIAN TRUST ASSETS

3.14.1 INTRODUCTION

Indian Trust Assets (ITAs) are legal assets associated with rights or property held in trust by the United States for the benefit of federally recognized Indian Tribes or individuals. The United States, as trustee, is responsible for protecting and maintaining rights reserved by, or granted to, Indian Tribes or individuals by treaties, statutes and executive orders. All Federal bureaus and agencies share a duty to act responsibly to protect and maintain ITAs. Reclamation policy, which satisfies the requirement of Interior's Departmental Manual at 512 DM 2, is to protect ITAs from adverse impacts resulting from its programs and activities whenever possible. Reclamation, in cooperation with Tribe(s) potentially impacted by a given project, must inventory and evaluate assets, and then mitigate, or compensate, for adverse impacts to the asset.

While most ITAs are located on a reservation, they can also be located off-reservation. Examples of ITAs include lands, minerals, water rights and hunting and fishing rights. ITAs include property in which a Tribe has legal interest. For example, tribal entitlements to Colorado River water rights established in each of the Basin States pursuant to water rights settlements are considered trust assets, and the reservations of these Tribes may or may not be located along the river. The present perfected federal reserved rights are rights held directly by the tribal entities for the reservations in whose name the rights are listed in the *Decree*. A tribe may also have other off-reservation interests and concerns that must be taken into account.

Reclamation has entered into government-to-government consultations with potentially affected Tribes to identify and address concerns for ITAs. The Tribes include those in the Ten Tribes Partnership whose landholdings are situated along the Colorado River and various tributaries in the Upper and Lower Basins. Additionally, meetings have been held with the central Arizona Tribes served by CAP facilities, the Coachella Valley Consortium of Mission Indians and other interested Tribes within the Lower Colorado Region. Through meetings and discussions among the Tribes, BIA and Reclamation staff (see Chapter 5), the following sections describe ITAs that have been identified to have the potential to be impacted by interim surplus criteria.

3.14.2 TEN TRIBES PARTNERSHIP

The Tribes comprising the Ten Tribes Partnership are listed below together with the states in which their reservations are located:

Northern Ute Tribe	Utah
Jicarilla Apache Tribe	New Mexico
Navajo Nation	Arizona, New Mexico and Utah
Southern Ute Indian Tribe	Colorado
Ute Mountain Ute Tribe	Colorado and New Mexico
Fort Mojave Indian Tribe	Arizona, Nevada and California
Chemehuevi Tribe	California
Colorado River Indian Tribes	Arizona and California
Quechan Indian Tribe	Arizona and California
Cocopah Indian Tribe	Arizona

The CRSS demand database used for the model analysis in this FEIS includes discrete representation of the Ten Tribes' demand schedules through "demand nodes" in the model. The Tribal demands and their respective points of diversion were obtained from the Tribes in the summer of 2000. The schedules and the full quantified entitlements on which they are based are shown in Attachment Q. The following discussion describes the Ten Tribes' water rights by Tribe.

3.14.2.1 NORTHERN UTE INDIAN TRIBE – UINTAH AND OURAY RESERVATION

The Northern Ute Tribe is located in northeastern Utah in the Green River watershed. Quantification of the Tribe's water rights began in 1923 with two federal court Decrees that quantified the water rights for the Uintah Indian Irrigation Project (UIIP). A 1960 report, commonly referred to as the "Decker Report," divided lands on the reservation into seven groups. Those land groups have served as the basis for discussions of settlement of the Tribe's water right claims over the subsequent 40 years. Congress ratified a 1990 tabulation of the Tribe's water rights in 1992 subject to re-ratification by the Tribe and State of Utah. That tabulation utilizes the Decker Report's land groups as follows:

1. UIIP lands with water rights decreed by the federal court in 1923, and certified by the State of Utah on the Lakefork, Yellowstone, Uinta and Whiterock rivers. Priority date - October 3, 1861.

2. UIIP lands with water rights certificated by the State of Utah served from the Duchesne River including the towns of Duchesne, Randlett and Myton. Priority date October 3, 1861.

3. Lands that are or can be served from the Duchesne River through UIIP which are not certificated by the state. Priority date would be October 3, 1861.

4. Lands found to be productive and economically feasible to be irrigated from privately constructed ditch systems on the Duchesne River or its tributaries above Pahcease Canal. Priority date would be October 3, 1861.

5. Lands susceptible to irrigation and proposed to be developed within the Central Utah Project. Priority date would be October 3, 1861.

6. Lands east of the Green River served from the White River for which Applications to Appropriate Water were once filed with the State of Utah.

7. Lands east of the Green River found to be productive and economically feasible to be irrigated from privately constructed ditch systems now in operation or to be constructed along the Green River, White River, Willow Creek, Bitter Creek, Sweet Water Creek and Hill Creek.

Tables quantifying the Tribe's diversion and depletion rights as tabulated in the 1990 Tabulation (but not yet ratified by the Tribe or state) are included in the Ten Tribes Depletion Schedule (Attachment Q). The diversion rights total approximately 480,000 af with depletions of 248,943 af. The water rights appurtenant to the Group 5 Duchesne Basin lands are proposed to be transferred to the Green River with a seven percent reduction explaining the difference in the table totals. Current water diversions by the Northern Ute Tribe are approximately 250,000 afy for irrigation applications and a small amount of M&I use for oil and gas and a small culinary water system.

The Northern Ute Tribe has five demand points modeled in the CRSS: two demand points on the Green River, two demand points on the Duchesne River and one point on the White River.

3.14.2.2 JICARILLA APACHE INDIAN RESERVATION

The Jicarilla Apache Indian Reservation is located in the upper reaches of the San Juan River Basin and the Rio Chama Basin in northwestern New Mexico. The reservation straddles the Continental Divide.

Pursuant to the Jicarilla Apache Tribe Water Rights Settlement Act ("Settlement Act"), the Tribe is authorized to divert 40,000 afy from the San Juan River Basin, 32,000 afy of which may be depleted. The Settlement Act provides the Tribe the right to divert 33,500 afy or deplete 25,500 afy from either the Navajo Reservoir supply or directly from the Navajo River as it crosses the Jicarilla Apache Indian Reservation. The Settlement Act also authorizes the Tribe to divert and deplete 6,500 afy from the San Juan River Basin through the transmountain San Juan-Chama Project. The Jicarilla Apache Tribe agreed to subordinate its 1880 priority date for the 40,000 afy (diversion) of "future use" federal reserved water rights in exchange for the 1955 priority date associated with the two federal projects. The Tribe's agreement to subordinate its 1880 priority date for the 1955 date is discussed in a settlement contract between the Jicarilla Apache Tribe and the Secretary. The settlement contract is ratified by the Settlement Act. These are fully adjudicated rights, which, by virtue of the Settlement Act, the Tribe may market to the full extent that the law allows. The Tribe's long-term plans for this water include both off-reservation leasing and on-reservation development.

In addition to these "future use" water rights adjudicated in accordance with the Settlement Act, the Jicarilla Apache Tribe also has adjudicated rights to divert 5,683.92 afy or to deplete 2,195 afy, whichever is less, for historic and existing water uses. Thus, the Jicarilla Apache Tribe's total water diversion rights from the San Juan River Basin amount to 45,683 afy and the Tribe's overall depletion rights from the San Juan Basin total 34,195 afy.

In the CRSS model, the Jicarilla Apache Tribe is represented by four demand points: There is a single node on the upper San Juan River for the current on-reservation uses of the Tribe and those Reclamation assumed were planned for the future. The Tribe's portion of the San Juan – Chama export diversion is in an existing demand point and does not need to be separated. During 2000, the Jicarilla Apache Tribe anticipates entering into a lease of 16,200 afy through 2025 to Public Service Company of New Mexico for depletion at the San Juan Generating Station. In addition, the Tribe anticipates entering into other short-term off-reservation water leases, ultimately preserving some off-reservation leases in 2060 while allowing the Tribe to use the majority of its San Juan River Basin depletions on-reservation. In order to show the change in water leases, a new demand point has been added to show the Jicarilla water going to the power station and future changes in deliveries. The Tribe is investigating the feasibility of leasing 7,500 afy of water to the City of Gallup via the Gallup-Navajo Municipal Water Supply Project. The Jicarilla lease portion of the project is a new demand point in the CRSS model.

3.14.2.3 NAVAJO INDIAN RESERVATION

The Navajo Nation is located in northeastern Arizona, southeastern Utah and northwestern New Mexico. Navajo reserved water rights to the mainstream Colorado River, the Little Colorado River and the San Juan River basins are not adjudicated. The Navajo Indian Irrigation Project was authorized by P.L. 87-483. When authorized, the project was envisioned as a gravity irrigated system with an average annual diversion of 508,000 afy, and a resulting depletion of 254,000 afy. Since authorization in 1962, the project has been re-designed as a pressurized sprinkler system with an anticipated average annual diversion of 337,500 afy, and a resulting depletion of 270,500 afy. The priority date for this diversion and depletion is not later than October 16, 1957.

The CRSS model includes six demand points for the Navajo Nation. There is a demand point for NIIP on the San Juan River upper reach. Current use and development data listed for the NIIP demand point are from the development schedule in the NIIP Biological Assessment dated June 11, 1999. The Navajo Nation also has a small share in the Animas-La Plata Project (ALP) of 4,680 af of withdrawal and 2,340 af of depletion annually. This future withdrawal and use has been accounted for in the CRSS model by splitting the existing ALP M&I node for New Mexico uses and adding a separate point on the Upper San Juan Reach for the Tribe's ALP water.

Present uses in the San Juan River Basin for project areas other than the NIIP have been quantified in the hydrology models of the basin in the formulation of the Animas-La Plata Project Draft EIS. CRSS demand points exist for the future Gallup-Navajo Project showing 5,000 acre-feet of depletion in Arizona and 17,500 acre-feet of depletion in New Mexico. The existing point was updated to include the Cudei Irrigation Project with the Hogback node, as these projects will soon be combined into a single diversion. A demand point was added to the CRSS to include the existing Fruitland, New Mexico project in the model. Other minor uses on the Navajo Reservation have been included in natural flow calculations and are not included as consumptive demands in the CRSS model.

The Navajo Nation currently operates a marina at Antelope Point on Lake Powell. The boat ramp is not operational when the lake level is below elevation 3,677 feet msl. See Section 3.9.2.3.1, Lake Powell, regarding impacts to Lake Powell elevations.

3.14.2.4 SOUTHERN UTE RESERVATION

The Southern Ute Indian Tribe is located in southwestern Colorado just west of Navajo Reservoir. The Tribe has settled its water rights pursuant to agreement with the State of Colorado and pursuant to 1988 federal legislation effective December 19, 1991. The settlement requires the construction of the Animas-La Plata Project. The Tribe has the right to reopen the adjudication of their water rights on the Animas and La Plata Rivers if certain agreed upon dates are not met regarding project implementation. The agreement provides the Tribe with a variety of direct flow rights with priorities ranging from 1868 to 1976 in streams and rivers passing through the Southern Ute Reservation.

The CRSS model has two demand points for the Southern Ute Tribe. In the model, the Present Level - Colorado Agriculture demand point on the San Juan River has been split to separate Southern Ute Tribal uses from non-reservation uses.

The Tribe also has a right to 39,525 acre-feet of water with 19,762 acre-feet of depletion from the future ALP with a project priority of not later than 1966 for M&I use. To account for the Southern Ute portion of the water use, the demand point in Colorado was split into three to separate Southern Ute, other tribes and non-tribal uses.

3.14.2.5 UTE MOUNTAIN UTE INDIAN RESERVATION

The Ute Mountain Ute Tribe is located in the southwestern corner of Colorado with a small part in northwestern New Mexico. The Tribe has settled its water rights pursuant to agreement with the State of Colorado and pursuant to 1988 federal legislation effective December 19, 1991. The settlement requires the construction of the Animas-La Plata Project. If it should prove impossible to construct this project, the Tribe has the right to reopen the adjudication of their water rights on the Animas and La Plata Rivers. The agreement provides the Tribe with a variety of direct flow rights with priorities ranging from 1868 to 1985 in three streams, the Mancos River, San Juan River and Navajo Wash, which pass through the Ute Mountain Ute Reservation.

The CRSS model has four demand points for the Ute Mountain Ute Tribe. In the model the Present Level - Colorado Agriculture demand point on the Lower San Juan River was split in two to separate Ute Tribal uses.

The Tribe also possesses 25,180 acre-feet of storage with 19,260 acre-feet of depletion per year from the Dolores Project for agricultural and other uses with a project priority of not later than 1963. The Dolores Project is accounted for in the CRSS model at two points, one of which is for the Ute Mountain Tribal water use.

The Ute Mountain Ute Reservation will have a share of the water in the future ALP. The Tribe will receive 39,525 af of withdrawal and 19,762 af of depletion rights from the ALP as it is now formulated. This water is intended for M&I use on the reservation. To account for the Ute Mountain Ute portion of the water use, the demand point in Colorado was split into three separate parts: Ute Mountain Ute Tribe, other Tribes and non-Tribal uses.

3.14.2.6 FORT MOJAVE INDIAN RESERVATION

The Fort Mojave Indian Reservation is located in the Lower Colorado River Basin where Nevada, Arizona and California meet. The Tribe possesses present perfected federal reserved water rights from the main stem of the Colorado River in all three of the states that contain reservation land, pursuant to the Decree in *Arizona v. California* and supplemental Decrees (1979 and 1984). Since the original Decree was entered, 1,102 acres of land have been added to the reservation along with rights to 6.464 acre-feet per acre of water as specified in the 1979 Decree. The amounts, including added lands, priority dates, and state where the water rights are perfected, are as follows:

Amount (afy)	Acreage	Priority Date	State
27,969	4,327	September 18, 1890	Arizona
75,566	11,691	February 2, 1911	Arizona
103,535	16,018		Arizona subtotal
13,698	2,119	September 18, 1890	California
12,534	1,939	September 18, 1890	Nevada
129,767	**20,076**		**Total**

The Fort Mojave Indian Tribe has exercised its water rights in California in excess of the amounts currently decreed. In it's June 19, 2000 Opinion, the United States

Supreme Court accepted the Special Master's uncontested recommendation and approved the proposed settlement of the dispute respecting the Fort Mojave Indian Reservation. Under the settlement, the Tribe is awarded the lesser of an additional 3,022 af of water or enough water to supply the needs of 468 acres.

The attached tables are estimates of use based upon calculations derived from records of electrical consumption at the various pump stations and are not from measured flows. The CRSS model contains four demand sub points for the Tribe's water diversions, which are divided among three states. The points are on the Lake Mohave reach of the model, and are further divided into sub points by state. A separate sub point is included for Reservation Land development, but has a diversion of zero af at this time. Current depletion amounts for the CRSS model nodes have been updated to reflect the most recent consumptive use numbers provided by the Lower Colorado River Accounting System (LCRAS) report for calendar year 1998. Future depletions at full development are calculated as the greater of 70 percent of diversion rights and the per acre rate of consumptive use from the LCRAS report multiplied by the full right acreage of the Tribe.

3.14.2.7 Chemehuevi Indian Reservation

The Chemehuevi Indian Reservation is located in southern California near Lake Havasu. The Tribe possesses present perfected federal reserved water rights from the main stem of the Colorado River pursuant to the Decree in *Arizona v. California* and supplemental Decrees (1979 and 1984). The amounts, priority dates, and state where the rights are perfected, are as follows:

Amount (afy)	Acreage	Priority Date	State
11,340	1900	February 2, 1907	California

The lands of the Chemehuevi Tribe are mostly on the plateau above the shoreline of Lake Havasu. Present agricultural water use is limited. Currently, the CRSS model includes a demand point for the Chemehuevi Reservation on the Lake Havasu reach of the model. Current depletion amounts for the CRSS model nodes have been updated to reflect the most recent consumptive use numbers provided by the LCRAS report for calendar year 1998. Future depletions at full development are calculated as the greater of 70 percent of diversion rights and the per acre rate of consumptive use from the LCRAS report multiplied by the full right acreage of the Tribe.

3.14.2.8 Colorado River Indian Reservation

The Colorado River Indian Reservation is located in southwestern Arizona and southern California south of Parker, Arizona. The Tribes possess present perfected federal reserved water rights from the main stem of the Colorado River pursuant to the Decree in *Arizona v. California* and supplemental Decrees (1979 and 1984). The amounts, priority dates, and state where the rights are perfected, are as follows:

Amount (afy)	Acreage	Priority Date	State
358,400	53,768	March 3, 1865	Arizona
252,016	37,808	November 22, 1873	Arizona
51,986	7,799	November 16, 1874	Arizona
662,402	99,375		Arizona subtotal
10,745	1,612	November 22, 1873	California
40,241	6,037	November 16, 1874	California
3,760	564	May 15, 1876	California
54,746	8,213		California subtotal
717,148	**107,588**		**Total**

The CRSS Model presently has three demand sub-nodes listed for the Colorado River Tribe on the reach above Imperial Dam number. The water diversions are split between sub-points for California demands, Arizona demands and a separate sub-node for future pumped diversions in Arizona. Current depletion amounts for the CRSS model nodes have been updated to reflect the most recent consumptive use numbers provided by the LCRAS report for calendar year 1998. Future depletions at full development are calculated as the greater of 70 percent of diversion rights and the per acre rate of consumptive use from the LCRAS report multiplied by the full right acreage of the Tribe.

3.14.2.9 QUECHAN INDIAN RESERVATION (FORT YUMA)

The Fort Yuma Indian Reservation (Quechan Tribe) is located in southwestern Arizona and southern California near Yuma, Arizona. The Tribe possesses present perfected federal reserved water rights from the main stem of the Colorado River pursuant to the Decree in *Arizona v. California* and supplemental Decrees (1979 and 1984). The amounts, priority dates and state where the rights are perfected, are as follows:

Amount (afy)	Acreage	Priority Date	State
51,616	7,743	January 9, 1884	California

A recent Supreme Court decision issued on June 19, 2000 allows the Tribe to proceed with litigation to claim rights to an additional 9,000 acres of irrigable lands. Proving this claim would increase the water rights for the reservation.

Water for the Quechan Tribe is diverted from the Colorado River at Imperial Dam and delivered through the Yuma Project Reservation Division-Indian Unit. The Tribe has other small uses at homestead sites south of Yuma, Arizona. The current water uses shown in the following tables include only Quechan Indian Tribe uses within the Fort Yuma Reservation. These uses are accounted for in the CRSS model with one diversion point on the Imperial Dam Diversions reach. The current withdrawal and depletion values have been updated to reflect the most recent consumptive use numbers provided by the LCRAS report for calendar year 1998. Future depletions at full development are calculated as the greater of 70 percent of diversion rights and the per acre rate of consumptive use from the LCRAS report multiplied by the full right acreage of the Tribe.

3.14.2.10 Cocopah Indian Tribe

The Cocopah Indian Reservation is located in southwestern Arizona near Yuma, Arizona. The Tribe possesses present perfected federal reserved water rights from the main stem of the Colorado River pursuant to the Decree in *Arizona v. California* and supplemental Decrees (1979 and 1984). The amounts, priority dates, and state where the rights are perfected, are as follows:

Amount (afy)	Acreage	Priority Date	State
7,681	1,206	September 27, 1917	Arizona
2,026	318	June 24, 1974	Arizona
1,140	190	1915	Arizona
10,847	**1,714**		**Total**

The rights listed above and in the attached tables include only that water diverted directly from the Colorado River at Imperial Dam. In addition to these rights, the Tribe has numerous well permits that divert groundwater that may be connected to the Colorado River within the boundaries of the United States (studies are ongoing).

The 1974 present perfected federal reserved right for the Cocopah Indian Reservation is unique because of its more recent priority date. The 1979 supplemental Decree in *Arizona v. California* specifies that in the event of a determination of insufficient mainstream water to satisfy present perfected rights pursuant to Article II (B) (3) of the 1964 Decree, the present perfected rights set forth in paragraphs (1) through (5) of Article II (D) of the Decree must be satisfied first. The 1984 supplemental Decree in *Arizona v. California* recognized the present perfected federal reserved right for the

Cocopah Indian Reservation dated June 24, 1974, and amended paragraph (5) of Article II (D) of the Decree to reflect this 1974 right.

The Tribe is involved in litigation to claim rights to a total of 2,400 acres of irrigable lands. Proving this claim would further increase the water rights for the reservation.

Water diversions for the Cocopah Indian Tribe are listed at two demand nodes in the CRSS model on two of the model reaches. A demand point on the Imperial Dam diversion reach accounts for all of the Tribe's rights and current uses in Arizona. Another node is provided for future pumped diversions below Imperial Dam, but it has a diversion of zero af at the current time. Current depletion amounts for the CRSS model nodes have been updated to reflect the most recent consumptive use numbers provided by the LCRAS report for calendar year 1998. Future depletions at full development are assumed to be 100 percent of the diversions as the location of the reservation prevents a return flow within Arizona.

3.14.2.11 ENVIRONMENTAL CONSEQUENCES

The Ten Tribes have a significant amount of undeveloped water rights. The current availability of surplus water on the Colorado River is primarily a direct result of unused existing entitlements, including those of the Tribes. The Ten Tribes have raised significant concerns that interim surplus criteria could: 1) foster a reliance on surplus water on the part of other entitlement holders; 2) provide a disincentive for those entitlement holders to support future Tribal development; and 3) have the practical effect of diminishing the Tribes' ability to utilize their entitlements.

The interim surplus criteria will not alter the quantity or priority of tribal entitlements. In fact, as noted by the description of the Ten Tribes' water rights above, the Tribes have the highest priority water rights on the Colorado River. Surplus determinations have been made since 1996. The interim surplus criteria would not make any additional surplus water available as compared with current conditions, but rather would provide more objective criteria for surplus determinations. Moreover, the preferred alternative would quantify the amounts of surplus water to be made available. Reclamation does not believe that identifying the limited amounts of surplus water will provide any additional disincentives for Tribal water development. Interim surplus criteria are intended to assist in the effort to reduce the overreliance by California on surplus water. The selection of any of the alternatives of this proposed action does not preclude any entitlement holder from using its water.

3.14.2.11.1 Upper Basin Mainstem Tribes

As expected, the model analyses showed that interim surplus criteria would have no effect on Upper Basin deliveries, including the Tribal demands above Lake Powell. As noted in Section 3.4.4.4, the normal delivery schedules of all Upper Basin diversions would be met under most water supply conditions. Only under periods of low hydrologic conditions would an Upper Basin diversion be shorted. Although the model is not presently configured to track the relative priorities under those conditions, such effects are identical under baseline and all alternatives.

3.14.2.11.2 Lower Basin Mainstem Tribes

Under normal conditions, deliveries to Lower Basin users are always equal to the normal depletion schedules, including those for the Tribes. Under shortage conditions, only CAP and SNWA share in the shortage until CAP goes to zero (which was not observed in any of the modeling runs done for this EIS). Therefore, the Tribes of the Ten Tribe Partnership in the Lower Basin would receive their scheduled depletion, with the exception of the Cocopah Tribe that has some Arizona Priority 4 water. However, adoption of the interim surplus criteria would not significantly increase the risk of shortages to holders of Arizona Priority 4 water. For example, the modeling analysis indicates that under the preferred alternative, the occurrence of Priority 4 shortages would be approximately four percent greater than under baseline conditions.

3.14.3 TRIBES SERVED BY CENTRAL ARIZONA PROJECT

Various Indian tribes and communities in central Arizona have been provided water pursuant to CAP contracts by either direct Secretarial actions or through negotiated water rights settlements (CAP Tribes). CAP water has played a primary role in facilitating water rights settlements in Arizona; it is expected to play such a role in the future. In fulfillment of the trust responsibility, the impact of shortages upon the water supplies provided to the CAP Tribes is a primary concern.

The Tribes that receive CAP water are listed below together with the counties in which their reservations are located:

Gila River Indian Community	Maricopa and Pinal
San Carlos Indian Tribe	Gila, Pinal and Graham
Tohono O'Odham Nation	Pina, Maricopa and Pinal
Tonto Apache Tribe	Gila
Yavapai-Apache Indian Community	Yavapai
Fort McDowell Indian Community	Maricopa
Salt River Pima Maricopa Indian Community	Maricopa
Ak Chin Indian Community	Pinal
Pascua-Yaqui Tribe	Pima
Yavapai-Prescott Indian Tribe	Yavapai

3.14.3.1 WATER RIGHTS SETTING

3.14.3.1.1 CAP Priority Scheme

An understanding of the CAP priority scheme is vital in order to understand how shortages could potentially impact the different priorities of CAP water and CAP water users, including Indians. Traditionally, Reclamation's view is that the CAP has five priorities of water rights. The first priority is known as Colorado River water. Colorado River water was secured by the United States for settlement of certain Indian water claims. The second priority includes M&I water and Indian Homeland water. The third priority is Indian agricultural water that was allocated to tribes by the Secretary but was not classed as Homeland water. The fourth priority is M&I water above the first 510,000 af of the M&I allocation (equal to 128,823 af).

The fifth priority is non-Indian agricultural water. The fifth priority is available to several users besides non-Indian agriculture. For example, 312,898 af of fifth priority CAP water, called Excess water, is available to the Central Arizona Groundwater Recharge District (CAGRD) for groundwater recharge, non-Indian agriculture, and the Arizona Water Banking Authority (AWBA) for in-lieu recharge and direct groundwater recharge. The remaining portion of fifth priority CAP water, 51,800 af, is non-Indian agricultural water that is assumed to be allocated to Indian users.

The priorities discussed in this section are internal to the CAP and must not be confused with priorities of water entitlements along the mainstream of the Colorado River.

The future allocation of CAP water to some CAP priorities is not definitive because of the dual possibility of finalizing or not finalizing two settlements. One settlement is among the Gila River Indian Community (GRIC), certain Arizona entities and the United States (GRIC Settlement). The second settlement is the CAP Settlement between the United States and the Central Arizona Water Conservation District (CAWCD). Under shortage, potential impacts to Indian CAP water users differ depending upon whether CAP water is allocated under settlement or without settlement.

Table 3.14-1 provides, in units of afy, allocations of CAP water to CAP priorities for certain Indian Tribes or communities under two scenarios. The first scenario, Likely Future Without, reflects assignment of water rights absent final GRIC and CAP settlements. The second scenario, With Settlement, assumes final GRIC and CAP settlements. The primary difference between the two scenarios is that with final settlements, GRIC is assigned an additional 102,000 af of non-Indian agricultural water and the United States reserves 69,800 af of other non-Indian water for future water rights settlements.

Table 3.14-2 reflects the CAP priority scheme under the two scenarios and identifies the points at which shortages on the Colorado River begin to impact different priorities of CAP water. Normal year diversions of CAP water are assumed to be 1.5 maf. Reductions for system losses result in deliverable water of 1,415,000 af. The effects of shortages on CAP water associated with various priorities is as follows:

> *Fifth Priority.* In the event of a shortage on the river restricting deliveries of CAP water to 925,000 af, the fifth priority water rights would go unfulfilled.

Table 3.14-1
Central Arizona Project Indian Water Allocations
Unit: Acre-Feet Annually

Indian Tribe and Allocation	Likely Future without GRIC (afy)	With GRIC Settlement (afy)
Gila River Indian Community		
Indian Allocation	173,100	173,100
Indian Priority – HVID	17,800	17,800
Settlement Water		
M & I – ASARCO	17,000	17,000
Non-Indian Agric.-RWCD	18,600	18,600
Other		102,000
Total	226,500	328,500
San Carlos Indian Tribe		
Indian Allocation	12,700	12,700
M & I Priority	18,145	18,145
Indian Reallocation (Ak Chin)(minus losses)	30,800	30,800
Total	61,645	61,645
Tohono O'Odham Nation (San Xavier, Schuk Toak, Chui-Chu)		
Indian Allocation	45,800	45,800
Non-Indian Agric.	28,200	28,200
Total	74,000	74,000
Tonto Apache Tribe		
Indian Allocation	128	128
Total	128	128
Yavapai-Apache Indian Community		
Indian Allocation	1,200	1,200
Total	1,200	1,200
Fort McDowell Indian Community		
Indian Allocation	4,300	4,300
Indian Priority-HVID	13,933	13,933
Total	18,233	18,233
Salt River Pima Maricopa Indian Community		
Indian Allocation	13,300	13,300
Colorado River (net of losses)	20,900	20,900
Non-Indian Agric.	5,000	5,000
Total	39,200	39,200
Ak Chin Indian Community		
Indian Allocation	25,000	25,000
Colorado River	50,000	50,000
Total	75,000	75,000
Pascua Yaqui Tribe		
Indian Allocation	500	500
Total	500	500
Yavapai-Prescott Indian Tribe (assigned to Scottsdale)		
Indian Allocation	500	500
Total	500	500
Total Indian Allocations		
Indian Allocation	309,828	309,828
Homeland	54,428	54,428
Agricultural	255,400	255,400
Colorado River	70,900	70,900
Indian Priority-HVID	31,733	31,733
M & I Priority	35,145	35,145
Non-Indian Agric.	51,800	153,800
Unassigned HVID	1,518	1,518
Future Settlements (agric. priority)		69,800
Total	498,424	670,224
Municipal and Industrial Water Supply	603,678	603,678
Non-Indian Agricultural Water Supply	312,898	141,098
Total Normal Water Supply	1,415,000	1,415,000

Source: Central Arizona Project 1996 Water Supply Study for Stage II Cost Allocation
Draft EIS for allocation of CAP water supply -- June, 2000

Fourth Priority. Subsequent reductions would impact M&I water amounts in excess of 510,000 af. Consequently, any M&I priority water which has been reallocated for Indian use would also be affected.

Third Priority. The next block of water to be impacted by shortages is a portion of the Indian agricultural water. The deliveries to GRIC would be reduced by 25 percent of its agricultural allocation; all other tribes having Indian agricultural water would be reduced by 10 percent of their respective agricultural allocations.

Second Priority. The remaining M&I and Indian priority water would be reduced on a pro rata basis as water deliveries decrease.

First Priority. Colorado River water would be unavailable only if a shortage were severe enough that no diversion could be made into central Arizona.

3.14.3.1.2 Examples of Reductions of CAP Water Deliveries

Table 3.14-3 demonstrates the incidence of reductions to the CAP Indian supplies during shortage on the Colorado River under the Likely Future Without scenario. Various quantities of CAP water deliveries have been assumed in order to show the varying impacts between Indian tribes. The amount of CAP water that represents a division between one priority and the next higher priority is referred to here as a "break point." For example, the estimated break point between the fifth and fourth priorities is 1,050,302 af. A total available CAP water supply of 1,050,302 af means that no deliveries of fifth priority CAP water would be made. If the shortage decreases the available total CAP water supply below 1,050,302 af, deliveries of fourth priority CAP water would be impacted. Similarly, between the fourth and third priorities, the break point is 921,479 af. The division between the third and second priority is 869,974 af. Finally, the last break point is 68,400 af. See Section 3.4.4.1.2 for a summary of the Arizona modeled annual depletions under normal, surplus and shortage conditions.

Reductions in Indian water supplies in the fifth priority are estimated to be 51,800 af. The affected amount of Indian water supply in the fourth priority is 7,087 af. The third priority Indian agricultural water affected totals 51,505 af. Indian priority water in the second priority totals 317,132 af. Finally, the Colorado River priority water held by Indians totals 68,400 af.

Table 3.14-4 shows the same information as Table 3.14-3, but assumes a final GRIC and CAP settlement. The same priority scheme is applied as used in the without settlement scenario. In this instance, GRIC is allocated an additional 102,000 af of non-Indian agricultural water. The amount of 69,800 af of non-Indian agricultural water is held by the United States for future Indian water rights settlements. As a result, the potential Indian/federal loss in the fifth priority increases to 223,600 af, as compared with 51,800 af without settlement. Impacts to the other priorities remain the same.

Table 3.14-2
Traditional Reclamation Priorities for Central Arizona Project Water[7]
Acre-Feet Per Year

		Likely Future without GRIC	Total Water	With GRIC Settlement	Total Water
First:	Colorado River Water – Yuma Mesa and Wellton Mohawk	68,400	68,400[1]	68,400[1]	68,400
Second:	Pro rata reduction of Indian and M & I water	801,574	869,974[2]	801,574	869,974
Third:	Indian agricultural water (reduce 25 % of GRIC ag. water, and 10 % of other Indian ag.) (Indian agric. water is that portion of original allocation which is not "Homeland")	51,505	921,479[3]	51,505	921,479
Fourth:	M & I water above 510,000 acre feet, including M&I reallocations to Indians	128,823	1,050,302[4]	128,823	1,050,302
Fifth:	Non-Indian agricultural water reallocated to Indians	51,800	1,102,102[5]	223,600	1,273,902
Fifth:	Excess water (priority = 1, CAGRD, 2, Agric., 3 AWBA)	312,898	1,415,000[6]	141,098	1,415,000

Notes:
[1] The total represents the Yuma Mesa water (50,000 af) plus Wellton-Mohawk water (22,000 af) minus estimated transmission losses.
[2] Total is composed of 510,000 af of M&I water plus 33,251 af of HVID water plus 258,323 af of Indian water after reductions in third priority and losses
[3] Amount is made up of 43,275 af of GRIC water and 8,230 af of other Indian agricultural water
[4] Amount is the difference between 638,823 af and 510,000 af of M&I priority water
[5] Likely Future" amount is 51,800 af of reallocated agricultural water
GRIC Settlement" amount is the sum of 153,800 af of reallocated agricultural water and 69,800 af of reallocated agricultural water held by U. S. for future Indian water settlements
[6] The amount is an estimate of the excess water pool, with and without settlement between the U.S. and CAWCD
[7] The traditional USBR interpretation of shortage sharing criteria is used in the analysis of the likely future with and without the GRIC settlement. It is understood that new shortage sharing criteria are included in the GRIC settlement but the settlement is under negotiation at the current time. Reclamation believes that the use of the traditional shortage sharing criteria for likely future with GRIC settlement will not have a major effect on the relative difference among the alternatives.

Table 3.14-3
Reductions in Indian CAP Water Supplies During Times of Shortage on Colorado River
Likely Future Without GRIC Settlement

	CAP Water Supply	Reduction	GRIC	San Carlos	Tohono O'Odham	Tonto Apache	Yavapai Apache	FMIC	SRPMIC	Ak Chin	Pascua Yaqui	Yavapai Prescott	Total Unassigned HVID	Accumulated Reductions per Priority	Reductions
Fifth	1,415,000		none	none	none	none	none	none	none	none	none	none			
Priority		115,000													
	1,300,000		5,865		8,892				1,577					16,334	
Agricultural		215,000													
	1,200,000		10,965		16,625				2,948					30,538	
		315,000													
	1,100,000		16,065		24,357				4,319					44,741	
		364,698													
	1,050,302		18,600		28,200				5,000					51,800	51,800
		50,302													
Fourth	1,000,000		1,339	1,429										2,767	
Priority		125,302													
	925,000		3,334	3,559										6,894	
M & I		128,823													
	921,479		3,428	3,659										7,087	58,887
		21,479													
Third	900,000		18,047	1,501	334				555	1,043				21,479	
Priority		51,505													
Indian Ag.	869,974		43,275	3,600	800				1,330	2,500				51,505	110,392
		69,974													
Second	800,000		14,072	4,748	3,928	11	105	1,592	1,045	1,964	44	44	133	27,684	
Priority		169,974													
	700,000		34,182	11,533	9,542	27	254	3,866	2,538	4,771	106	106	322	67,248	
M & I		269,974													
and	600,000		54,292	18,317	15,156	43	404	6,141	4,032	7,578	168	168	511	106,812	
Indian		369,974													
	500,000		74,402	25,102	20,770	59	554	8,416	5,525	10,385	231	231	701	146,375	
		469,974													
	400,000		94,512	31,887	26,384	75	704	10,690	7,018	13,192	293	293	890	185,939	
		569,974													
	300,000		114,622	38,672	31,998	91	853	12,965	8,511	15,999	356	356	1,079	225,502	
		669,974													
	200,000		134,732	45,457	37,612	107	1,003	15,240	10,005	18,806	418	418	1,269	265,066	
		769,974													
	100,000		154,842	52,242	43,226	123	1,153	17,514	11,498	21,613	480	480	1,458	304,630	
		799,074													
	68,400		161,197	54,386	45,000	128	1,200	18,233	11,970	22,500	500	500	1,518	317,132	427,524
First		70,900													
Priority	0								20,900	47,500				68,400	
Colo. River															
Total Reductions			226,500	61,645	74,000	128	1,200	18,233	39,200	75,000[1]	500	500	1,518		

[1] Ak-Chin values are not additive because system losses on the 50,000 af of Colorado River Priority water are borne by San Carlos Tribe, except in the instance of CAP deliveries restricted to Colorado River rights only [first priority]. In this case system losses are borne by Ak-Chin.

3.14-4
Reductions in Indian CAP Water Supplies During Times of Shortage on Colorado River
Likely Future with GRIC Settlement

	CAP Water Supply	Reduction	GRIC	San Carlos	Tohono O'Odham	Tonto Apache	Yavapai Apache	FMIC	SRPMIC	Ak Chin	Pascua Yaqui	Yavapai Prescott	Unassigned HVID	Total Reserved Federal	Accumulated Reductions per Priority	Reductions
Fifth	1,415,000		none	none	none	none	none	none	none	none	none	none	none	none		
Priority		115,000														
	1,300,000		38,029		8,892				1,577					22,010	70,508	
Agricultural		215,000														
	1,200,000		71,097		16,625				2,948					41,149	131,819	
		315,000														
	1,100,000		104,166		24,357				4,319					60,288	193,130	
		364,698														
	1,050,302		120,600		28,200				5,000					69,800	223,600	223,600
		50,302														
Fourth	1,000,000		1,339	1,429											2,767	
Priority		125,302														
	925,000		3,334	3,559											6,894	
M & I		128,823														
	921,479		3,428	3,659											7,087	230,687
		21,479														
Third	900,000		18,047	1,501	334				555	1,043					21,479	
Priority		51,505														
Indian Ag.	869,974		43,275	3,600	800				1,330	2,500					51,505	282,192
		69,974														
Second	800,000		14,072	4,748	3,928	11	105	1,592	1,045	1,964	44	44	133		27,684	
Priority		169,974														
	700,000		34,182	11,533	9,542	27	254	3,866	2,538	4,771	106	106	322		67,248	
M & I		269,974														
and	600,000		54,292	18,317	15,156	43	404	6,141	4,032	7,578	168	168	511		106,812	
Indian		369,974														
	500,000		74,402	25,102	20,770	59	554	8,416	5,525	10,385	231	231	701		146,375	
		469,974														
	400,000		94,512	31,887	26,384	75	704	10,690	7,018	13,192	293	293	890		185,939	
		569,974														
	300,000		114,622	38,672	31,998	91	853	12,965	8,511	15,999	356	356	1,079		225,502	
		669,974														
	200,000		134,732	45,457	37,612	107	1,003	15,240	10,005	18,806	418	418	1,269		265,066	
		769,974														
	100,000		154,842	52,242	43,226	123	1,153	17,514	11,498	21,613	480	480	1,458		304,630	
		799,074														
	70,900		161,197	54,386	45,000	128	1,200	18,233	11,970	22,500	500	500	1,518		317,132	599,324
First		70,900														
Priority	0								20,900	47,500					68,400	
Colo. River																
Total Reductions			328,500	61,645	74,000	128	1,200	18,233	39,200	75,000[2]	500	500	1,518	69,800		

[1] Due to ongoing GRIC negotiations, Reclamation decided to use the traditional USBR interpretation of shortage sharing criteria to compare the relative differences among alternatives. Reclamation believes that the negotiated shortage sharing criteria to be included in the GRIC settlement will not impact the relative differences among alternatives.

[2] Ak-Chin values are not additive because system losses on the 50,000 af of Colorado River Priority water are borne by San Carlos Tribe, except in the instance of CAP deliveries restricted to Colorado River rights only [first priority]. In this case system losses are borne by Ak-Chin.

Losses of fifth priority water impacts only GRIC, Tohono O'Odham Nation (TON), Salt River Pima Maricopa Indian Community (SRPMIC) and the United States. Fourth priority losses impact only GRIC and the San Carlos Apache Tribe (San Carlos). Third priority Indian agricultural water losses impact GRIC, San Carlos, TON and SRPMIC. If Colorado River shortages reduce CAP deliveries below 869,974 af, thereafter all Indian tribes are affected on a proportional basis, except for SRPMIC and Ak Chin, who have rights to Colorado River water. Tables 3.14-3 and 3.14-4 show reductions within each priority as water supplies diminish for selected delivery and supply scenarios.

3.14.3.2 ENVIRONMENTAL CONSEQUENCES

3.14.3.2.1 Impacts Resulting from Baseline Conditions and Alternatives

Under the current CAP operational assumptions regarding shortage on the Colorado River, diversions to the CAP are estimated to be restricted to one mafy with deliveries of about 925,000 af.

The assumptions and estimated shortages of CAP Indian water deliveries determined in this EIS did not consider implementation of any proposals to provide for firming of the CAP Indian water supply. Should firming programs be developed for portions of the non-Indian agricultural priority water supply allocated to the Tribes, the reductions calculated in this EIS may be overstated. The relative impacts between alternatives shown here are not anticipated to change significantly.

Baseline. Reclamation estimates of baseline conditions show a zero percent chance of shortage for the period 2002 through 2016. For the period 2002 through 2050, the average chance of shortage is about 35.7 percent. Thus, over the next 49 years, it is expected that 17.5 of those years will be shortage and 31.5 will be either normal or surplus. This scenario would result in a loss of about 120,645 af of M&I priority water out of a total of 1,722,105 af over a 49-year period for Indian Tribes.

Under the current definition of shortage impacts to CAP, a shortage year would necessarily eliminate delivery of any non-Indian agricultural priority water. In the Likely Future Without scenario, Indian tribes would lose 51,800 af of non-Indian agricultural priority water in each shortage year, or a total of about 906,500 af out of a total of 2,538,200 af over a 49-year period. Under the With Settlement scenario, the annual loss would be 223,600 af of non-Indian agricultural water, or a total of 3,913,000 af out of a total of 10,956,400 af over the 49-year period.

Basin States Alternative. Model runs by Reclamation indicate a 39.2 percent chance of shortage over the next 49 years. Under the Preferred Alternative, 19.2 years of shortages are projected to occur. The loss of M&I priority water for Indian Tribes would total about 132,365 af out of a total of about 1,722,105 af. For the Likely Future Without Settlement scenario, total non-Indian agricultural priority water lost would be about 994,560 af. With Settlement, the total non-Indian agricultural priority water lost would be about 4,293,120 af.

Six States Alternative. Employing the assumptions of the Six State Plan, the period of a zero percent chance of shortage would be 2002 through 2008, a slightly shorter period compared to baseline conditions. For the period 2002 through 2050, the average chance of shortage would be about 38.8 percent. This results in 19 years of shortage and 30 years of normal or surplus years. About 130,986 af of M&I water out of a total of 1,722,105 af would be lost to the Indian Tribes during the next 49 years.

Applying the current shortage criteria would mean that all non-Indian agricultural priority water would not be delivered in a water short year. In the future without settlement scenario, Indian Tribes would lose a total of about 984,200 af out of a total of 2,538,200 af. In the With Settlement scenario, the total loss to Indians would increase to about 4,248,400 af of a total of 10,956,400 acre-feet.

California Alternative. The California Alternative is more restrictive in that the period of zero percent chance of shortage would last only five years between 2002 through 2006. An average 42.3 percent chance of shortage would prevail through the study period. Hence, the total years of shortage would increase to 20.7. The loss of M&I priority water for Indian Tribes would total to about 142,706 af of a total of about 1,722,105 af during the next 49 years.

As in the previous two scenarios, a Colorado River shortage would eliminate any deliveries of non-Indian agricultural priority water. For the Likely Future Without Settlement scenario, the total water not delivered to Indians would be about 1,072,260 af out of a total of about 2,538,200. With Settlement, the total water lost by Indians would be about 4,628,520 acre-feet out of a total of about 10,956,400 af.

Shortage Protection Alternative. Estimates by the Reclamation show a 41.1 percent chance of shortage over the next 49 years. Therefore, the total number of years of shortage would increase to 20.3. The expected loss of M&I priority water for Indian Tribes would total about 139,948 acre-feet over the study period.

For the Likely Future Without Settlement, total non-Indian agricultural priority water not available for delivery to Indians would be about 1,051,540 af. With Settlement, total non-Indian agricultural priority water lost would be about 4,539,080 af.

Flood Control Alternative. The number of years of zero percent shortage are 9 years, 2002-2010. The chance of shortage is 35.5 percent over the 49-year period. The years of shortage are 17.4 years. M&I water loss to Indians is 119,956 af. Under the Likely Future Without, total loss of non-Indian agricultural priority water is 901,320 af. With Settlement, 3,890,640 af non-Indian agricultural priority water would be lost.

3.14.3.2.2 Summary of Impacts

While shortages on the Colorado River and the resulting impact upon the CAP are impossible to eliminate, the selection of interim surplus criteria does affect the magnitude of impacts. The most severe impact upon water resources of central Arizona Indian tribes and communities is projected to occur under the California Alternative. Conversely, the least impact upon Indian CAP water supplies is projected to occur under the Flood Control Alternative.

Comparison of the Preferred Alternative with the baseline projections results in a loss of Indian M&I water of about 11,720 af. Under the Likely Future Without Settlement scenario, the loss of non-Indian agricultural priority would be about 88,060 af and the impact under the With Settlement scenario would be a loss of about 380,120 af.

Compared with the baseline projections, the implementation of the Six States Alternative would increase total shortages to Indians in the CAP service area by 10,341 af of M&I water and under the Likely Future Without Settlement scenario 77,700 af of non-Indian agricultural priority water. Similarly, under the Likely Future Without Settlement scenario, the loss of non-Indian agricultural priority water would increase to 335,400 af.

Comparisons of the California Alternative with the baseline shows that the M&I impact would be 22,061 af and under the Likely Future Without Settlement scenario the non-Indian agricultural priority water impact would be a loss of 165,760 af. Under the With Settlement scenario, the loss of non-Indian agricultural priority water would increase to 715,520 af.

Comparison of the Flood Control Alternative to baseline projections shows gains to Indian CAP water users of 689 af of M&I water. Under the Likely Future Without scenario, Indians would gain 5,180 af of non-Indian priority water. Under the With Settlement Scenario, Indians would gain 22,360 af of non-Indian agricultural water. This alternative is the best alternative for Indian CAP water users and Indian trust asset protection.

Finally, comparing the Shortage Protection Alternative with the baseline, the M&I impact would be a loss of 14,174 af. The impact to non-Indian agricultural priority water would be a loss of 145,040 under the Likely Future Without Settlement scenario and With Settlement, the loss would be 626,080 af.

3.15 ENVIRONMENTAL JUSTICE

Environmental justice refers to the fair treatment of people of all races, income and cultures with respect to the development, implementation and enforcement of environmental laws, regulations and policies. Fair treatment implies that no person or group of people should shoulder a disproportionate share of negative impacts resulting from the execution of environmental programs. Executive Order 12898, dated February 11, 1994, establishes the achievement of environmental justice as a federal agency priority:

> *To the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health and environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States...*

The memorandum accompanying the order directs heads of departments and agencies to analyze environmental effects of federal actions, including human health, economic and social effects when required by NEPA and to address significant and adverse effects on minority and low-income communities. Interior and Reclamation policy and strategy for addressing environmental justice also stresses the importance of providing opportunities for community involvement in the NEPA process considering the effects of Reclamation's decisions on minority and low income populations and communities and identifying mitigation measures in consultation with the affected communities.

Populations that depend on the Colorado River for their water supply include minority and low-income communities in rural and urban areas in each of the seven Basin States. On- and off-reservation populations of Native American Indians are included.

Reclamation has involved potentially affected Tribes and the BIA to identify and address Tribal concerns (see Chapter 5, Consultation and Coordination). This includes Tribes with reservations along the Colorado River, as well as Tribes with Colorado River water rights in the Basin States. Tribal concerns are discussed in Section 3.14, Indian Trust Assets, and are based on further evaluation of impacts as they affect Tribal interests.

Reclamation is not aware of exposure of any minority or low-income populations to a human health or environmental hazard that would result from implementation of interim surplus criteria. No significant difference in the distribution of benefits and burdens would occur to minority or to low-income communities from any of the alternatives.

Scoping for, and public review of, the DEIS did not identify potential adverse impacts on minority populations in the United States, including Native American, Hispanic or low-income communities. No minority or low-income communities are expected to be affected in any disproportionate way as a result of any of the action alternatives considered in this EIS. Therefore, no potentially significant environmental justice issues are analyzed further in this section.

3.16 TRANSBOUNDARY IMPACTS

3.16.1 INTRODUCTION

Potential effects on resources in Mexico could occur from changes in the frequency and magnitude of excess flows to Mexico (i.e., flows in excess of scheduled deliveries to Mexico) as a result of adoption of interim surplus criteria. The analysis in this section utilizes results of system modeling as described in Section 3.3 to determine potential changes in excess flows to Mexico and discusses the potential effects on the natural and physical environment within Mexico. The potential effects on scheduled delivery of water to Mexico under the terms of the United States-Mexico Water Treaty of 1944 (Treaty) are presented in Section 3.4, Water Supply.

This analysis of potential impacts in Mexico is fully consistent with Executive Order 12114 - Environmental Effects Abroad of Major Federal Actions and CEQ Guidance on NEPA Analyses for Transboundary Impacts, dated July 1, 1997. Each of these documents are contained within Attachment B, Environmental Guidelines for Transboundary Impacts.

3.16.2 METHODOLOGY

For the analysis of impacts in Mexico, the direct potential effect of interim surplus criteria would be associated with changes in the frequency of excess flows to Mexico. The incremental differences in excess flows to Mexico between baseline conditions and each of the interim surplus criteria alternatives were determined using modeling of the Colorado River system as described in Section 3.3.

Environmental conditions currently existing and those expected to result from the full development of the Upper Division states' apportionments are part of the baseline conditions. The impacts attributable to interim surplus criteria would include changes to excess flow frequency downstream of Morelos Dam and the reduction of available excess flows for irrigation and M&I use in Mexico. However, the potential effects of the reduced excess flows on Mexico's resources cannot be specifically determined due to the uncertainty of water use once it flows across the NIB into Mexico. The waters of the Colorado River, once delivered to Mexico, as agreed upon in the Treaty, are within the exclusive control of Mexico. The Treaty contains no provisions requiring Mexico to provide water for environmental protection, nor any requirements relating to Mexico's use of that water. It is reasonably foreseeable that Mexico will continue to maximize consumptive use of Colorado River water for agricultural, municipal and industrial purposes.

Potentially affected species that occur in Mexico and that are federally listed as endangered under the United States Endangered Species Act (ESA) are the desert pupfish (*Cyprinodon macularius*), Vaquita (*Phocaena sinus*) and totoaba (*Totoaba macdonaldi*); listed bird species which occur in Mexico include the Southwestern willow flycatcher (*Empidonax traillii extimus*) and the Yuma clapper rail (*Rallus longirostris yumanensis*). Consideration is also given to the Yellow-billed cuckoo (*coccyzus americanus*), which is proposed for listing. Additional species of special concern and their habitat that are addressed in this section are the California black rail (*Laterallus jamaicensis coturniculus*), Elf owl (*Micrathene whitneyi)*, Bell's vireo (*Vireo bellii arizonae),* and Clark's grebe (*Aechmophorus clarkii).* The Vaquita and totoaba are species associated with the Colorado River as it flows into the Gulf of California and occur only in Mexico. Critical habitat for species listed under the ESA is only designated within the United States and therefore, habitat in Mexico is not protected under the ESA. The desert pupfish and each of the bird species occur in both the United States and Mexico, and potential impacts to these species and their habitat within the United States are discussed in Section 3.8.

3.16.3 CONSULTATION WITH MEXICO

Pursuant to an international agreement for mandatory reciprocal consultations, Reclamation, through the United States Section of the International Boundary and Water Commission (USIBWC), consulted with Mexico in an effort to identify Mexico's concerns with regard to potential transboundary impacts from adoption of interim surplus criteria.

During the preparation of the DEIS, a meeting was held in Henderson, Nevada, on April 12, 2000, during which the topic of developing interim surplus criteria was described for the Mexican delegation. A subsequent meeting was held in Mexico City, Mexico, on May 11 and 12, 2000. During the May 11-12, 2000 meeting, Reclamation provided additional data which had been requested by Mexico and technical issues were discussed. Reclamation requested that Mexico provide an analysis of how the incremental changes between baseline conditions and the interim surplus criteria would affect Mexico. In response, a letter from Commissioner J. Arturo Herrera of the Mexican Section of the IBWC, was provided to the United States Section of the IBWC on May 22, 2000. The original letter, and an English translation, is included in Attachment T (Mexico advised the IBWC that there is no objection to the public release of this diplomatic document).

In this transmittal, Commissioner Herrera expressed a concern that currently proposed plans for the distribution of surplus water among the Lower Division states tend to reduce excess flows below Morelos Dam over the 15-year period of the interim surplus criteria. Mexico estimates that the elimination of these excess flows would have the following effects on the Mexican natural and physical environment:

1. Effects on the recharge of the aquifer both in quantity and quality, reducing the beneficial use of the same;

2. Increase in salinity in the 200,000 hectares (500,000 acres) of cultivation in the Mexicali Valley, since part of the surplus is used to leach this soil;

3. Deterioration in the quality of water delivered to Mexico at the Southerly International Boundary (SIB), especially in terms of salinity given that the flows of fresh water are used to reduce high concentrations of salinity at this site;

4. Deterioration in the quality of water received by Mexico at NIB in reducing the flow to the value of the Mexican demand and maintaining the discharges to the river from agricultural drains in the Yuma, Arizona area;

5. In the upper part of the Sea of Cortez, species in danger of extinction or which require special protection will be affected, such as the rarest and most scarce cetacean in the world, the sea cow (Vaquita) and the Totoaba. Also, commercial fishing activities will be affected in the region, especially shrimping and two species of Corvina, fish which had not appeared in significant numbers in the last 25 years; and,

6. In terms of the existing flora in the reach between Morelos Dam and the mouth of the Colorado River at the Sea of Cortez, in recent years around 33,000 hectares (85,500 acres) of native riparian vegetation have been restored in the channel, mostly poplars, willows, mesquite and salt cedar, among other species which are fundamental in the ecosystem since many of these are used as nesting areas for a great number of birds, such as the Yuma clapper rail, the yellow seagull, the sea swallow and the royal blue swan, among others, same which would be affected by these measures.

Coordination with Mexico continued during the DEIS review period and development of this FEIS. Reclamation met with representatives of Mexico on August 31, 2000, to brief them on the operational modeling process described in Section 3.3. In response to the DEIS, comment letters were provided to Reclamation from the Border Affairs Coordinator of Mexico's National Water Commission and from the IBWC. Both letters reiterated the issues raised in Commissioner Herrera's May 22, 2000, letter and are included in Volume III of this FEIS along with Reclamation's responses to the specific issues raised in the letters. Mexico provided further correspondence on October 10, 2000, which is also included in Attachment T. In this letter, Mexico suggests there be more consideration of habitat and species information in Mexico.

Although Reclamation recognizes the potential for the United States, acting through the Secretary of State, to continue to work with Mexico on a bi-national basis to clarify and resolve Mexico's concerns, it is not clear that the concerns raised are associated with interim surplus criteria. Issues not arising from interim surplus criteria are outside of the scope of this FEIS. However, such issues could become the subject of other cooperative, bi-national processes of a voluntary nature.

Attachment T also contains a draft document dated December 28, 1999 that states the United States "Authority and Assumptions" for the United States-Mexico consultations under the Treaty and subsequent resolutions and Minutes. Within that document, the

United States acknowledges Mexico's rights under the authority of Article 10 of the Treaty: "Mexico has the right to 1.5 maf annually." As discussed in Section 3.4.4, statistical projections from the model with respect to flows to Mexico indicated that under baseline conditions and each of the interim surplus criteria alternatives, Mexico would receive no less than its apportionment of 1.5 maf per year. Thus, interim surplus criteria would not affect the ability of the United States to meet Treaty obligations. However, as noted in Chapter 1, Mexico would share reductions in delivery if extraordinary drought conditions were to significantly reduce deliveries to Lower Division states below their basic apportionments.

The "Authority and Assumptions" also reiterates the United States position that "Mexico may schedule an additional 200,000 af of surplus annually, but does not have the right to Colorado River water beyond the 1.5 maf" and provides that the United States will develop and supply technical data that identify the potential future deliveries of up to 200,000 af of surplus for use in Mexico. Technical information regarding the frequency of occurrence of Mexico's 200,000 af delivery pursuant to the Treaty is presented with the water supply discussion in Section 3.4.4.5.

Further clarification is needed to distinguish between the delivery of surplus flows and the delivery of excess flows to Mexico. Mexico has an annual apportionment of 1.5 maf of Colorado River water, based on the provisions of the Treaty. Mexico may receive additional Colorado River water (beyond the 1.5 maf) under two conditions. First, when surplus water exists in excess of the amount that can be beneficially used by the Basin States, Mexico is apportioned up to an additional 200,000 af of water. Under current practice, this 200,000 is available when flood control releases are made. This water, which Mexico may schedule throughout the year in accordance with Article 15 of the Treaty, is also referred to as "surplus" water. This class of "surplus" water under the Treaty is distinct however, from surplus water for use in the Lower Basin states as described in Article II(B)(2) of the Decree and Article III of the LROC. Second, the delivery of excess flows to Mexico may result from flood control operations, unanticipated contributions from events such as flooding along the Gila River and/or other factors resulting in canceled water orders by water users below Parker Dam. Excess flows are therefore typically considered to be any flows that are over and above the 1.5 maf normal apportionment (or 1.7 maf in certain years) that may be available to Mexico pursuant to the Treaty. It is acknowledged that Mexico has complete autonomy as to how they choose to manage apportioned and excess Colorado River flows.

3.16.4 AFFECTED ENVIRONMENT

3.16.4.1 HISTORICAL COLORADO RIVER BETWEEN THE SOUTHERLY INTERNATIONAL BOUNDARY AND THE GULF OF CALIFORNIA

The Colorado River flows approximately 1440 miles from its headwaters in the Rocky Mountains to its mouth at the Gulf of California. The location of the Colorado River within Mexico is shown on Map 3.16-1. The 22-mile reach of the river from the NIB to the SIB acts as the east-west boundary between Baja California in Mexico and the state of Arizona in the United States. This section of the river is referred to as the Limitrophe Division.

Although the section of the river between the SIB and the Gulf of California (which is also called the Sea of Cortez) is less than 50 air miles in length, the river meanders as much as 175 miles through this stretch (Browne, 1869; Rudkin, 1953).

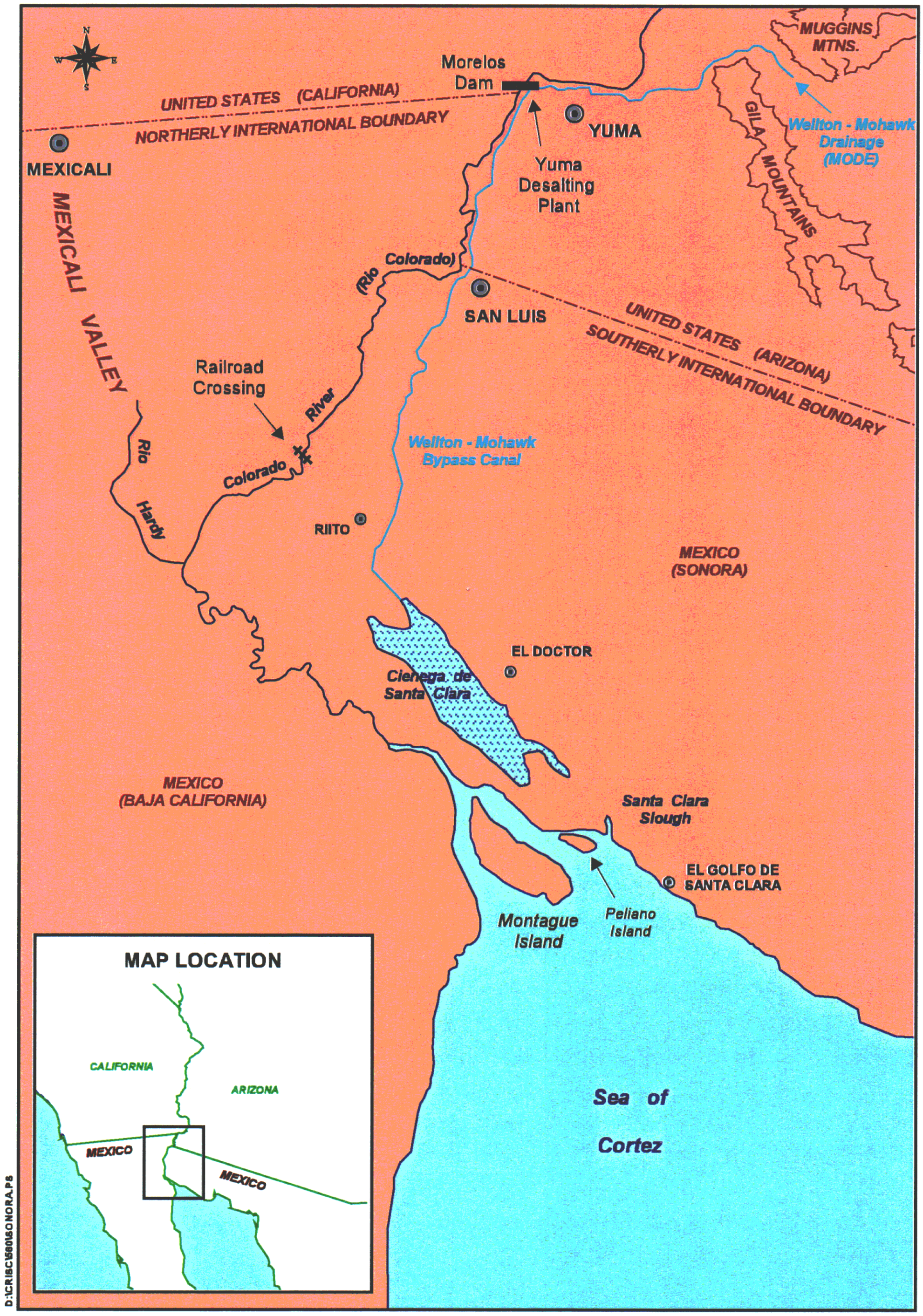
Historically, the portion of the Colorado River within Mexico could be divided into two reaches: the upper reach, which was influenced mainly by flood events; and the lower reach, which was influenced mainly by tidal fluctuations in the Gulf of California. The upper reach extends from the international boundary to approximately the confluence of the Rio Hardy and the Colorado (Mearns, 1907). The plant community found in this reach of the Colorado was similar to that found in the Yuma Valley. Large cottonwoods and dense willow thickets lined the river channel and oxbows within the floodplain (Johnson, 1869; Mearns, 1907). Honey and screwbean mesquites formed large dense thickets in areas that were subject to occasional overbank flooding (Bolton, 1930; Thwaites, 1905). Dense stands of arrowweed were noted in many historical journals throughout this reach of the river (Bolton, 1930; Mearns, 1907). Unlike the portion of the Colorado River that lies within the United States, large marshes were common within this stretch of the river. Several journals note expanses of cattails, rushes, and cane (Twaites, 1905; Mearns, 1907; Bolton, 1930). Large grass savannas were present within the floodplain that supported a cattle industry from the late 1800's through the early 1900's (Mearns, 1907; Kniffen, 1929 *in* Ohmart, 1982; Bolton, 1930).

The ecosystem found in the lower reach of the Colorado River, below the Rio Hardy to the Gulf of California was heavily influenced by tidal fluctuations in the Gulf of California and by heavy soil deposition from annual flood events. As the river meandered south of its confluence with the Rio Hardy, cottonwoods became scarce. Dense thickets of mesquite and arrowweed were still recorded on the upper terraces within this reach of the river. Dense stands of willows formed on newly deposited sediments. Large marshes, comprised mainly of cattails, rushes, and cane, dominated this stretch of the river (United States War Department, 1852; Mearns, 1907). Saltgrass became prevalent at the mouth of the river (Kniffen, 1929 *in* Ohmart, 1982).

3.16.4.2 PRESENT STATUS OF THE COLORADO RIVER BETWEEN THE NIB AND THE GULF OF CALIFORNIA

Human activities have significantly changed the lower Colorado River ecosystem since the early 1900's. Completion of Morelos Dam in 1950 allowed delivery of Colorado River water to irrigate lands in the Mexicali Valley. Flooding along the river is an infrequent event and riparian vegetation is sustained by groundwater, excess flows and/or return flows from agriculture.

Map 3.16-1
Colorado River Location Within Mexico



A 1997 survey of floodplain vegetation along the lower Colorado River (CH2MHill, 1997) classified 88 percent of over 4300 acres of the Limitrophe Division as saltcedar. Saltcedar (also commonly referred to a tamarisk) is an exotic species that appeared along the mainstem Colorado River about 1920 (Ohmart *et al.,* 1988) and has displaced native riparian species throughout the lower Colorado River.

Cottonwood willow communities were mapped on only 7.5 percent of the area, and the historically common and large marshes comprise only 3.5 percent of the communities.

The most current information available on the vegetation composition present along the upper reach of the Colorado River floodplain between the SIB and the Rio Hardy comes from a 1999 study conducted by the University of Monterrey (Guaymas), the University of Arizona, the Environmental Defense Fund, and the Sonoran Institute (Glenn, unpub. data and Luecke *et al.,* 1999). Aerial and remote sensing methods, combined with ground surveys to check accuracy, were used to estimate the number of acres of each habitat type. Habitat types were separated into two broad categories: (1) areas where Fremont cottonwood and Goodding willow comprised greater than 10 percent of the stand (determined by measuring percent vegetation cover by using remote sensing techniques); and (2) areas where Fremont cottonwood and Goodding willow comprised less than 10 percent of the stand. In stands where cottonwoods and willows comprised greater than 10 percent of the vegetative cover, the stands were further subdivided by height class and density (Open Gallery Forest, Closed Gallery Forest, and Shrub Dominated). In stands where cottonwoods and willows comprised less than 10 percent of the vegetative cover, the stands were further divided by species composition (saltcedar/arrowweed and saltcedar/mesquite).

The University of Monterrey study estimated approximately 9545 acres of greater than 10 percent cottonwood-willow habitat, 4492 acres classified as open gallery forest and 5053 acres classified as shrub dominated. Analysis of tree ring data indicated that the majority of these cottonwood-willow stands had been regenerated during high flow events over the last two decades, especially the 1993 Gila River flood event. This study also identified 25,829 acres of saltcedar/arrowweed habitat. Although the study does not specify, it is likely that these stands were actually monotypic saltcedar and monotypic arrowweed stands or clumps as arrowweed does not usually grow as a mixed stand with other vegetation types. Interestingly, this study did not identify any saltcedar/mesquite acreage within the entire study area (E. Glenn, 2000).

In December, 1998, biologists from the Bureau of Reclamation, San Bernardino County Museum, and the Upper Gulf of California and Colorado River Delta Biosphere Preserve conducted an aerial survey of the Rio Hardy and the Colorado River to determine potentially suitable Southwestern willow flycatcher breeding habitat. This survey noted that the vegetation at the confluence of the Rio Hardy and Colorado River was mostly narrow, dry stands of saltcedar. Northeast of the town of Venustiano Carranza, patches of Goodding willow and Fremont cottonwood were evident. Approximately five kilometers north of the Mexican Railroad crossing of the Colorado

River, the river contained long, linear stands of Goodding willow with a few cottonwoods also present. Approximately 15 kilometers south of San Luis, Sonora, the Colorado River begins to broaden out and from this point north to the NIB, a variety of habitats believed to be suitable breeding habitat for Southwestern willow flycatcher were present (McKernan, 1999).

The Cienega de Santa Clara (Cienega) is a large wetland complex located adjacent to the mouth of lower Colorado River in Sonora, Mexico. It is a large basin approximately 80,000 acres in size, including roughly 9700 vegetated acres with the remaining area consisting of highly saline tidal salt flats. The Cienega is typically included in discussions of the region of the Colorado River from the Rio Hardy confluence to the Sea of Cortez.

Geologically, the Cienega was formed by a tectonic slump. The Colorado River probably at many times in the geologic past flowed through the Cienega on its way to the Sea of Cortez. The Cienega retains sea water which intrudes into the southern end as a result of tidal action and evaporation results in TDS of the water exceeding 60,000 ppm in some areas. The upper end of the Cienega has two major brackish water inflows; the Main Outlet Drain Extension (MODE) and the Riito Drain (Drain). The MODE transports saline irrigation return flows from the Wellton-Mohawk Irrigation and Drainage District (WMIDD) east of Yuma, Arizona, and the Drain carries irrigation return flows from the eastern Mexicali Valley in Sonora, Mexico. The MODE and the Drain annually contribute approximately 140,000 and 28,000 af of water, respectively. There are other smaller sources of inflow to the Cienega, including springs along the eastern edge.

Salinity in the MODE water is approximately 3,200 ppm TDS while the salinity of the Drain is approximately 4,600 ppm TDS. This brackish water inflow supports the wetland vegetation at the upper end of the Cienega. The vegetation is limited by the brackish water interface with the highly saline water and soils comprising the extensive salt flats of the southern portion of the Cienega. The salt flats and associated shallow water exceed 60,000 ppm TDS. This is a result of tidal action bringing sea water into the basin, and evaporation and subsurface drainage accounting for water loss from the basin.

The vegetation in the Cienega is dominated by cattail and bulrush. The cattail and bulrush is interspersed with small channels and open water pools. The water depths in the vegetated area vary from one to four feet.

The vegetated area supports a variety of bird species. There is considerable use of the open water by waterfowl, including many varieties of ducks and geese. Several fish species are found in the fresher water areas of the Cienega including largemouth bass, carp, channel catfish, and tilapia. Several species of shiners and mollies are also found in the Cienega. Also notable is the presence of United States Federally listed threatened or endangered species, state designated special status species, and internationally recognized species of concern. These include the Yuma clapper rail, desert pupfish, Bald eagle, and American peregrine falcon.

The present size of the vegetated area of the Cienega is a result of construction of the MODE which carries brackish irrigation return flows from the WMIDD. Prior to the completion of the MODE the vegetated area of the Cienega was less than 500 acres and this consisted mainly of a narrow fringe to the east of the present large vegetated area. Since 1977, when the MODE was completed, the vegetated area has expanded from virtually no vegetation to its present size.

Because flows into the Cienega are from the MODE and Drain and the Cienega is not connected to the floodplain of the Colorado River, natural and physical resources located within the Cienega are not anticipated to be affected by the adoption of interim surplus criteria.

The lower Colorado River supported a large estuary at its mouth in the Sea of Cortez. The historic lower Colorado River exhibited the typical annual fluctuations in flow with the peak flows generally occurring in the spring to early summer. These flows carried nutrients and sediments into the estuary, creating the conditions suited for various phases of the life history of the endemic species.

The upper end of the Sea has remarkably changed due to the lack of annual inflow from the lower Colorado River, following the construction of dams and water diversions upstream. In recent years, there have been only three events of note that have resulted in large quantities of water reaching this estuary from the lower Colorado River. High flows were experienced on the lower Colorado River during flood control operations from 1983 through 1987 and flows from the Gila River through the lower Colorado River reached the estuary in 1993. There were space building flows in the fall of 1997 and fall of 1998 and flood control releases in January 1998. All but the flows of 1983-85 and 1993 probably had little effect on the Sea of Cortez. Therefore, the hydrology of the estuary is primarily dominated by tidal processes and sediment contribution to the estuary is a result of erosion of the delta itself (Carriquiry and Sanchez, 1999).

In spite of the reduced inflow from the lower Colorado River the estuary is extremely rich in nutrients, with the corresponding richness of plankton, leading to rich amounts of organisms on up the food chain. High chlorophyll values are found in the estuary typical of very rich coastal waters (Santamaria-Del-Angel, et al. (1994). Zooplankton biomass values are similar to those of the rich central Sea of Cortez, and the values for the channels around Montague Island at the mouth of the Colorado River are as high as those of estuaries and coastal lagoons (Farfan and Alvarez-Borrego, 1992). The nutrient inflow is primarily a result of agricultural drainage into the Rio Hardy, which joins the lower Colorado River immediately above the Sea.

3.16.5 EXCESS FLOWS TO MEXICO

Currently, water has the potential to flow past Morelos Dam under three circumstances: (1) as a result of operational activities upstream (e.g., canceled water orders in the United States, maintenance activities, etc.); (2) during a Gila River flood event; and (3) during flood control releases along the mainstream Colorado River. However, Mexico has complete autonomy as to how it chooses to manage scheduled and excess flows that arrive at Morelos Dam.

Water released from Parker Dam, under orders from 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 Dam for use in Mexico; however, some of this water may flow past Morelos Dam. The volume of water passing by Morelos Dam is rarely enough to have much effect on species and habitat in Mexico below the NIB. Adoption of interim surplus criteria will not affect water that flows past the NIB as a result of canceled water orders.

Gila River flood events are extremely rare. Only once has flow been recorded over 4,000 cfs at the Dome, Arizona, gaging station since 1941. In 1993, up to 27,500 cfs flowed past the 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 (Glenn, 2000).

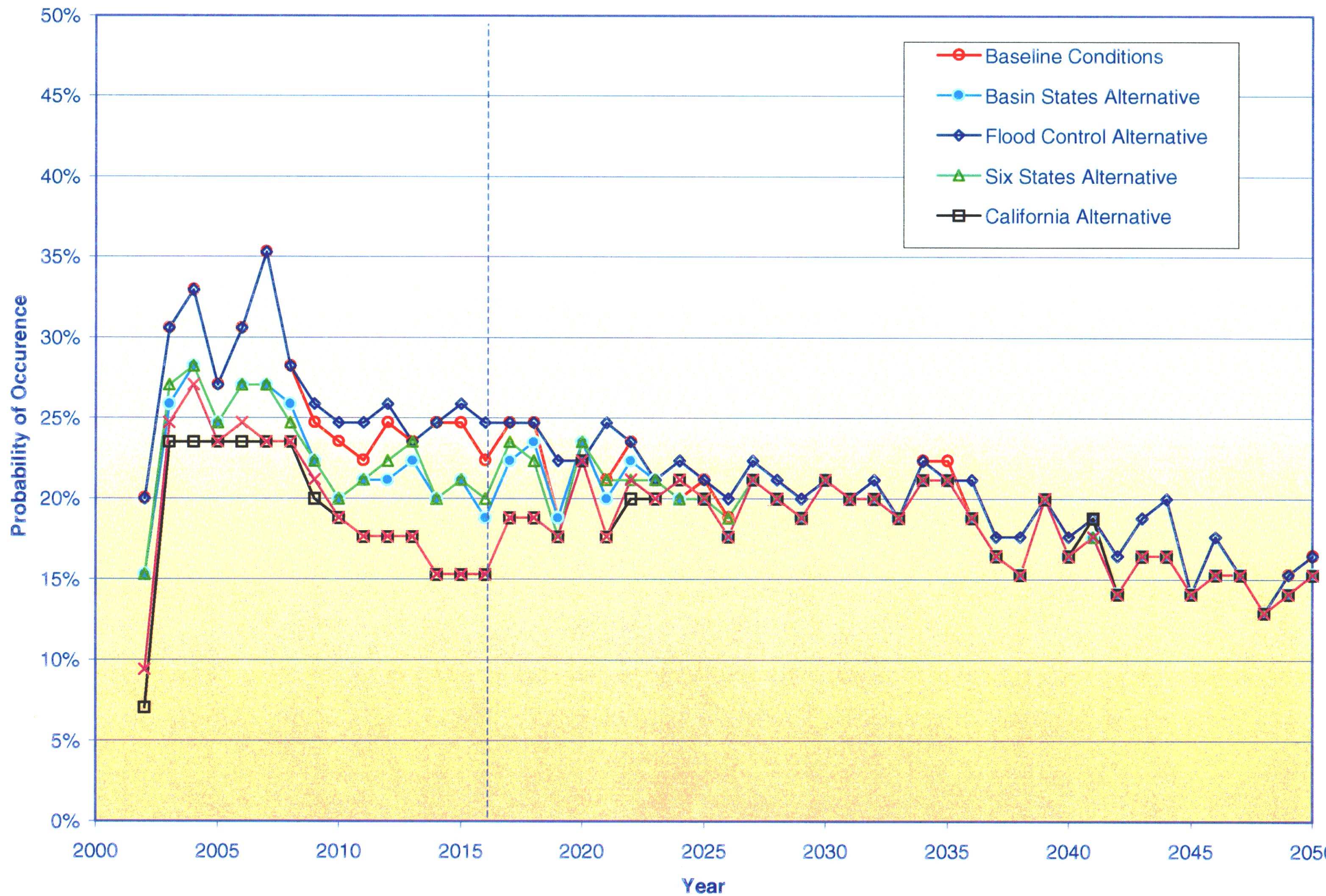
Excess flows to Mexico are almost entirely due to flood control releases originating at Hoover Dam. As discussed in Section 3.3.1.2, these flood control releases are dictated by the flood control criteria established for Lake Mead and Hoover Dam and are dependent upon hydrologic conditions.

3.16.5.1 BASELINE CONDITIONS

The potential range of water deliveries to Mexico under the baseline conditions and surplus alternatives was discussed in Section 3.4.4.5. Flows below Morelos Dam at various seasons were also analyzed in Section 3.3.4.5.4. Both the frequency and magnitude of excess flows are important factors in restoring and maintaining riparian habitat below Morelos Dam and are analyzed in more detail in this section. It should be emphasized that Mexico's management decisions at and below Morelos Dam are not modeled. This is due to uncertainty of what Mexico chooses to do with excess water. Therefore, the hydrologic analyses assume that any water in excess of Mexico's scheduled surplus deliveries are those flows that have the potential to occur below Morelos Dam.

Figure 3.16-1 presents a comparison of the frequency of occurrence of future delivery of excess flows to Mexico observed under the surplus alternatives to those of baseline

Figure 3.16-1
Probability of Occurrence of Excess Flows Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions



conditions. The frequency of occurrence is compiled by counting the number of modeled traces for each year that have excess flows and dividing by the total number of traces. As illustrated in Figure 3.16-1, with the exception of the Flood Control Alternative, the excess flows below Morelos Dam occur less frequently under the surplus alternatives when compared to baseline, during the interim surplus criteria period (2002 to 2016). These differences decrease to negligible amounts after 2027. The low frequency of occurrence in excess flows under the baseline conditions in the first year (2002) can be attributable to the relatively low reservoir starting conditions (approximately 33 feet below full content level at Lake Mead). The differences between the baseline and surplus alternatives, with the exception of the Flood Control Alternative, can be attributed to more frequent surplus deliveries which tend to lower Lake Mead reservoir levels. With lower reservoir levels, the frequency of flood control events (which are the primary source of the excess flows) is decreased.

The maximum frequency under baseline conditions is observed in 2006 (35 percent). Thereafter, a gradual declining tendency is observed to about 16 percent in 2050. The gradual declining trend observed under both the baseline conditions and surplus alternative coincide with the Basin States' plans to maximize consumptive use of their Colorado River water apportionment for agricultural, municipal and industrial use application, as exhibited by the Basin States' demand projections.

It is generally believed that periodic flows of 250,000 af or greater are necessary for maintaining the health of the Colorado River corridor in Mexico and the upper end of the Sea of Cortez (Leucke *et al.,* 1999) and help to restore floodplain habitat. Figure 3.16-2 presents the probability of occurrence of excess flows greater than 250,000 af and Figure 3.16-3 shows the probability of occurrence of excess flows greater than 1,000,000 af below the Mexico Diversion at Morelos Dam.

Figure 3.16-2
Potential Magnitude of Excess Flows Greater than 250,000 Acre-Feet Below Mexico Diversions at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions

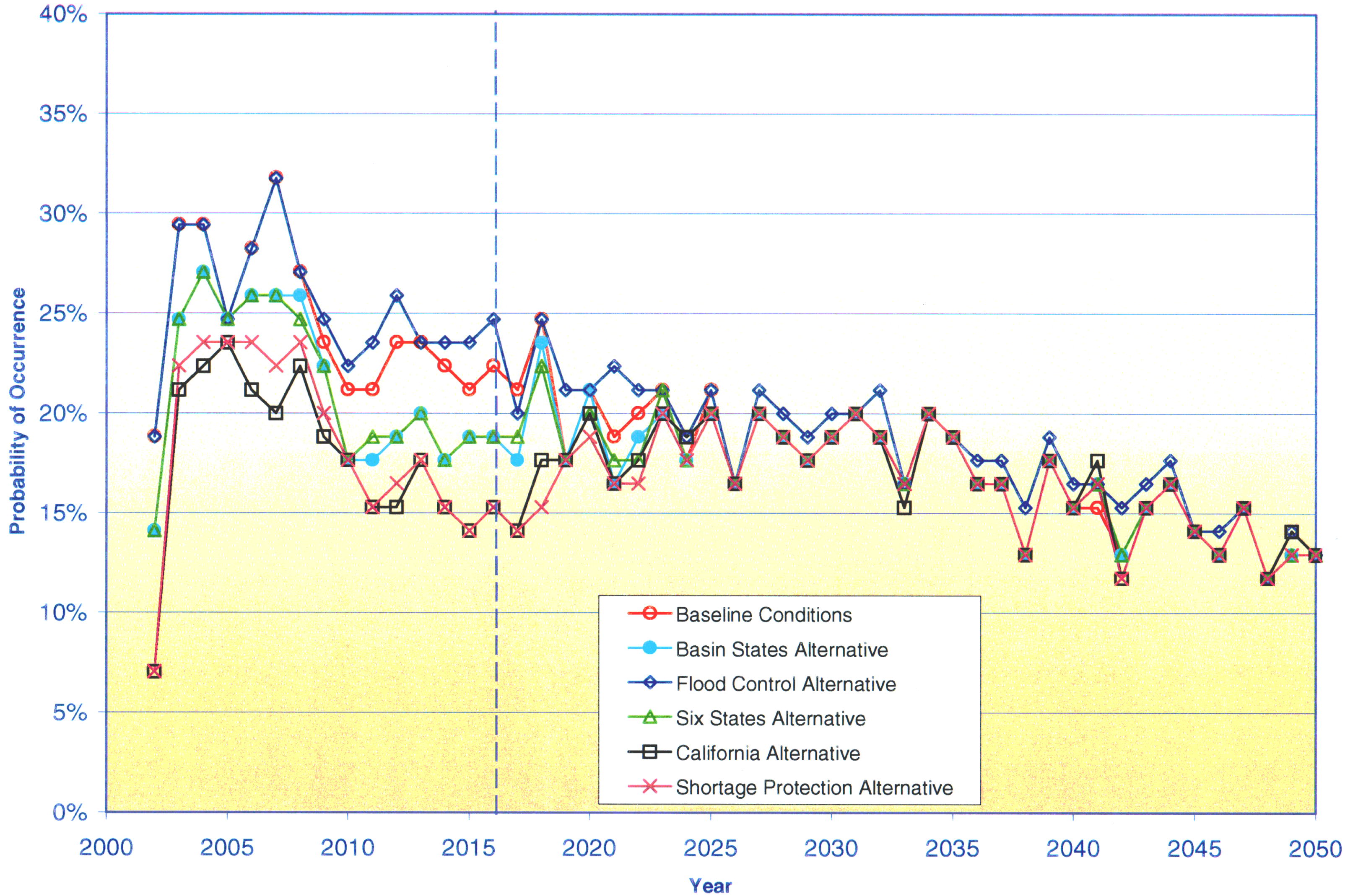
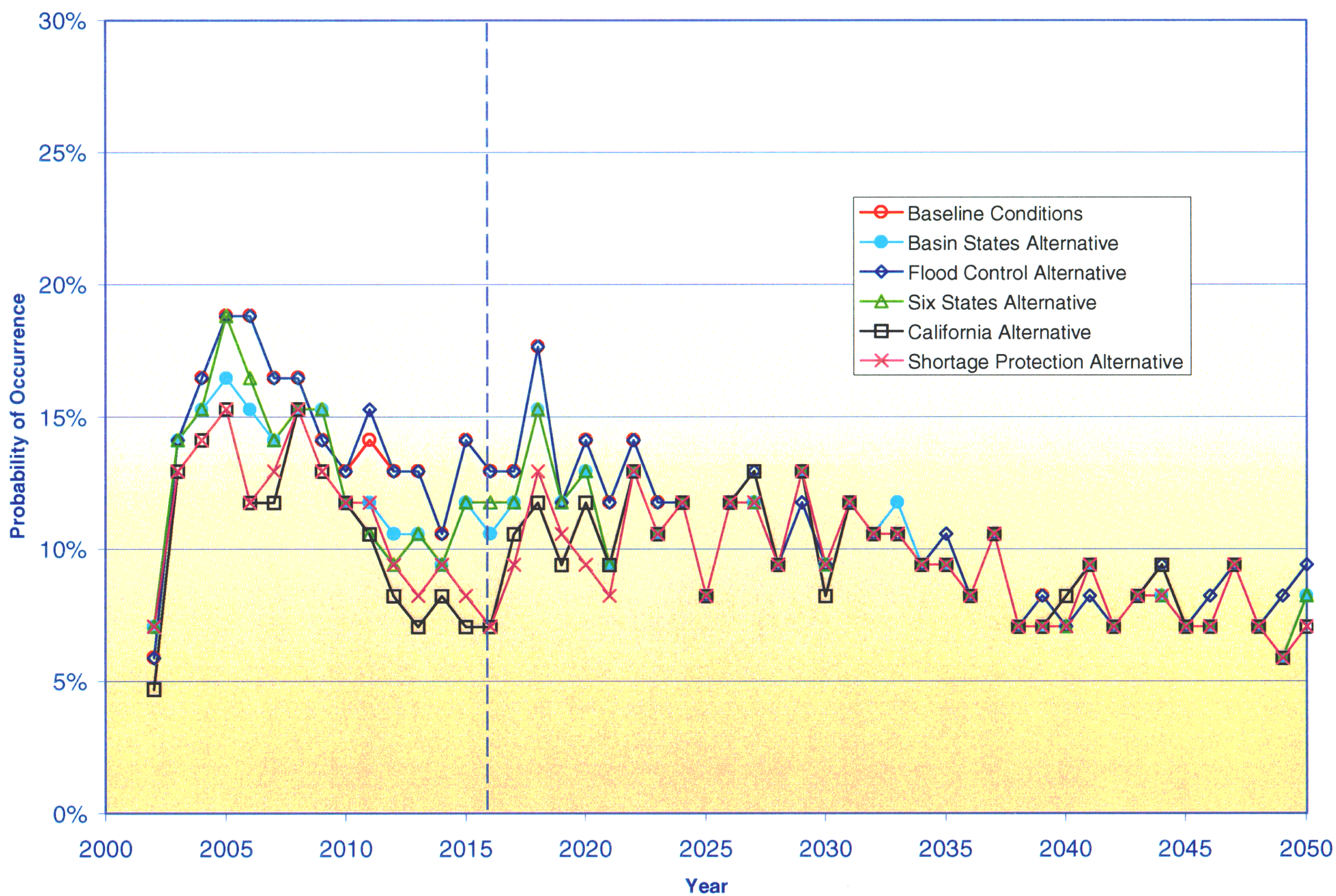


Figure 3.16-3
Potential Magnitude of Excess Flows Greater Than 1,000,000 Acre-Feet
Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions



3.16.5.2 COMPARISON OF SURPLUS ALTERNATIVES TO BASELINE CONDITIONS

Figure 3.16-1 presented a graphical comparison of the probability of delivery of future excess flows to Mexico under the surplus alternatives to those under the baseline conditions. A similar comparison for selected years is presented in tabular format in Table 3.16-1. In general, the Flood Control Alternative provides the highest frequency while the California and Shortage Protection alternatives provide the lowest frequency. The largest difference in frequency observed at the end of the interim surplus criteria period (2016) and is about seven percent for the California and Shortage Protection alternative compared to baseline conditions. This difference is reduced to approximately one percent by 2026. In 2016, the difference in frequency between the Basin States and Six States when compared to baseline conditions is three and two percent, respectively. After 2016, the differences in frequency between the surplus alternatives and baseline conditions gradually decreases to one percent or less by 2050.

Table 3.16-1
Frequency Occurrence of Excess Flows Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions

	Baseline Conditions	Basin States Alternative	Flood Control Alternative	Six States Alternative	California Alternative	Shortage Protection Alternative
2002	20%	15%	20%	15%	7%	9%
2003	31%	26%	31%	27%	24%	25%
2004	33%	28%	33%	28%	24%	27%
2005	27%	25%	27%	25%	24%	24%
2006	31%	27%	31%	27%	24%	25%
2007	35%	27%	35%	27%	24%	24%
2008	28%	26%	28%	25%	24%	24%
2009	25%	22%	26%	22%	20%	21%
2010	24%	20%	25%	20%	19%	19%
2011	22%	21%	25%	21%	18%	18%
2012	25%	21%	26%	22%	18%	18%
2013	24%	22%	24%	24%	18%	18%
2014	25%	20%	25%	20%	15%	15%
2015	25%	21%	26%	21%	15%	15%
2016	22%	19%	25%	20%	15%	15%
2026	19%	18%	20%	19%	18%	18%
2050	16%	15%	16%	15%	15%	15%

As discussed in Section 3.3.4.5.4, the annual volume of excess flows can be compared for the surplus alternatives and baseline conditions. Figures 3.16-4 and 3.16-5 show the cumulative distributions for years 2016 and 2050, respectively (Figure 3.3-28 showed the data for 2006). Although the frequency of occurrence of flows of a particular magnitude is decreased, the range of excess flows is preserved for the surplus alternatives when compared to baseline conditions.

Figure 3.16-4
Potential Magnitude of Excess Flows Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2016

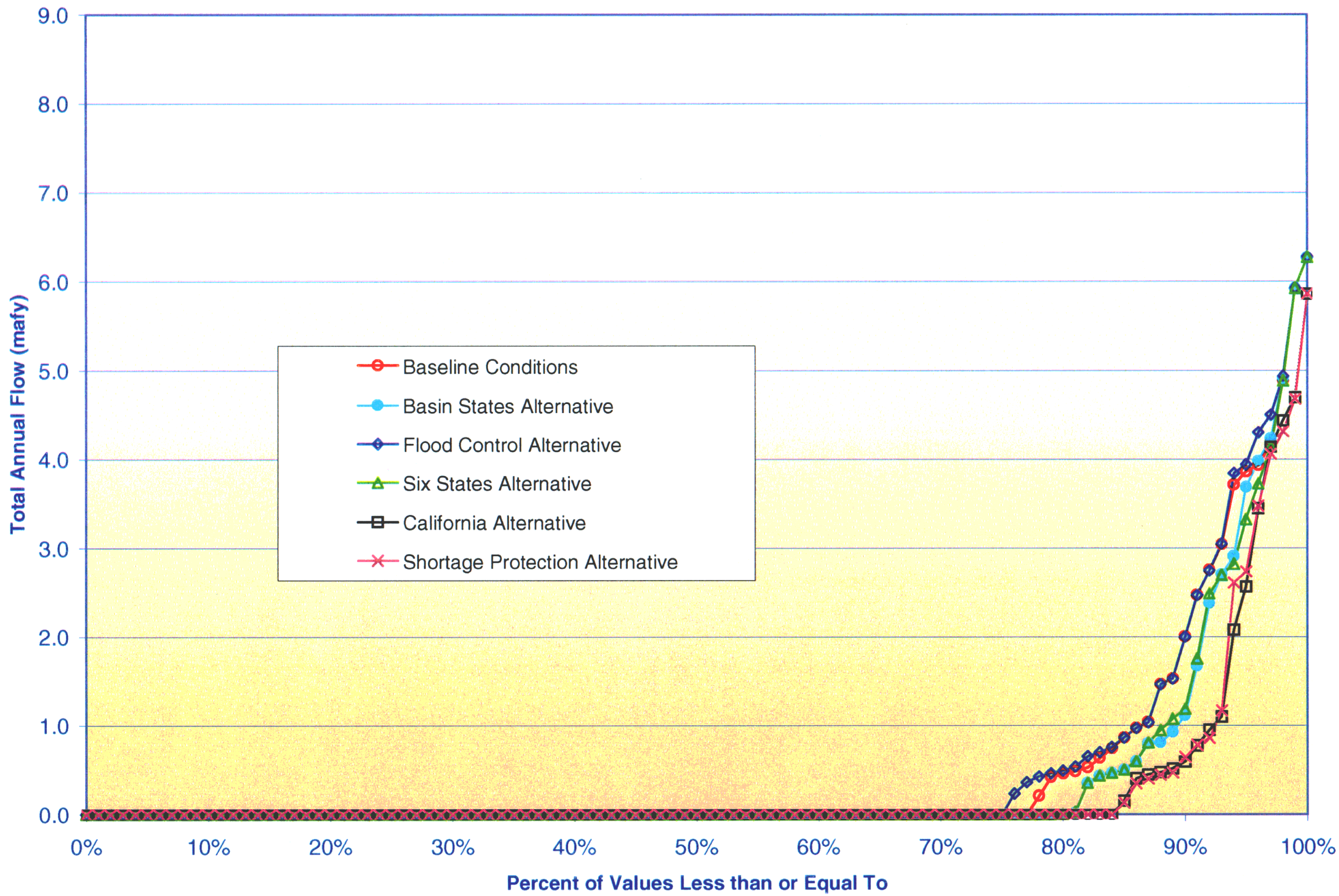
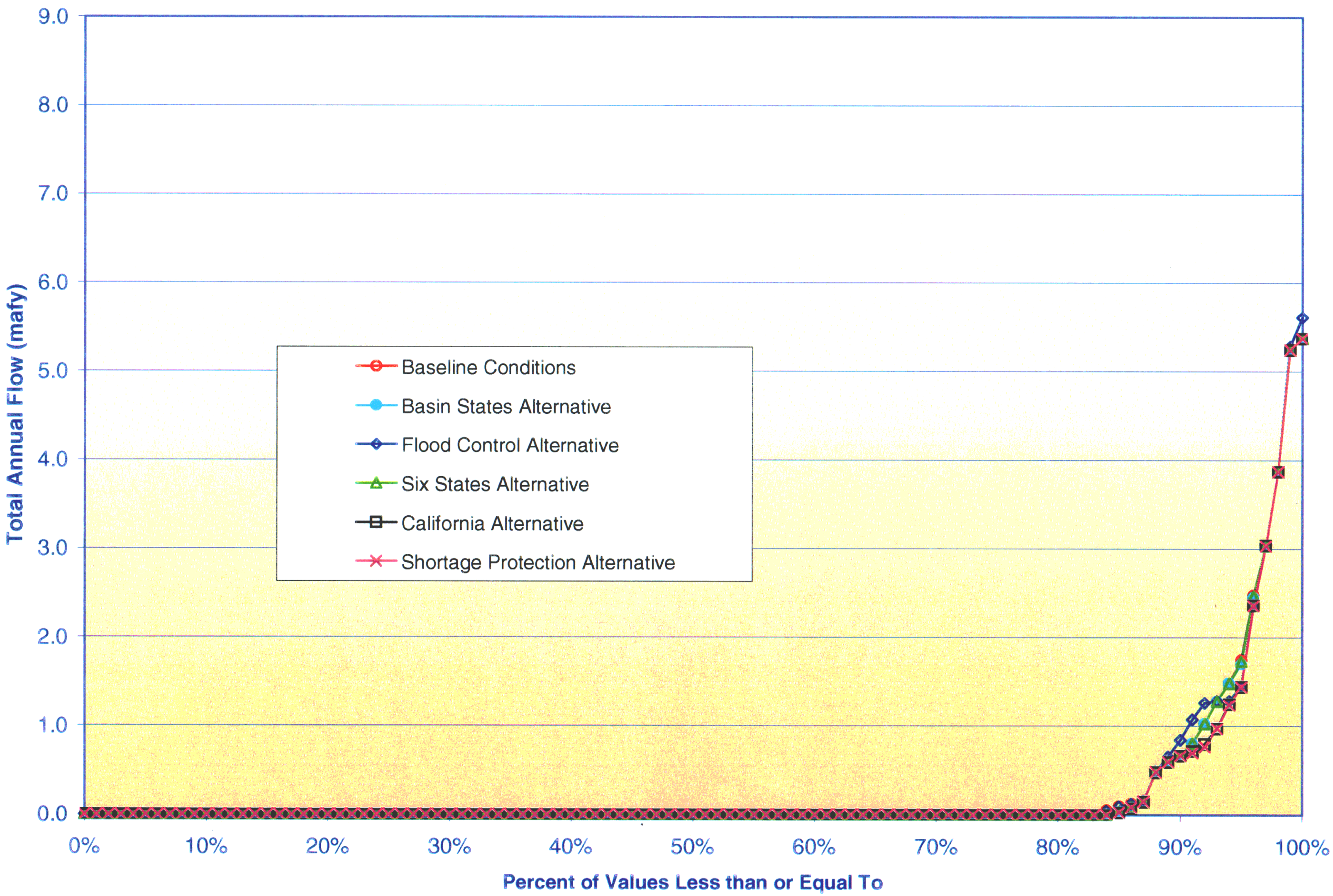


Figure 3.16-5
Potential Magnitude of Excess Flows Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions for Modeled Year 2050



Alternatively, the potential magnitudes of excess flows for the 75th and 90th percentiles are shown in Figure 3.16-6. The 75th and 90th percentile values are also presented in tabular format for years 2002 through 2026 in Table 3.16-2 and Table 3.16-3, respectively. The 75th percentile flow is defined as the flow that would not be exceeded 75 percent of the time (i.e., the minimum flow that would be expected to occur 25 percent of the time) and likewise, the 90th percentile flow would be expected to occur 10 percent of the time.

In summary, there are only minor differences in the potential magnitudes and potential frequencies of excess flows between baseline conditions and the Basin States Alternative. During the interim surplus criteria period, the average frequency of occurrence of beneficial flows (exceeding 250,000 af) in any year is 24.5 percent for baseline conditions, which is equivalent to approximately one year in four. This compares to a frequency of 17.8 percent for the California Alternative (one year in six) and 21.3 percent for the Basin States Alternative (one year in five). After the interim surplus criteria period, the average frequency of occurrence is approximately the same for all surplus alternatives and baseline (ranging between 17.0 percent and 18.2 percent or about one in every six years).

The above probabilities indicate conditions below Morelos Dam would be similar to those presumed to be beneficial. Leucke, et al, 1999 states it is not yet possible to quantify with certainty the required volume and frequency of these high flows.

While the probable frequency of approximately one in four years under the baseline would change to a probable frequency of approximately one in five years under the Basin States Alternative, the change in benefits to species and habitat would likely be insignificant. The riparian vegetation existing along the Colorado River corridor in Mexico is extremely resilient.

Mexico has complete discretion over the use of water entering that country. As stated before, excess flows are generally diverted when possible species and habitat can benefit only when the amount of water arriving at Mexico is in excess of that which can be diverted.

Figure 3.16- 6
Potential Magnitude of Excess Flows To Mexico
90th and 75th Percentile Values

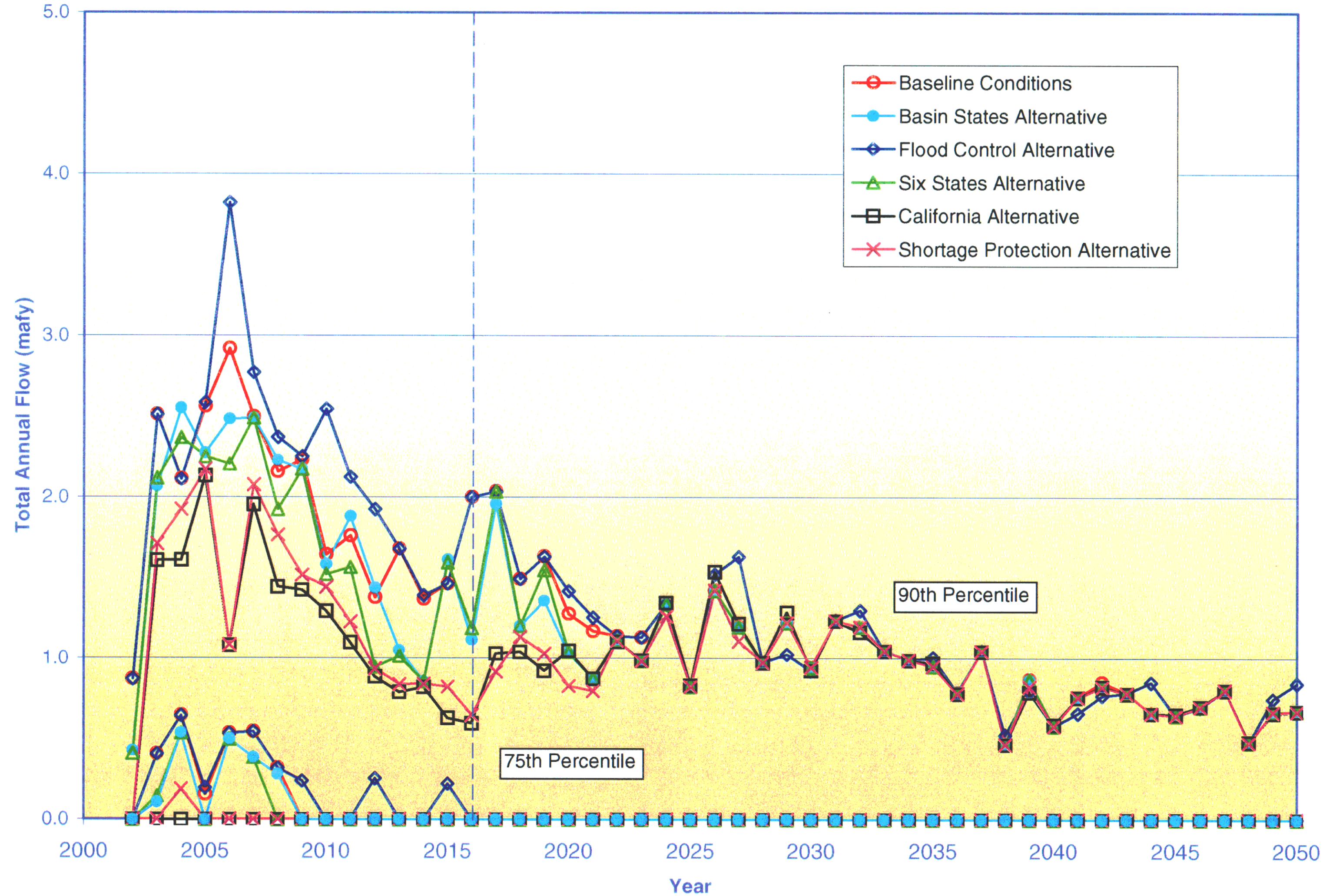


Table 3.16-2
Excess Flows Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions
75th Percentile Values for Selected Years (kaf)

	Baseline Conditions	Flood Control Alternative	Six States Alternative	Basin States Alternative	California Alternative	Shortage Protection Alternative
2002	0	0	0	0	0	0
2003	406	406	146	109	0	0
2004	645	645	536	536	0	186
2005	153	195	0	0	0	0
2006	534	534	500	500	0	0
2007	545	545	386	386	0	0
2008	318	319	0	282	0	0
2009	0	239	0	0	0	0
2010	0	0	0	0	0	0
2011	0	0	0	0	0	0
2012	0	253	0	0	0	0
2013	0	0	0	0	0	0
2014	0	0	0	0	0	0
2015	0	221	0	0	0	0
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	0	0	0	0	0	0
2019	0	0	0	0	0	0
2020	0	0	0	0	0	0
2021	0	0	0	0	0	0
2022	0	0	0	0	0	0
2023	0	0	0	0	0	0
2024	0	0	0	0	0	0
2025	0	0	0	0	0	0
2026	0	0	0	0	0	0

Table 3.16-3
Excess Flows Below Mexico Diversion at Morelos Dam
Comparison of Surplus Alternatives to Baseline Conditions
90th Percentile Values for Selected Years (kaf)

	Baseline Conditions	Flood Control Alternative	Six States Alternative	Basin States Alternative	California Alternative	Shortage Protection Alternative
2002	870	870	412	429	0	0
2003	2510	2510	2116	2068	1608	1709
2004	2112	2111	2368	2550	1610	1924
2005	2560	2584	2249	2274	2135	2171
2006	2918	3822	2203	2481	1083	1083
2007	2495	2772	2489	2489	1954	2076
2008	2157	2369	1924	2227	1445	1765
2009	2230	2249	2172	2175	1426	1516
2010	1641	2542	1522	1583	1295	1441
2011	1758	2124	1563	1881	1100	1226
2012	1378	1924	947	1438	887	934
2013	1680	1680	1014	1049	792	837
2014	1368	1391	857	857	823	840
2015	1464	1464	1595	1611	631	821
2016	1999	1999	1189	1114	599	647
2017	2034	2034	2033	1957	1032	915
2018	1492	1492	1201	1201	1041	1132
2019	1630	1629	1548	1358	924	1028
2020	1276	1417	1041	1032	1048	828
2021	1167	1254	876	876	876	796
2022	1136	1136	1112	1112	1106	1112
2023	1130	1130	981	981	988	981
2024	1338	1336	1338	1338	1348	1261
2025	823	823	823	823	833	823
2026	1422	1521	1422	1422	1537	1422

3.16.5.3 Potential Transboundary Effects of Reduced Flood Flow Frequency

As discussed in the previous sections, modeling of baseline conditions and each of the interim surplus criteria alternatives indicates a potential for reductions in the frequency of excess flows delivered to Mexico throughout the period of analysis. Excess flows can have both positive and negative impacts on salinity, groundwater, and water available for diversion by Mexico at Morelos Dam. This section discusses the general effects of excess flows to Mexico, and the potential impacts of reduced frequencies of such flows. Potential effects on floodplain habitat and species within Mexico could also occur from a reduction in excess flows to Mexico are discussed in Section 3.16.6.

3.16.5.3.1 General Effects of Flood Flows

On the positive side, excess flows to Mexico are lower in salinity than normal flows (i.e., flows associated with traditional downstream requirements and deliveries). These flows can, therefore, improve the water quality of deliveries to farms in the United States and Mexico, thereby reducing the salinity of the deep percolation from farm application and gradually improving the quality of groundwater and drainage return flows.

Because the volume and quality of water arriving at the NIB is larger and better during flood flow conditions, the salinity levels at NIB will be lower than in normal years. The salinity of flows carried to the SIB and into Mexico closely reflect the salinity of flows arriving at NIB. These high quality flows will tend to improve the groundwater quality and raise the groundwater levels along the river channel downstream of Morelos Dam.

However, on the negative side, higher river elevations resulting from flood control releases can cause groundwater levels to rise. In agricultural and urban areas, higher groundwater levels can cause crop damage or damage to municipal facilities. Higher groundwater levels can also require increased drainage pumping after flood conditions occur to return groundwater levels to normal, non-damaging conditions.

In addition, flood flows carry more sediment, which is deposited in the river channel both upstream and downstream of Morelos Dam. This sediment deposition will have the tendency to raise river levels for normal flow conditions, raise the groundwater levels near the river and reduce flow carrying capacity of the river channel both above and below Morelos Dam.

Flows in excess of 15,000 cfs below Imperial Dam and below Morelos Dam can be very destructive and can cause substantial damage to levees, river structures, and other private and public facilities. Considerable expense can be incurred to protect these facilities.

3.16.5.3.2 Effects of Reduced Excess Flows

As discussed in Section 3.16.5.1 and 3.16.5.2, modeling indicates an increasing likelihood over time of reduced frequency of excess flows to Mexico. Such reductions would occur to varying degrees under baseline conditions and each of the alternatives. The potential effects in Mexico of reduced excess flow frequencies could include the following:

- Mexico would have fewer opportunities to take water in excess of their maximum water order for uses such as groundwater recharge for agricultural and municipal wells, leaching of salts from farm soils, raising of additional crops, and improvement of water quality being delivered to farms along the east bank of the Colorado River.

- Groundwater levels downstream of areas being farmed in the United States and Mexico would decline and salinity levels of the groundwater would be expected to increase. However, damage caused by high groundwater would be less frequent and less substantial than experienced in the past. Also, it would take less time and less volume of additional drainage pumping to return groundwater to acceptable levels, reducing impacts to the salinity of flows arriving at NIB once deliveries to Mexico return to normal levels.

- The frequency of future excess flows would likely be less than those experienced in the past, reducing the potential for damage to public and private facilities and reducing costs associated with floods and flood control releases. Also the duration of flood control releases would be less, further reducing damage to levees and river control structures.

- Less sediment control work would be required in the river channel, reducing maintenance costs for both Mexico and the United States.

3.16.5.4 SUMMARY OF POTENTIAL EFFECTS TO SPECIAL-STATUS STATUS AND HABITAT IN MEXICO

3.16.5.5 POTENTIAL EFFECTS TO HABITAT IN MEXICO

The historic reduction in Colorado River flows below the NIB affected the ecosystem of the delta. However, these reductions have been instituted while meeting the requirements of an international treaty and the diversion and use of such treaty water is solely at Mexico's discretion. Except for periods of high flow or flood control operations, little water reaches the delta and the upper Gulf. It is not within Reclamation's discretionary authority to make unilateral adjustments to water deliveries to the international border.

Riparian habitat, along the Colorado River between the NIB and the Gulf of California, requires scouring flood events for regeneration. Both the frequency and magnitude of excess flows are important for this regeneration. As discussed previously, changes in the potential frequency and magnitude of beneficial excess flows (flows greater than 250,000 af) is not significantly affected by interim surplus criteria. As shown in Figure 3.16-4, under baseline conditions, the frequency of such excess flows to Mexico could potentially decrease over the next 25 years. The frequencies under the interim surplus alternatives follow this trend albeit lower during the interim surplus criteria period, with the maximum differences between the surplus alternatives and the baseline conditions occurring in 2015.

It is difficult to quantify the effect of reduced frequencies of excess flows to the existing habitat. The majority of the existing cottonwood-willow habitat regenerated during the 1983-87 Colorado River and 1993 Gila River flood events. This habitat has been sustained by a variety of potential water sources, including high groundwater and agricultural runoff.

Special status species that utilize riparian habitat along the Mexican reach of the Colorado River could be affected by the decrease in frequency of flood control releases and excess flows that occur below the Mexico Diversion at Morelos Dam. Existing habitat is, and will continue to be adversely affected by wildfire, agricultural clearing, and clearing for channel maintenance and flood control. New habitat is less likely to regenerate due to the decrease in flood frequency. However, these events are likely to occur whether or not surplus criteria are implemented. As shown in Figure 3.16-1, all alternatives (including the baseline condition) indicate a decrease in frequency of flood control releases and excess flows over the period of analysis (2002 through 2050), due to increased Upper Basin depletions.

The Cienega de Santa Clara is the largest wetland in the delta. This action will not affect the habitat occurring there, as the Cienega is sustained by irrigation return flows from the United States that will not be affected by the proposed action. The Rio Hardy wetlands occurring at the confluence of the Rio Hardy are also expected not to be affected by the action. These wetlands are also sustained by agricultural runoff, from the west side of the Mexicali Valley.

3.16.5.5.1 Potential Effects to Special Status-Species in Mexico

3.16.5.5.2 Desert pupfish

The desert pupfish (*Cyprinodon macularius)* is a small killifish with a smoothly rounded body shape. Adults generally range from 2-3 inches in length. Males are smaller than females and during spawning the males are blue on the head and sides and have yellow edged fins. Most adults have narrow, dark, vertical bars on their sides. The species was described in 1853 from specimens collected in San Pedro River, Arizona. There are two recognized subspecies and possibly a third form (yet to be described). The nominal subspecies, *Cyprinodon macularius macularius*, occurs in both the Salton Sea area of southern California and the Colorado River delta area in Mexico and is the species of concern, herein. The other subspecies is *C.m. eremus* and is endemic to Quitobaquito Spring, Arizona.

The desert pupfish was listed as an endangered species on March 31, 1986. Critical habitat for the species was designated in the United States at the time of listing and included the Quitobaquito Spring which is in Organ Pipe Cactus National Monument, and San Felipe Creek along with its two tributaries Carrizo Wash and Fish Creek Wash in southern California. All of the former and parts of the latter were in federal ownership at the time of listing. Reclamation purchased the remaining private holdings along San Felipe Creek and its tributary washes and turned them over to California Department of Fish and Game in 1991. All of the designated critical habitat is now under state or federal ownership.

Desert pupfish are adapted to harsh desert environments and are extremely hardy. They routinely occupy water of too poor quality for other fishes, most notably too warm and too salty. They can tolerate temperatures in excess of 110° F; oxygen levels as low as 0.1 ppm; and salinity nearly twice that of sea water (over 70,000 ppm). In addition to their absolute tolerance of these parameters, they are able to adjust and tolerate rapid, extreme changes to these same parameters (Marsh and Sada 1993). Pupfish have a short life span, usually only two years, but they mature rapidly and can reproduce as many as three times during the year.

Desert pupfish inhabit desert springs, small streams, creeks, marshes and margins of larger bodies of water. The fish usually inhabit very shallow water, often too shallow for other fishes. Present distribution of the subspecies *C. m. macularius* includes natural populations in at least 12 locations in the United States and Mexico, as well as over 20 transplanted populations.

One of the natural populations in Mexico is in the Cienega de Santa Clara, a 100,000-acre shallow basin on the Colorado River delta 60 miles south of the United States/Mexico border. The area is about 90 percent unvegetated salt flats with a number of small marsh complexes along the eastern edge of the bowl where it abuts an escarpment. The area is disconnected from both the Colorado River and the Gulf (Sea of Cortez), however extreme high tides result in the lower half of the basin becoming inundated to a level of one foot or less of salt water from the gulf. The marsh areas on the east side are small and are spring fed. The largest marsh complex is on the northeast side where two agricultural drains provide relatively fresh water inflows. The desert pupfish occur in a number of these marsh complexes.

Reclamation biologists discovered this population of desert pupfish in 1974 during preproject investigations for a feature of the Colorado River Basin Salinity Control Project. At that time, inflow to the Cienega was by agricultural return flows from the

Riito Drain in Mexico which provided about 35 cfs flow. The project feature being investigated was construction of a bypass canal for drain water from WMIDD.

Desert pupfish were found in the marsh along with mosquito fish, sailfin mollies, carp and red shiners. The bypass canal was completed in 1978 and provided a steady flow of over 150 cfs to the marsh. Based upon aerial surveys, the added inflow caused the marsh to grow from an estimated 300 acres of vegetated area in 1974 to roughly 10,000 acres in 1985. Recent aerial surveys show that while the inflows have continued, the marsh has not continued to grow in size. Desert pupfish continue to exist in the marsh. The fish tend to inhabit the shallow edges of the marsh in vegetated areas. Desert pupfish from the Cienega were transported to Dexter National Fish Hatchery during May 1983, and many of the transplanted populations in the United States are of this subspecies and stem from this initial transplant.

Reclamation has determined that desert pupfish would not be affected by the implementation of interim surplus criteria. The main population exists in the Cienega de Santa Clara which is not dependent on flows from the lower Colorado River. As such, the potentially reduced frequency of excess flows that may occur as a result of the adoption of interim surplus criteria would not have a direct effect on the water in the Cienega. The other populations of desert pupfish are not found proximate to the Colorado River.

3.16.5.5.3 Vaquita

The Vaquita (*Phocaena sinus)* is a small porpoise and is widely believed to be the most endangered marine cetacean in the world (Klinowska 1991; Taylor and Gerrodette 1993). It is also the only endemic species of marine mammal from the Gulf.

The Vaquita was listed as "Vulnerable" in 1978 by the IUCN-The World Conservation Union [formerly the International Union for Conservation of Nature and Natural Resources (IUCN)] in their Red Data Book and also in the Mexican list of wild vertebrates in danger of extinction. The Vaquita was also listed in Appendix I of the Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora on 28 June 1979, and in February 1985 as an endangered species under the United States Endangered Species Act. Recently, this porpoise was classified as "Endangered" in the IUCN Cetacean Red Data Book.

The Vaquita is very similar in external morphology to the harbor porpoise (*Phocaena phocaena*). Based on a very small sample and a maximum recorded total length of about five feet, the Vaquita may be the smallest of all the delphinoids (Brownell *et al.*, 1987). The pectoral fins are larger and the dorsal fin is higher proportionally to the body length than in any other extant porpoise species (Brownell *et al.,* 1987).

The coloration of adult Vaquitas is unique. On the dorsal portion, the color is dark gray, the sides are pale gray, and the ventral surface is white with some pale-gray elongated spots. The porpoise has a large, dark eye spot and lip patches that contrast with the gray background (Ramirez, 1993).

The life history of the Vaquita appears, in many ways, to be similar to its better-studied congener, the harbour porpoise, from the Bay of Fundy, Canada and the Gulf of Maine. Both species have a maximum longevity of about 20 years (Hohn, *et al.,* 1996). Little is known about the reproductive biology of the species. It has been suggested that calving occurs in the spring and mating in late spring or soon thereafter (Vidal, 1990). Food habits are also practically unknown; Fitch and Brownell (1968) reported small fish such as grunt (*Orthopristis reddingi*) and croaker (*Bairdiella icistia*) from stomach contents and Brownell (1982) also reported squid. More details regarding the life history of the Vaquita are documented in Vidal (1995) and Hohn, *et al.,* (1996).

The range of the Vaquita is restricted to the northwestern corner of the Gulf of California, Mexico (Jaramillo-Legorreta, *et al.,* 1999), representing the most restricted range for any cetacean species (Ramirez 1993). Stranding data, mortalities in fishing nets and sightings of live animals all confirm that the present distribution of Vaquita is concentrated in a small area rear Rocas Consag in the northwestern Gulf of California (Gerrodette, *et al.,* 1995). Sightings outside of this region (south of 30E 45' N latitude) may represent occasional departures by some individuals from the center of distribution (Silber and Norris, 1991) or temporary extensions in distribution due to climatic changes (Vidal, 1990). The region south of Puerto Penasco, Sonora, Mexico, remains insufficiently monitored to further increase the accuracy of population estimates and to establish the southern limit of the geographic range of the species (Ramirez 1993). The range of the Vaquita overlaps that of the endangered totoaba, to which it may be linked ecologically (Ramirez 1993).

A number of factors make the Vaquita an extremely difficult species to survey; habitat characteristics such as turbid water, fraction of the time spent at the surface, elusive behavior, and its erratic surfacing mode (Ramirez 1993). Despite these difficulties, and biases in collection of survey data, it is clear that the species is rare. The total population size is estimated to be 567 animals, with a 95 percent confidence interval from 177 to 1073 (Jaramillo-Legorreta, *et al.,* 1999).

The Vaquita is particularly vulnerable to incidental mortality in gillnets. The Vaquita has probably been incidentally caught in gillnets since the mid-1920's. It can be assumed the significant expansion of the fishing industry during the early 1940's further reduced the population (Vidal, 1995). Vaquita bycatch in gillnet fisheries was identified as a defining factor which may drive the species to extinction. The total estimated incidental mortality caused by the fleet of El Golfo de Santa Clara was 39 Vaquitas per year, over 17 percent of the most recent estimate of population size. El Golfo de Santa Clara is one of three main ports that support gillnet fisheries throughout the range of the Vaquita. The fishing effort for San Felipe, Baja California appears to be similar to that of El Golfo de Santa Clara, suggesting that this estimate of incidental mortality of Vaquitas represents a minimum (D'Agrosa, *et al.,* 2000).

Ramirez (1993) identified three actual and potential impacts to the Vaquita: incidental mortality caused by fishery activities, reduced Colorado River flows into the Gulf of California and pollution from various sources associated with Colorado River flows into the Gulf.

Rojas-Bracho and Taylor (1999) concluded habitat alteration from reduced flow of the Colorado River does not currently appear to be a risk factor because productivity remains high in Vaquita habitat. Pollutant loads are low and pose low to no risk. Reduced fitness from inbreeding depression and loss of genetic variability are unlikely to pose high risk currently, though risk will increase if Vaquitas remain at low abundance over long periods of time. Mortality resulting from fisheries is the greatest immediate risk for Vaquitas.

Therefore, Reclamation concluded that the implementation of any of the interim surplus criteria alternatives would have no effect on the Vaquita.

3.16.5.5.4 Totoaba

The totoaba *(Totoaba macdonaldi)* is a fish endemic to the Gulf of California. In 1976 the species was listed as threatened under the Convertion on International Trade in Endangered Species (CITES). On May 21, 1979, the totoaba was listed in the United States as endangered pursuant to the Endangered Species Act (44 FR 99).

Totoaba are large schooling fish that undertake a seasonal migration within the Gulf and may live to 25 years of age (Cisneros-Mata *et al.,* 1995). Totoaba are the largest of the sciaenid fish, with a maximum reported weight of over 100 kg and a length of over two meters (Flanagan and Hendrickson 1976). Adults spawn in the shallow waters of the Colorado River delta in the upper Gulf where they remain for several weeks before migrating south. Spawning originally occurred from February to June. More recently, it has been determined that spawning takes place from February through April (Cisnereo-Mata, *et al.,* 1995). Juveniles are thought to emigrate south after spending two years in the upper Gulf, which is considered their nursery ground (Flanagan and Hendrickson 1976).

Juvenile fish eat small benthic organisms, mainly crabs and fish, amphipods, and shrimp; adults eat larger more pelagic items, such as sardines and adult crabs (Flanagan and Hendrickson 1976, Cisneros-Mata *et al.,* 1995). Many aspects of the biology and ecology of this species are unknown.

The totoaba is thought to have ranged from the mouth of the Colorado River to Bahia Concepcion on the west coast of the Gulf and to the mouth of the El Fuerte River in the east (Jordan and Everman 1896 *cited in* Berdegue 1955). Historically, millions of totoaba migrated north in the spring to spawn at the mouth of the Colorado River (Gause 1969).

A more thorough description of the life history of the totoaba is found in Cisneros-Mata, *et al.,* 1995.

The first commercial harvesting of totoaba began in the early 1890s and by 1942, annual catches peaked at 2.3 million kg. In 1975, the catch had declined to 59,142 kg (Lagomarsino 1991). Beginning as early as 1940, the Mexican government imposed restrictions on the commercial fishery for totoaba, and in 1975, the government designated totoaba as endangered and declared an indefinite prohibition on all types of commercial and recreational fishing (Flanagan and Hendrickson 1976).

In April-June 1994, the School of Marine Sciences of the Autonomous University of Baja California developed a field technique that permitted successful capture and transport of totoaba broodstock from the Upper Gulf to the laboratory at Ensanada (True *et al.,* 1997). They were able to keep these specimens of totoaba alive and successfully spawned them. In October of 1997 they released 250 juveniles, back into the upper gulf. These were four months old and 20-25 cm long.

Despite the closure of the fishery, illegal exploitation continues. It is believed that the incidental catch of juvenile totoaba in the shrimp trawling fishery is the principal factor affecting recovery of the species (Barrera-Buevara, 1990). Much of the illegal gillnetting for totaba occurs during the spawning migration. Current knowledge indicates that decrease of the adult stock may be responsible for the decline experienced by the totoaba population (Cisneros-Mata, *et al.,* 1995).

Cisneros-Mata, *et al.,* (1995) concluded that a negative impact on totoaba due to decreased flow from the Colorado River may be questionable because the claimed effects would have caused extinction of totoaba over 40 years time. Flanagan and Hendrickson (1976) concluded that recruitment and over-fishing explained the decline better than habitat alteration. It is estimated that a steady flow of water reaching an annual total of 1.6 maf would be necessary to restore the brackish water conditions that historically occurred in the estuary (US Bureau of Reclamation file data). Even if that amount of water were available at present, Reclamation has no control over Colorado River water once it reaches the NIB.

As illustrated in Figure 3.16-1, the adoption of interim surplus criteria has the potential to reduce the frequency of occurence of excess flows below the Mexico diversion of Morelos Dam by as much as seven percent during the interim surplus criteria period (California and Shortage Protection alternatives in year 2016). However, the range of excess flows (magnitude) that are expected to occur, albeit less frequent, under the surplus alternatives are not expected to vary from those observed under baseline conditions (see Figures 3.16-4 and 3.16-5). Therefore, based upon this potential reduced frequency of excess flows, the inadvertent mortality resulting from commercial fishing as described above and Reclamation's lack of discretion over Colorado River water in Mexico led Reclamation to determine that the interim surplus criteria may affect but is not likely to adversely affect the totoaba.

3.16.5.5.5 Southwestern Willow Flycatcher

Willow flycatchers (*Empidonax traillii extimus)* are found throughout North America and are further divided taxonomically into four subspecies, *E.t. brewseri, E.t. adastus, E. t. traillii,* and *E.t. extimus.* The latter, *E.t. extimus*, the southwestern willow flycatcher, breeds on the Lower Colorado River and its tributaries (McKernan *et al.*, 1996, 1997, 1998, 1999, 2000). In January 1992, the Service was petitioned to list the southwestern willow flycatcher, *Empidonax traillii extimus* as an endangered species. In July 1993, the species was proposed as endangered with critical habitat (58 FR 39495). On February 27 1995, the Service listed the southwestern willow flycatcher as an endangered species (60 FR 10694). The Service has not issued a recovery plan to date and the designated critical habitat does not include the lower Colorado River (60 FR 10694).

As a member of the genus *Empidonax,* Willow flycatchers are known for the difficulty in identifying individuals to species in the field (Phillips *et al.,* 1964; Peterson 1990; Sogge *et al.,* 1997a). The Southwestern willow flycatcher is a small bird, approximately 5.75 inches in length, with a grayish green back and wings, whitish throat, light grey olive breast, and pale yellowish body. Two white wing bars are visible. The upper mandible is dark, the lower light. The most distinguishable taxonomic characteristic of the Southwestern willow flycatcher is the absent or faintly visible eye ring. The Southwestern willow flycatcher can only be positively differentiated in the field from other species of its genus by its distinctive "fitzbew" song.

Southwestern willow flycatchers nest in riparian habitat characterized by dense stands of intermediate sized shrubs or trees. Most Southwestern willow flycatcher nests are located in the fork of a shrub or tree from four to 25 feet above the ground (Unitt 1987; Sogge *et al.,* 1997a). These trees are either in or adjacent to soils that are either saturated or have surface water (Phillips *et al.,* 1964; Muiznieks *et al.,* 1994, McKernan 1998). The southwestern willow flycatcher is an insectivore, foraging within and above dense riparian habitat, catching insects in the air or gleaning them from the surrounding foliage. It also forages along water edges, backwaters, and sandbars adjacent to nest sites. Details on specific prey items can be found in Drost *et al.,* (1998). On the Lower Colorado River, Southwestern willow flycatchers begin arriving on breeding territories in early May and continue to be present until August, with some records into early September (McKernan, 1998). Recent studies have documented nest building as early as May 1 (McKernan 1997) and fledging dates as late as September 9 (McKernan 1998).

A long-distance migrant, the Southwestern willow flycatcher winters in Mexico from Nayarit and southwestern Oaxaca south to Panama and possibly extreme northwestern Columbia and migrates widely through the southern United States occurring as a regular migrant south to the limits of the wintering range (Peterson 1990; Sogge *et al.,* 1997a, AOU 1998). Recent field studies in Costa Rica by Koronkiewicz and Whitfield (1999) and studies of museum specimens by Phil Unitt (1999) collaborate previous information on the species' range. One specimen of willow flycatcher captured in Costa Rica during the winter of 1999 was banded at the Ash Meadows National Wildlife Refuge (NWR) in southern Nevada in July 1998 (Koronkiewicz and Whitfield 1999). The Ash Meadows NWR is within the identified breeding range of this southwestern subspecies and thus the capture in Costa Rica is the most recent confirmed wintering site of *E.t. extimus*. Breeding range for the species as a whole extends as far south as northern Sonora, and northern Baja California (AOU 1998) and north into Canada.

Breeding range for the southwestern subspecies of the willow flycatcher, *E. t. extimus*, extends from extreme southern Utah and Nevada, through Arizona, New Mexico, and southern California, but records from west Texas and extreme northern Baja California and Sonora, Mexico remain lacking to date (Unitt 1987). Molina (1998) observed the species in exotic plantings in the El Golfo de Santa Clara fishing village, and in the saltcedar-mesquite-acacia woodland corridor along the pozos near El Doctor in 1997. The species has also been documented at El Doctor wetlands, Colorado River delta, Sonora, Mexico June 7 and 8, 1999 (Hinojosa-Huerta, 2000). These sighting confirm the area is used for migration, but does not confirm breeding. The presence of the subspecies after June 15 is required to confirm breeding (Sogge *et al.,* 1997; Braden and McKernan 1998). A survey for southwestern willow flycatcher was conducted on the Copopah Indian Reservation near Yuma, Arizona in 2000. Twenty-six birds were detected on May 22 and June 6, 2000, and none later. It was concluded the riparian habitat on the Reservation was being used as a stopover area during the migration (Garcia-Hernandez, *et al.,* 2000).

The majority of Southwestern willow flycatchers found during the past five years of surveys on the Lower Colorado River have been found in saltcedar, *Tamarix ramosissima*, or a mixture of saltcedar and native cottonwood and willow, especially Gooddings willow, *Salix gooddingii*, coyote willow, *S. exigua* and Fremont cottonwood, *Populus fremontii*. Based on available information at the time of this writing, aside from this general description, no clear distinctions can be made based on perennial species composition or foliage height profiles, as to what constitutes appropriate southwestern willow flycatcher habitat. Due to the difficulty in determining the presence of this species in dense habitat, their presence should not be ruled out until surveys have been conducted if habitat meeting the general description given above is present.

Historically, the Southwestern willow flycatcher was widely distributed and fairly common throughout its range, especially in southern California and Arizona (Unitt 1987; Schlorff 1990). Nest and egg collections by Herbert Brown suggest that the Southwestern willow flycatcher was a common breeder along the lower Colorado River near Yuma in 1902 (Unitt 1987).

Grinnell (1914) also believed that the Southwestern willow flycatcher bred along the lower Colorado River due to the similarities in habitat between the lower Colorado

River and other known breeding sites. He noted the abundance of Southwestern willow flycatchers observed in the willow association and possible breeding behavior. However, the date of his expedition corresponds more to the migration season of the Southwestern willow flycatcher with only a small overlap with the beginning of the breeding season.

In 1993, the Service estimated that only 230 to 500 nesting pairs existed throughout its entire range (58 FR 39495). However, since extensive surveying has been implemented, this number has likely increased, especially on the lower Colorado River where the species was thought to have been extirpated (Hunter *et al.*, 1987b; Rosenberg *et al.*, 1991; McKernan and Braden 1999). Sixty-four nesting attempts were documented on the lower Colorado River from southern Nevada to Needles, California in 1998 (McKernan and Braden 1999).

Several factors have caused the decline in Southwestern willow flycatcher populations. Extensive areas of suitable riparian habitat have been lost due to river regulation and channelization, agricultural and urban development, mining, road construction, and overgrazing (Phillips *et al.*, 1964; Johnson and Haight 1984; Unitt 1987; Rosenberg *et al.*, 1991; Sogge *et al.*, 1997a). The total acreage of riparian vegetation has changed little in the last 20 years (Anderson and Ohmart 1976; Younker and Anderson 1986), although there is less native vegetation and more non-native present (Rosenberg *et al.*, 1991). The most recent estimate of historical, potentially suitable willow flycatcher habitat as delineated from 1938 aerial photography from the Grand Canyon to Mexico is 89,203 acres (USBR 1999d). Only some portion of this potentially suitable habitat can be assumed to be suitable habitat for the flycatcher, as the microclimate and other factors required which existed at the time are undeterminable. The total amount of occupied habitat for willow flycatchers along the lower Colorado River in the United States is estimated to be slightly over 6,000 acres (USBR 1999). A certain amount of habitat that apparently has the necessary components to be utilized as breeding habitat is not always being used (McKernan and Braden, 1998). This could indicate that lack of breeding habitat may not be what is limiting the Southwestern willow flycatcher's population.

In December, 1998, biologists from the Bureau of Reclamation, San Bernardino County Museum, and the Upper Gulf of California and Colorado River Delta Biosphere Reserve conducted an aerial survey of the Rio Hardy and the Colorado River to determine potentially suitable Southwestern willow flycatcher breeding habitat. Results of this survey indicate suitable habitat is present in the vicinity of Campo Mosqueda and Cucapa El Mayor and San Luis, Sonora along the Rio Colorado. Southwestern willow flycatchers utilize dense riparian habitat with moist soil or standing water present. Large volume flood control releases and Gila River flood flows are the primary condition under which riparian habitats are established in the delta and a high ground water table is needed to maintain this habitat. Potential reductions in the frequency of excess flows below Morelos Dam resulting from the adoption of either the Basin States, Six States, California or Shortage Protection alternative could potentially reduce the amount of water available for groundwater recharge in the areas adjacent to the main channel of the Colorado River over an extended period of time. This, coupled with continued groundwater production in these areas, could affect the high groundwater table that is needed to maintain habitat used by the Southwestern willow flycatcher. However, Reclamation believes that groundwater recharge in these area is more a result of percolation induced by agricultural irrigation, drainage water and the more frequent but lower-volume excess flows that are attributable to unused water delivery orders (by users in the Lower Basin states) that make it past Morelos Dam. This belief, considered with the uncertainty associated with excess flows, led to Reclamation's determination that the adoption of interim surplus criteria may affect, but is not likely to adversely affect the Southwestern willow flycatcher.

3.16.5.5.6 Yuma Clapper Rail

Yuma clapper rails (*Rallus longirostris yumanensis*) are federally endangered. They are found in emergent wetland vegetation such as dense or moderately dense stands of cattails (*Typha latifolia* and *T. domingensis*) and bulrush (*Scirpus californicus*) (Eddleman 1989; Todd 1986). They can also occur, in lesser numbers, in sparse cattail-bulrush stands or in dense reed (*Phragmites australis*) stands (Rosenberg *et al.*, 1991). The most productive clapper rail areas consist of a mosaic of uneven-aged marsh vegetation interspersed with open water of variable depths (Conway *et al.*, 1993). Annual fluctuation in water depth and residual marsh vegetation are important factors in determining habitat use by Yuma clapper rails (Eddleman 1989).

Yuma clapper rails may begin exhibiting courtship and pairing behavior as early as February. Nest building and incubation can begin by mid-March, with the majority of nests being initiated between late April and late May (Eddleman 1989, Conway *et al.*, 1993). The rails build their nests on dry hummocks, on or under dead emergent vegetation and at the bases of cattail or bulrush. Sometimes they weave nests in the forks of small shrubs that lie just above moist soil or above water that is up to about 2 feet deep. The incubation period is 20-23 days (Ehrlich *et al.*, 1988, Kaufman 1996) so the majority of clapper rail chicks should be fledged by August. Yuma clapper rails nest in a variety of different micro habitats within the emergent wetland vegetation type, with the only common denominator being a stable substrate. Nests can be found in shallow water near shore or in the interior of marshes over deep water (Eddleman 1989). Nests usually do not have a canopy overhead as surrounding marsh vegetation provides protective cover.

Crayfish (*Procambarus clarki*) are the preferred prey of Yuma clapper rails. Crayfish were introduced into the lower Colorado River about 1934. This food source and the development of marsh areas resulting from river control such as dams and river management helped to extend the breeding range of the Yuma clapper rail. The original range of the Yuma clapper rail was primarily the Colorado River delta. The southernmost confirmed occurrence of Yuma clapper rail in Mexico was three birds collected at Mazaltan, Sinaloa; Estero Mescales, Nayarit; and inland at Laguna San Felipe, Puebla (Banks and Tomlinson 1974).

Crayfish comprise as much as 95 percent of the diet of some Yuma clapper rail populations (Ohmart and Tomlinson 1977). Availability of crayfish may be a limiting factor in clapper rail populations and is believed to be a factor in the migratory habits of the rail (Rosenberg *et al.,* 1991). Eddleman (1989), however, has found that crayfish populations in some areas remain high enough to support clapper rails all year and that seasonal movement of clapper rails can not be correlated to crayfish availability.

One issue of concern with the Yuma clapper rail is selenium. Eddleman (1989) reported selenium levels in Yuma clapper rails and eggs and in crayfish used as food were well within levels that will cause reproductive effects in mallards. Rusk (1991) reported a mean of 2.24 ppm dry weight selenium in crayfish samples from six lower Colorado River backwaters from Havasu National Wildlife Refuge, near Needles, California to Mittry Lake, near Yuma, Arizona. Over the past decade, there has been an apparent two to five fold increase in selenium concentrations in crayfish, the primary prey species for the Yuma clapper rail (King *et al.,* 2000). Elevated concentrations of selenium (4.21- 15.5 ppm dry weight) were present in 95 percent of the samples collected from known food items of rails. Crayfish from the Cienega de Santa Clara in Mexico contained 4.21 ppm selenium, a level lower than those in the United States, but still above the concern threshold. Recommendations from this latest report on the subject conclude that if selenium concentrations continue to rise, invertebrate and fish eating birds could experience selenium induced reproductive failure and subsequent population declines (King *et al.,* 2000).

Yuma clapper rail may be impacted by man-caused disturbance in their preferred habitat. In recent years the use of boats and personal watercraft has increased along the lower Colorado River. This has led to speculation that the disturbance caused by water activities such as those may have a negative impact on species of marsh dwelling birds.

This subspecies is found along the Colorado River from Needles, California, to the Gulf, at the Salton Sea and other localities in the Imperial Valley, California, along the Gila River from Yuma to at least Tacna, Arizona, and several areas in central Arizona, including Picacho Reservoir (Todd 1986; Rosenberg *et al.,* 1991). In 1985, Anderson and Ohmart (1985) estimated a population size of 750 birds along the Colorado River north of the International Boundary. The Service (1983) estimated a total of 1,700 to 2,000 individuals throughout the range of the subspecies. Based on call count surveys, the population of Yuma clapper rail in the United States appears to be holding steady (Service, Phoenix, Arizona, unpublished data). Due to the variation in surveying over time, these estimates can only be considered the minimum number of birds present (Eddleman 1989; Todd 1986).

The range of the Yuma clapper rail has expanded in the past 25 years and continues to do so (Ohmart and Smith 1973; Monson and Phillips 1981; Rosenberg *et al.,* 1991, SNWA 1998, McKernan 1999), so there is a strong possibility that population size may increase. Yuma clapper rails are known to expand into desired habitat when it becomes available. This is evidenced by the colonization of the Finne-Ramer habitat management unit in Southern California. This unit was modified to provide marsh habitat specifically for Yuma clapper rail and a substantial resident population exists there. There is also recent documentation of the species in Las Vegas Wash, Virgin River and the lower Grand Canyon (SNWA 1998; McKernan 1999).

A substantial population of Yuma clapper rail exists proximate to the Colorado River delta in Mexico. Eddleman (1989) estimated a total of 450 to 970 Yuma clapper rails were present there in 1987. The birds were located in the Cienega, Sonora, Mexico (200-400 birds), along a dike road on the delta proper (35-140 birds), and at the confluence of the Rio Hardy and Colorado River (200-400 birds). Piest and Campoy (AGFD) detected a total of 240 birds responding to taped calls in the Cienega. From these data, they estimate a total population of around 5,000 rails in the approximately cattail habitat the Cienega. Data from 1999 estimated the clapper rail population in the Cienega at 6400.

Yuma clapper rail were thought to be a migratory species, the majority of them migrating south into Mexico during the winter, with only a small population resident in the United States during the winter. Eddleman (1989) concluded the Yuma clapper rail was not as migratory as once thought and estimated approximately 70 percent remained in or near their home range during the winter.

A Recovery Plan was implemented in 1983 for the Yuma clapper rail. The criteria for downlisting of the species states there must be a stable breeding population of 700-1000 individuals for a period of 10 years. Other goals to be met include:

- Clarifying the breeding and wintering status in Mexico.
- Obtaining an agreement with Mexico for management and preservation of the species.
- Development of management plans for federal and state controlled areas where the rails are known to breed.

Written agreements are made with federal and state agencies to protect sufficient wintering and breeding habitat to support the proposed population numbers.

As of 1994 not all of the above recovery actions had been met, and the Yuma clapper rail remains classified as endangered. The recovery goals are currently being clarified by the Service based on information provided by rail experts in 1999.

Yuma clapper rail use dense stands of cattail marsh habitat in the delta. The currently known populations of Yuma clapper rail in Mexico are found in areas supported primarily by agricultural drainage water and would therefore, not be affected by potential reductions in excess flows available to Mexico as a result of the adoption of surplus criteria. Therefore, Reclamation determined that the Yuma clapper rail would not be affected by implementation of any of the interim surplus alternatives.

3.16.5.5.7 Yellow-billed Cuckoo

The Yellow-billed cuckoo is proposed for listing under the Endangered Species Act. Cuckoos are riparian obligates, found along the lower Colorado River in mature riparian forests characterized by a canopy and mid-story of cottonwood, willow and saltcedar, with little ground cover (Haltermann 1998). Within the area of interest, cuckoos occur during the breeding season from interior California and the lower parts of the Grand Canyon, and Virgin River delta in southern Nevada (McKernan 1999) south to southern Arizona, Baja California, Chihuahua, Choahuila, Nuevo Leon, and Tamaulipas and have been recorded breeding as far south as Yucatan. The species winters in the southern United States, and from northern South America to Northern Argentina (AOU 1998, Hughes 1999). Cuckoos are largely insectivorous, with cicadas, (*Diceroprocta apache*) comprising 44.6 percent of their diet on the Bill Williams River National Wildlife Refuge (Halterman 1998). The Bill Williams River is a tributary of the lower Colorado River near Parker Dam, Arizona. The lower 10 miles of this tributary is designated as the Bill Williams River National Wildlife Refuge, comprised of a large expanse of native cottonwood and willow habitat, interspersed with saltcedar. This area is believed to contain the largest cuckoo population in the lower Colorado River Valley.

In February 1998, the western subspecies of the Yellow-billed cuckoo, *C. a. occidentalis,* was petitioned for listing under the ESA. The Service determined that the petition presented substantial scientific or commercial information to indicate that the listing of the species may be warranted (Service 2000). Surveys for this species were conducted throughout Arizona in 1998 and 1999 (Corman and Magill 2000), and have been conducted on the Bill Williams River NWR, beginning in 1993 (Halterman 1994). In 2000, surveys have been expanded into southern Nevada and also include the Bill Williams River and Alamo Lake in Arizona.

As presented in Table 3.16-4, the numbers of cuckoos detected have fluctuated widely since surveying began in 1993 on the Bill Williams River. In 1997, on the Kern River in California, numbers of cuckoos detected declined in a similar manner as that seen on the Bill Williams River during the same time period, 1994-1997. On the Kern River, cuckoos detected declined from 14 pairs in 1996 to six pairs in 1997 (Halterman 1998); on the Bill Williams, cuckoos detected declined from 26 pairs to 12 pairs. In 1990, numbers were back up on the Bill Williams, but down again in 1999. In other areas of the lower Colorado River in the United States, cuckoos have been detected as far south as Gadsden and Imperial National Wildlife Refuge (Corman and Magill 2000, McKernan 1999).

Table 3.16-4
Yellow-billed Cuckoos Survey Results

Survey Results BWRNWR	1993	1994	1997	1998	1999
Pairs Detected	22	26	12	20	6
Single Birds Detected	11	14	11	11	8
Nests Found	6	5	3	4	2
Date First Pair Encountered	June 25	June 27	June 20	June18	June 5

Without complete and standardized surveys, it can only be speculated that the birds are present in the Colorado River delta in Mexico. The range of this species includes the Colorado River delta (AOU, 1998).

Yellow-billed cuckoos utilize mature riparian habitat with some mid- and under-story present. Large volume flood control releases and Gila River flood flows are the only condition under which riparian habitats are established in the delta, and a high ground water table is needed to maintain this habitat. Potential reductions in the frequency of excess flows below Morelos Dam resulting from the adoption of either the Basin States, Six States, California or Shortage Protection alternative could potentially reduce the amount of water available for groundwater recharge in the areas adjacent to the main channel of the Colorado River over an extended period of time. This, coupled with continued groundwater production in these areas, could affect the high groundwater table that is needed to maintain habitat used by the Yellow-billed cuckoo. However, Reclamation believes that groundwater recharge in these area is more a result of percolation induced by agricultural irrigation, drainage water and the more frequent but lower-volume excess flows that are attributable to unused water delivery orders (by users in the Lower Basin states) that make it past Morelos Dam. This belief, combined with the uncertainty associated with excess flows, led to Reclamation's determination that the adoption of interim surplus criteria may affect, but is not likely to adversely impact the Yellow-billed cuckoo.

3.16.5.5.8 California Black Rail

California black rail (*Laterallus jamaicensis coturniculus*) is a federal species of concern and is protected by the state of California as a threatened species. Black rails are most often found in shallow salt marshes, but also utilize freshwater marshes, wet meadow-like areas and riparian habitat along rivers. Both males and females of this species exhibit slate black plumage with narrow, white barring on the back and flanks and a chestnut nape with a very short tail and a small black bill. Juveniles look much the same as adults, but their eyes are brown or olive rather than red like those of adults. Full grown birds measure about five to six inches in length.

The life history and status of the California black rail are poorly known (Wilbur 1974, Evens *et al.*, 1991), due to its secretive nature and tendency to inhabit densely vegetated marshes. The preferred habitat of the California black rail is characterized by minimum water fluctuations that provide moist surfaces or very shallow water, gently sloping shorelines, and dense stands of marsh vegetation (Repking and Ohmart 1977). California black rails are most often found in areas where cattails (*Typha* sp.) and California bulrush (*Scirpus californicus*) are the predominant plant species (Rosenberg *et al.,* 1991). While California black rails are more commonly associated with cattail and bulrush, habitat structure as described above was more effective than plant composition in predicting California black rail use of habitat. Water depth appeared to be a limiting factor, as the California black rails prefer shallow water (Flores and Eddleman 1995). The breeding season along the lower Colorado River extends from April through July (Flores and Eddleman 1995). California black rails eat mainly aquatic insects and some seeds (Ehrlich 1988, Rosenberg *et al.,* 1991, Kaufmann 1996).

This subspecies of California black rail occurs along the California coast from Tomales Bay in Marin County, south to San Diego and extreme northern Baja California and Veracruz. It also occurs in interior California around the Salton Sea and along the Colorado River from Imperial National Wildlife Refuge south to the International Boundary (Peterson 1990; Rosenberg *et al.,* 1991, AOU 1998). The species has also been recorded as recently as 1997 at the Bill Williams River National Wildlife Refuge and at Havasu National Wildlife Refuge. Historically, the California black rail primarily occurred along the California coastline. In the mid-1970s, an estimate of between 100 and 200 individuals was given for the area between Imperial National Wildlife Refuge and Mittry Lake, Arizona (Repking and Ohmart 1977). No quantitative data are yet available on the current populations of the California black rail along the lower Colorado River or in the Colorado River delta area, although the species is present in both areas. Surveys are currently underway on the Lower Colorado River between Havasu National Wildlife Refuge and Yuma, Arizona. Various agencies, including BLM and the Service, survey California black rail concurrently during surveys for the Yuma clapper rail.

California black rails utilize very shallow marshes containing cattail and bulrush and are sensitive to small changes in water levels. Some surface water is necessary for their presence to occur. Like the Yuma clapper rail, they are primarily found in areas supported by agricultural drainage water and would not be affected by the potential reduction in the frequency of occurrence of excess flows that may result from the adoption of interim surplus criteria. Therefore, Reclamation believes the California black rail will not be affected by implementation of any of the interim surplus alternatives.

3.16.5.5.9 Elf Owl

The Elf owl (*Micrathene whitneyi*) is listed as endangered species by the state of California. The Elf owl is near the limit of its northwestern (central Riverside County, California) range along the Colorado River (AOU 1998,) and, as such, has never been abundant here (Rosenberg 1991). However, declines associated with loss of trees containing suitable cavities for nesting and loss of appropriate foraging habitat are indicated (Rosenberg 1991). Elf Owls utilize abandoned woodpecker cavities or natural cavities for nesting. Declines in populations of woodpeckers on the lower Colorado River have been documented as well (Rosenberg 1991). In other parts of its range, namely central Arizona, saguaro cacti are more often used by Elf owls than on the lower Colorado River. Although saguaros are utilized along the Colorado River to some degree (as well as cottonwood, willow and mesquites), this cacti species is at its northwestern range, not extending further north than Fort Mojave, Arizona on the river. Therefore, it is less abundant in the Mohave Desert than in the Sonoran Desert.

To the south in Mexico, the winter range of Elf owls is from southern Sinaloa, Michoacan, Morelos and Guerrero, Pueblo and northwestern Oaxaca (AOU 1998). Breeding occurs in Coahuila and Nuevo Leon south to Sonora, Guanajuato and Puebla and in southern Baja California (AOU 1998). Elf owls have been documented during breeding season as far south as Picacho, Imperial Co., California as recently as 1998 (McKernan 1999). Recent field documentation of breeding for this species in the Colorado River delta are not available at this time. However, there is suitable habitat present there (Briggs and Cornelius 1998 Glynn 1999), and similar species, such as the great horned owl, have been recently documented there (Hinojosa-Huerta, 2000). As with the willow flycatcher, if suitable habitat is present, the presence of the species should not be ruled out until adequate surveys have been conducted.

Elf owls utilize mature riparian habitat with trees large enough to contain either natural cavities or cavities excavated by woodpeckers. Large volume flood control releases and Gila River flood flows are the only conditions under which riparian habitats are established in the delta and a high ground water table is needed to maintain this habitat. Potential reductions in the frequency of excess flows below Morelos Dam resulting from the adoption of either the Basin States, Six States, California or Shortage Protection alternative could potentially reduce the amount of water available for groundwater recharge in the areas adjacent to the main channel of the Colorado River over an extended period of time. This, coupled with continued groundwater production in these areas, could affect the high groundwater table that is needed to maintain habitat used by the Elf owl. However, Reclamation believes that groundwater recharge in these area is more a result of percolation induced by agricultural irrigation, drainage water and the more frequent but lower-volume excess flows that are attributable to unused water delivery orders (by users in the Lower Basin states) that make it past Morelos Dam. This belief, combined with the uncertainty associated with excess flows, led to Reclamation's determination that the adoption of interim surplus criteria is not likely to adversely impact the Elf owl.

3.16.5.5.10 Bell's Vireo

Bell's vireo (*Vireo bellii arizonae*) is protected as an endangered species by the state of California. It is a small, insectivorous grayish to greenish-yellow bird is found in riparian habitat along the lower Colorado River and its tributaries in dense brush, including willow, cottonwood, mesquite and saltcedar. In the vicinity of the lower

Colorado River, the species breeds from interior California, southern Nevada and northwestern and east-central Arizona to northern Baja California, south through Sonora, southern Durango, Zacatecas, and southern Tamaulipas. During winter, it can be found as far south as north-central Nicaragua (AOU 1998). Bell's vireos experienced a decline in southern California and throughout the lower Colorado River beginning in the 1950s. Between 1974-1984, breeding was documented at only a few locations on the river, all north of Cibola NWR (Rosenberg *et al.,* 1991). Loss of habitat due to extensive flooding in 1983 is thought to have contributed to this decline. Stable populations in other parts of its range, including northern Mexico, prevented the species from being listed as endangered after being proposed in 1981 (Rosenberg *et al.,* 1991).

Without standardized surveys, it is difficult to determine the species' current abundance. The species appears to be recovering from previous lows as its presence has been documented recently as far north as Meadow Valley Wash and the lower Virgin River in southern Nevada and below Imperial Dam to the south (McKernan 1999) and is one of the most frequently heard species throughout the area. Habitat does exist across the border in Mexico similar to what is utilized by this species in the United States and observations of this species there confirm its presence during the breeding season (Hinojosa-Huerta, 2000).

Bell's vireos utilize mature riparian habitat with dense saltcedar, mesquite cottonwood and willow stands present. Large volume flood control releases and Gila River flood flows are the only conditions under which riparian habitats are established in the delta and a high ground water table is needed to maintain this habitat. Potential reductions in the frequency of excess flows below Morelos Dam resulting from the adoption of either the Basin States, Six States, California or Shortage Protection alternative could potentially reduce the amount of water available for groundwater recharge in the areas adjacent to the main channel of the Colorado River over an extended period of time. This, coupled with continued groundwater production in these areas, could affect the high groundwater table that is needed to maintain habitat used by the Bell's vireo. However, Reclamation believes that groundwater recharge in these area is more a result of percolation induced by agricultural irrigation, drainage water and the more frequent but lower-volume excess flows that are attributable to unused water delivery orders (by users in the Lower Basin states) that make it past Morelos Dam. This belief combined with the uncertainty associated with excess flows, led to Reclamation's determination that the adoption of interim surplus criteria may affect but is not likely to adversely impact the Bell's vireo.

3.16.5.5.11 Clark's Grebe

Clark's grebe (*Aechmophorus clarkii*) is a species of special concern to the state of– Arizona. Extensive knowledge of this species in the Colorado River delta in Mexico is not available, so any speculation on its abundance and status there is based on known available habitat only. Clark's grebes utilize marshes, lakes and bays with emergent vegetation and can also be found on inland reservoirs and rivers (AOU 1998, Kaufman 1996, Rosenberg 1991). In the area of interest, the species is resident year round in Mexico south to Guerrero and western Puebla, and north of Mexico on lakes that do not freeze in winter, and winters from central California south to southern Baja California (AOU 1998). Clark's grebes have been documented at the Cienega de Santa Clara (Hinojosa-Huerta, 2000). The species is present during winter on the lower Colorado River and has been documented nesting in cattail marshes on the lower Colorado River at Havasu National Wildlife Refuge, near Needles, California in recent years (M. Connolly Havasu National Wildlife Refuge, pers.comm).

Threats to this species include recreation during breeding, as increased boating activity can swamp nests. In addition, as with other fish-eating species on the river, bioaccumulation of selenium in grebes is a potential threat both in the United States and in Mexico (King *et al.,* 2000).

Clark's grebes utilize marsh habitat for nesting and some surface water is needed to maintain this habitat. They also require open water and a prey base of small fish and crustaceans for foraging. Like the Yuma clapper rail, they are primarily found in areas supported by agricultural drainage water and would not be affected by potential reductions in the frequency of occurrence of excess flows that may result from the adaptation of the interim surplus criteria. These factors led Reclamation to determine that the Clark's grebe will not be affected by implementation of any of the interim surplus alternatives.

3.17 SUMMARY OF ENVIRONMENTAL COMMITMENTS

As discussed in this chapter, impacts are associated with changes in the difference between probabilities of occurrence for specific resource issues under study when comparing the action alternatives to baseline conditions. Reclamation has determined that most of the potential impacts identified are not of a magnitude that would require specific mitigation measures to reduce or eliminate their occurrence because the small changes in probabilities of occurrence are within Reclamation's current operational regime and authorities under applicable federal law. In recognition of potential effects that could occur under baseline conditions or with implementation of the interim surplus criteria alternatives under consideration, Reclamation has developed a number of environmental commitments, described below, that will be undertaken if interim surplus criteria are implemented. Some commitments are the result of compliance with specific consultation requirements.

3.17.1 WATER QUALITY

Reclamation will continue to monitor salinity and TDS the Colorado River as part of the ongoing Colorado River Basin Salinity Control Program to ensure compliance with the numeric criteria on the river as set forth in the Forum's 1999 Annual Review.

Reclamation will continue to participate in the Lake Mead Water Quality Forum and the Las Vegas Wash Coordination Committee as a principal and funding partner in studies of water quality in the Las Vegas Wash and Lake Mead. Reclamation is an active partner in the restoration of the Las Vegas Wash wetlands.

Reclamation is and will continue to acquire riparian and wetland habitat around Lake Mead and on the Lower Colorado River related to ongoing and projected routine operations.

Reclamation will continue to participate with the Nevada Division of Environmental Protection and Kerr-McGee Chemical Company in the perchlorate remediation program of groundwater discharge points along Las Vegas Wash which will reduce the amount of this contaminant entering the Colorado River.

Reclamation will continue to monitor river operations, reservoir levels and water supply and make this information available to the CRMWG, agencies and the public. See also Reclamation's website (http.//www.lc.usbr.gov and http.//www.uc.usbr.gov).

3.17.2 RIVERFLOW ISSUES

Reclamation will continue to work with the stakeholders in the AMP to develop an experimental flow program for the operations of Glen Canyon Dam which includes Beach/Habitat-Building-Flows (BHBFs) and is designed to protect, mitigate adverse impacts to and improve the values for which GCNP and GCNRA were established.

3.17.3 AQUATIC RESOURCES

Reclamation will initiate a temperature monitoring program below Hoover Dam with state and other federal agencies to document temperature changes related to baseline conditions and implementation of interim surplus criteria and assess their potential effects on listed species and the sport fishery. The existing hydrolab below Hoover Dam will be modified as necessary to provide this temperature data.

3.17.4 SPECIAL-STATUS SPECIES

Section 7 consultation is in progress and commitments will be identified in the ROD.

3.17.5 RECREATION

Reclamation is initiating a bathymetric survey of Lake Mead in fiscal year 2001 and will coordinate with the Lake Mead National Recreation Area to identify critical recreation facility elevations and navigational hazards that would be present under various reservoir surface elevations.

Reclamation will continue to monitor river operations, reservoir levels and water supply and make this information available to the CRMWG, agencies and the public. This operational information will provide the Lake Mead National Recreation Area and the Glen Canyon National Recreation Area with probabilities for future reservoir elevations to aid in management of navigational aids, recreation facilities, other resources, and fiscal planning.

Reclamation will continue its consultation and coordination with the Glen Canyon National Recreation Area and the Navajo Nation on the development of Antelope Point as a resort destination.

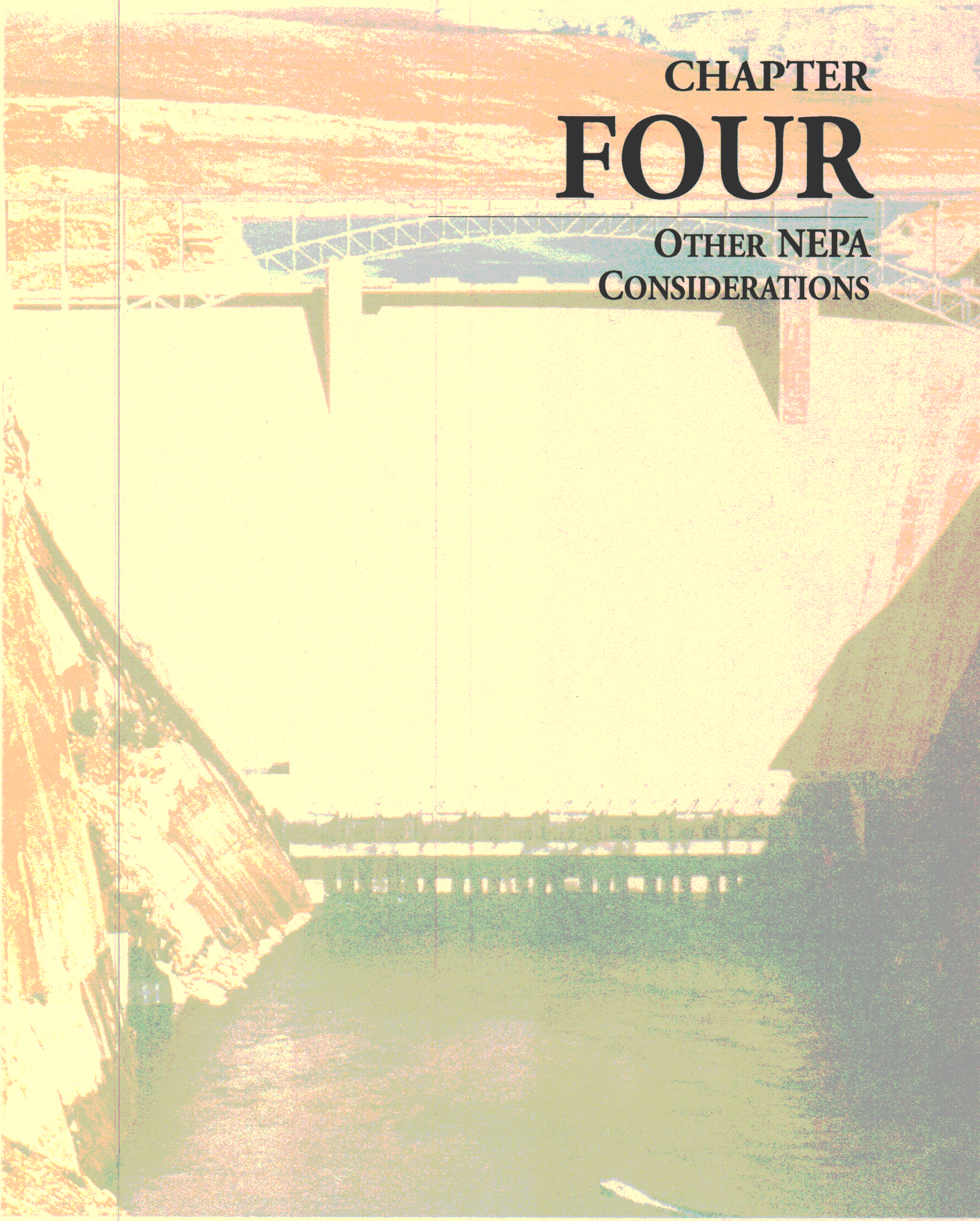
3.17.6 CULTURAL RESOURCES

Reclamation shall continue to consult and coordinate with the State Historic Preservation Officer, the Advisory Council on Historic Preservation (Council), Glen Canyon National Recreation Area, Lake Mead National Recreation Area, Tribes and interested parties with regard to the potential effects of the proposed action as required by Sections 106 and 110 of the National Historic Preservation Act following the

Council's recommended approach for consultation for the Protection of Historic Properties found at 36 CFR 800.

3.17.7 TRANSBOUNDARY IMPACTS

It is the position of the United States State Department through the United States Section of the International Boundary and Water Commission (USIBWC) that the United States does not mitigate for impacts in a foreign country. The United States will continue to participate with Mexico through the USIBWC Technical Work Groups to develop cooperative projects beneficial to both countries.



CHAPTER FOUR

OTHER NEPA CONSIDERATIONS

4 OTHER NEPA CONSIDERATIONS

4.1 INTRODUCTION

NEPA requires that the impacts to resources from proposed federal actions include the perspectives of cumulative impacts, relationship between short-term uses of the environment and long-term productivity, and irreversible and irretrievable commitments of resources. While an attempt was made to incorporate those considerations in the discussion for each resource, they are discussed further here in recognition of the emphasis they are given in NEPA and the CEQ Regulations.

4.2 CUMULATIVE IMPACTS

A cumulative impact is an impact that 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 CFR 1508.7).

As discussed in Chapter 3, effects that could occur within the United States as a result of interim surplus criteria are each associated with potential changes in the probabilities for Lake Mead and Lake Powell surface elevation reductions and changes in Colorado River flows from Glen Canyon Dam to the SIB. Generally, other actions that could result in cumulative impacts when considered in tandem with the effects of interim surplus criteria (as identified in Chapter 3) 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 and various requirements and constraints applied to the operation of the Colorado River system.

The environmental effects of the various components of the CA Plan, including the various intrastate storage facilities (such as Cadiz, Hayfield/Chuckwalla, and Desert/Coachella projects), and the other related and ongoing actions are undergoing separate compliance. Where there is a federal nexus to actions in California, a combined CEQ/NEPA compliance document is being prepared.

Potential cumulative effects to the resources affected by surplus criteria were analyzed within the 100-year floodplain of the lower Colorado River from the full-pool elevation of Lake Powell to the Gulf of California in Mexico through year 2050. Only the issue area of "transboundary impacts" was identified as possibly experiencing cumulative effects.

No past, present, or reasonably foreseeable actions in the United States are expected to result in cumulative impacts to the issue area of transboundary impacts. In addition to the direct and indirect effects on the physical and natural environment in Mexico from actions identified by Mexico that are discussed in Section 3.16, it is recognized that some future actions taken by Mexico may have a cumulative effect. Exactly what these actions are is not known at this time. Any impacts of these projects are the responsibility of Mexico.

In addition, Reclamation is consulting with the Service on potential adverse effects to species found in both Mexico and the United States. For potentially affected species found only in Mexico, Reclamation is consulting with the National Marine Fisheries Service. Concurrent with these consultations, Reclamation is also continuing dialog with Mexico, through the IBWC's Fourth Technical Work Group, to reach mutually agreeable solutions to address cumulative impacts.

4.3 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

Because the implementation of interim surplus criteria is a management action that would require no direct physical change to the environment, for the purposes of this discussion, short-term uses of resources are limited to potential changes in the probability for certain environmental effects to occur as a result of changed system conditions. Also for the purposes of this discussion, long-term productivity refers to the benefits that would be realized during and following the period in which interim surplus criteria would be in place.

As stated in Section 1.1.3, Purpose of and Need for Action, the benefit sought by means of the interim surplus criteria alternatives consists of increasing the efficiency of the Secretary's annual decision-making process regarding the availability of Colorado River water. This would afford the mainstream users of this water a greater degree of predictability which would assist them in their water resources planning and operation.

The resources that may be affected in the short-term would be primarily those affected by lower reservoir levels. The effects of the interim surplus criteria on those resources would depend on the alternative selected for implementation. The Flood Control Alternative would result in insignificant changes in reservoir levels from baseline conditions. The other four alternatives would tend to cause lower average water levels than baseline conditions by 2016 and for a limited period of time thereafter. However, these alternatives would have a greater probability of surplus water than the Flood Control Alternative or baseline conditions through the year 2016. Long-term benefits that would be realized due to interim surplus criteria would include increased opportunities for making more efficient use of Colorado River water supplies.

4.4 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible commitments are decisions affecting renewable resources such as soils, wetlands and waterfowl habitat. Such decisions are considered irreversible because their implementation would affect a resource that has deteriorated to the point that renewal can occur only over a long period of time or at great expense or because they would cause the resource to be destroyed or removed.

The application of the interim surplus criteria would include reviews at five-year intervals to consider the workability of the criteria in light of the multiple purposes served by the operation of the Colorado River system, including environmental maintenance. Based on those reviews, interim surplus criteria could be revised or eliminated as needed. If California fails to meet its water conservation and management goals throughout the stipulated term of implementation of the criteria (through 2016), the Secretary may choose to terminate the interim criteria and revert to the 70R Strategy. Finally, after 2016, determinations of the availability of surplus will revert to the AOP process.

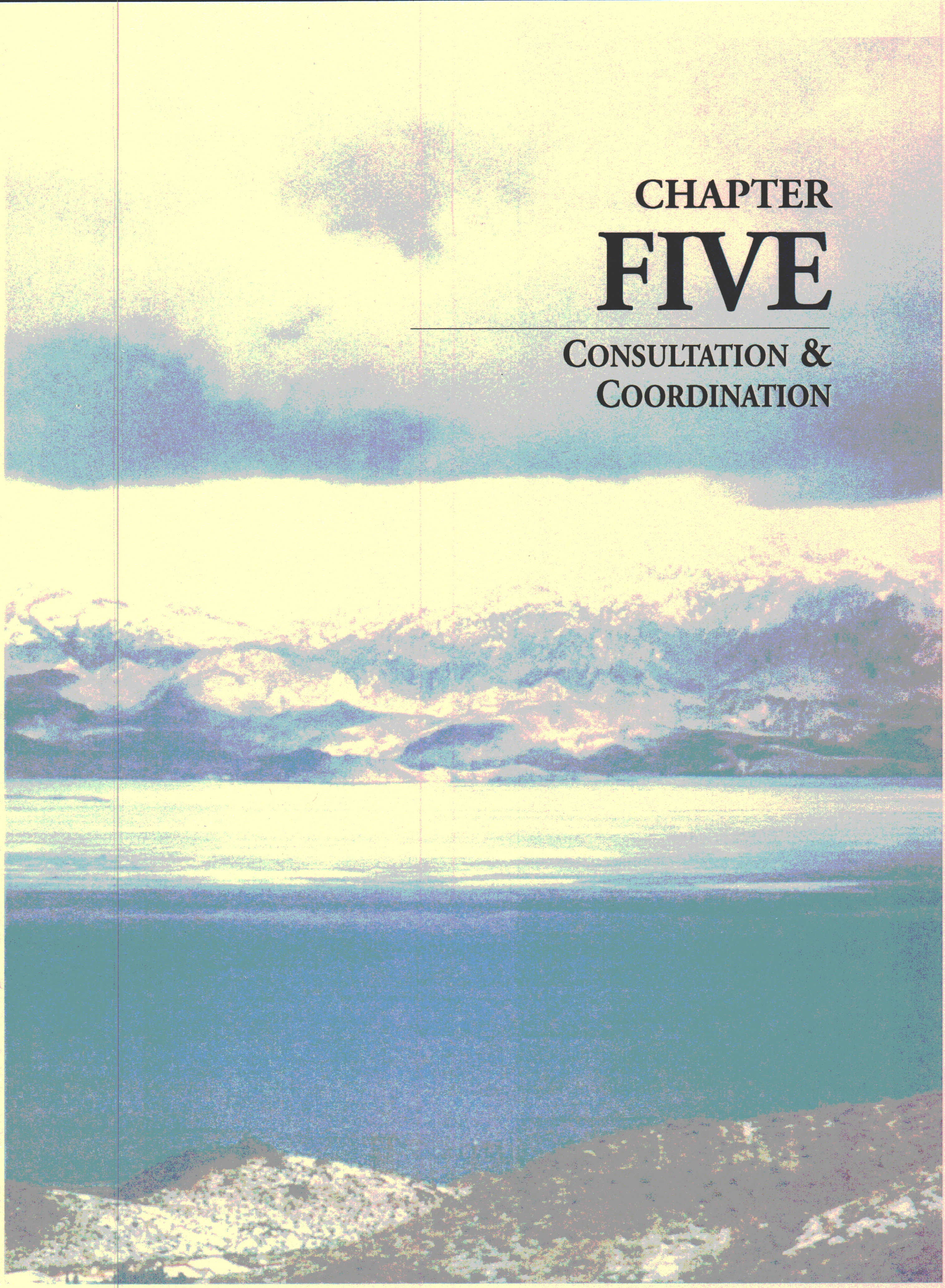
None of the resources assessed in this FEIS would experience a deterioration in condition such that the resource would be destroyed or removed as a result of implementation of interim surplus criteria or under the No Action Alternative. The Colorado River System may also reset at any time in the future, due to high inflows, resulting in full reservoirs. There would be no construction of facilities needed to facilitate the Secretary's determination of surplus water under the criteria.

Irretrievable commitment of natural resources means loss of production or use of resources as a result of a decision. It represents opportunities foregone for the period of time that a resource cannot be used.

All of the resources assessed in the FEIS would continue to be available for production or use under any of the alternatives; however, application of the interim surplus criteria may result in a determination for any given year that surplus water is available from the Colorado River. That water could also have been determined to be surplus in the absence of interim surplus criteria through the AOP process. Although water is a renewable resource, the delivery of surplus water under all of the alternatives, including no action, would irretrievably commit (to beneficial consumptive uses) the water declared to be surplus, but authorized by the *Law of the River*.

CHAPTER FIVE

CONSULTATION & COORDINATION



5 CONSULTATION AND COORDINATION

5.1 INTRODUCTION

This chapter describes Reclamation's public involvement program and coordination with specific federal, state and local agencies, non-governmental organizations and the general public for the preparation of this FEIS.

5.2 GENERAL PUBLIC INVOLVEMENT ACTIVITIES

The public involvement program leading to this FEIS consisted essentially of two phases: project scoping and public hearings and public review of the DEIS.

5.2.1 PROJECT SCOPING

In 1999, Reclamation conducted a public scoping process that featured public scoping meetings to inform interested parties of the purpose and need for the development of interim surplus criteria, and to obtain public comment to assist in identifying the scope of the proposed action and environmental issues to be addressed in the DEIS. The scoping meetings were held in June 1999 in Las Vegas, Nevada; Phoenix, Arizona; Ontario, California; and Salt Lake City, Utah. The meetings were announced in *Federal Register* notices on May 18, 1999 and May 28, 1999, on Reclamation's Lower Colorado Region internet website and by a press release on May 28, 1999. The press release was mailed not only to the media but also to hundreds of federal, state and local agencies, non-governmental organizations and private citizens known to have an interest in Colorado River operations. The public was asked to identify any concerns about development and implementation of the interim surplus criteria.

Public comments in the form of letters to Reclamation (35 letters) and oral responses at the scoping meetings (eight presenters) expressed numerous concerns regarding the effect of the proposed interim surplus criteria on the future quantity of water available from the Colorado River, and other resource issues. Attachment R to this DEIS contains details of the scoping process and a digest of the public comments that resulted from the scoping process. Based on the scoping comments, Reclamation issued a Notice of Intent to prepare this DEIS in the *Federal Register* on December 7, 1999.

Reclamation also discussed the development of the proposed interim surplus criteria with various agencies and groups at their own regular meetings or at meetings set up by Reclamation. Included were Indian Tribes and Indian Communities having allocations of Colorado River water, Basin States water resource departments, various water agencies within the states, contractors for federal hydropower, environmental groups and water agencies of Mexico. The coordination activities with each agency or group are summarized below in this chapter. Table 5-1 in Section 5.8 lists the agencies and organizations that were invited to such meetings by letter, and/or met with Reclamation regarding interim surplus criteria on other occasions.

5.2.2 PUBLIC REVIEW OF DEIS

The DEIS was distributed to interested federal, Tribal, state and local entities and members of the general public for a 60-day review when it was filed with EPA on July 7, 2000, and announced in the *Federal Register.* The DEIS was sent to 407 interested parties on Reclamation's mailing list, and a copy of the DEIS was made available for public viewing on Reclamation's Lower Colorado Region website. Reclamation conducted a public technical meeting at Las Vegas, Nevada on August 15, 2000, to provide information and answer questions regarding the modeling process for analysis in the DEIS. Between August 21 and August 24, 2000, Reclamation conducted public hearings on the DEIS in Ontario, California; Las Vegas, Nevada; Salt Lake City, Utah; and Phoenix, Arizona. Public comments from the hearings are noted in Volume III of this FEIS. The DEIS was available for public viewing on Reclamation's website (www.lc.usbv.gov). The FEIS is now available at the same website.

When the public review period closed on September 8, 2000, Reclamation had received 68 comment letters from the public, which are reproduced in Volume III of this FEIS. Individual comments from the public resulted in technical and editorial changes to the document. These included a change in the baseline operating strategy, better definition of Tribal water rights and diversions, inclusion of the Basin States Alternative and refinements in descriptions of alternatives and operational modeling results. Reclamation's response to each comment is included in Volume III.

After the DEIS was completed and ready for public review and comment, Reclamation received the document "Interim Surplus Guidelines, Working Draft" from the Seven Basin States (Seven States Proposal). Reclamation made a preliminary review of the specific surplus criteria in the information presented by the Basin States and made a preliminary determination that the criteria were within the range of alternatives and impacts analyzed in the DEIS. After its review of the Seven States Proposal, Reclamation published it in the *Federal Register* of August 8, 2000 for review and consideration by the public during the public review period for the DEIS.

5.3 FEDERAL AGENCY COORDINATION

5.3.1 NATIONAL PARK SERVICE

As noted in Section 1.1.5, NPS is a cooperating agency with Reclamation for the purpose of NEPA compliance for the interim surplus criteria, in recognition of its administration of national park and recreation areas along the Colorado River corridor. NPS staff participated in numerous meetings with Reclamation's project evaluation team and participated in internal document reviews as sections of the DEIS were being prepared. This facilitated close coordination with the NPS regarding resources and facilities potentially affected and the nature of the effects. The NPS offices involved in these activities are those at the GCNRA, Grand Canyon National Park and the LMNRA, under the coordination of the office at the GCNRA.

5.3.2 UNITED STATES SECTION OF THE INTERNATIONAL BOUNDARY AND WATER COMMISSION

As noted in Section 1.1.5, the United States Section of the International Boundary and Water Commission (USIBWC) is a cooperating agency with Reclamation for the purposes of NEPA compliance for the interim surplus criteria, in recognition of its administration of 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 DEIS were being prepared. This facilitated close coordination with the USIBWC in developing information needed for this FEIS and in Reclamation's participation in the consultation with Mexico as discussed below in Section 5.7. The USIBWC head office in El Paso, Texas was directly involved.

5.3.3 UNITED STATES BUREAU OF INDIAN AFFAIRS

The Bureau of Indian Affairs (BIA) administers programs to promote Tribal economic opportunity and to protect and improve Indian Trust Assets. The BIA assisted Reclamation with the Tribal consultation described in Section 5.4 and generally served in an advisory capacity to the Tribes. Through letters of comment on the DEIS, the BIA further amplified Tribal concerns regarding Colorado River operations and the interim surplus criteria.

5.3.4 UNITED STATES FISH AND WILDLIFE SERVICE INCLUDING ENDANGERED SPECIES ACT COMPLIANCE

Under Section 7(a)(2) of the Endangered Species Act (ESA), 16 U.S.C. δ 1536 (a)(2), each federal agency must, in consultation with the Secretary (either the Secretary of Commerce through the National Marine Fisheries Service (NMFS) or the Secretary of the Interior through the U.S. Fish and Wildlife Service (Service), insure that any discretionary action authorized, funded or carried out by the 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 CFR δ 402.

Adoption of specific interim surplus criteria by the Secretary is a discretionary federal action and is, therefore, subject to compliance with the ESA. On May 22, 2000, Reclamation provided the Service with a memorandum identifying listed or proposed species and designated critical habitat that may be present in the action area. The

Service provided a response to Reclamation on June 5, 2000, which concurred with Reclamation's list and added two species: Bald Eagle and Desert Pupfish. This information was used to assess potential effects of the proposed interim surplus criteria. Copies of this correspondence are in Attachment S.

Reclamation has prepared a BA which addresses the effects of both interim surplus criteria and the California Water Transfers (USBR, 2000), to reduce the consultation time frame on these two independent operational actions on the lower Colorado River. The BA and memorandum requesting formal consultation were mailed to the Service on August 31, 2000.

The action area for the BA identified above is the 100-year floodplain of the Colorado River to the SIB and the full pool elevations of lakes Mead, Mohave and Havasu. Implementation of the interim surplus criteria is not expected to affect any listed species upriver of Lake Mead (full pool elevation) nor impact implementation of any provisions of the existing BO on the operation of Glen Canyon Dam. Within the United States, implementation of interim surplus criteria is not anticipated to affect any listed species in areas beyond the 100-year floodplain of the lower Colorado River and the full pool elevations of lakes Mead, Mohave and Havasu. Consultation with the Service is in progress and the results of the consultation will be identified in the ROD.

Preliminary evaluations of the effects of adopting interim surplus criteria on listed species which may be present in the river corridor below Glen Canyon Dam led to the conclusion that there would be no affect. More recent output, resulting from refinement of the model used to predict future dam operations and riverflows, indicated that there would be a minor change in the frequency with which flows recommended by the 1995 biological opinion would be triggered, but that such changes would not adversely affect any listed species between Glen Canyon and Lake Mead. Reclamation is consulting with the Service on these changes.

Reclamation is also consulting with the Service regarding special status species in Mexico, which are discussed in Section 3.16. To facilitate consultation, Reclamation prepared a BA Supplement addressing the potential effects of interim surplus criteria (USBR, 2000), along the Colorado River corridor in Mexico from the SIB to the Sea of Cortez. Consultation is in progress and the results of the consultation will be identified in the ROD.

5.3.5 NATIONAL MARINE FISHERIES SERVICE

The NMFS administers programs that support the domestic and international conservation and management of living marine resources. Under Section 7(a)(2) of the ESA, NMFS is the responsible federal agency for consultation on special status marine species. Reclamation consulted with NMFS regarding the special status fish at the upper end of the Sea of Cortez, which are discussed in Section 3.16. The consultation was facilitated by a BA supplementing the BA described in Section 5.3.4 (USBR, 2000). Consultation is in progress and the results of the consultation will be identified in the ROD.

5.3.6 NATIONAL HISTORIC PRESERVATION ACT COMPLIANCE

As mentioned in Section 3.13 for Cultural Resources, Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, requires all federal agencies to take into account the effects of their actions on historic properties, and to afford the Advisory Council on Historic Preservation (Council) a reasonable opportunity to comment when an action will have an effect on historic properties. The Council's recommended approach for consultation for the Protection of Historic Properties is found in 36 CFR 800 (FR Vol. 64, No. 95, May 18, 1999, pages 27071-27084).

The first step of the Section 106 process, as set forth in 36 CFR 800.3(a), is for the Agency Official to determine whether the proposed federal action is an undertaking as defined in §800.16(y) and, if so, whether it is a type of activity that has the potential to cause effects to historic properties. Reclamation has determined development and implementation of interim surplus criteria meets the definition of an undertaking, but an undertaking that is without potential to affect historic properties. Reclamation's determination and the rationale for its decision are documented in Section 3.13. Per 36 CFR 800.3(a)(1), if the undertaking does not have the potential to cause effects on historic properties, the agency official has no further obligations under Section 106 or this part and Reclamation has fulfilled its responsibilities to take into account the effects of the development and implementation of interim surplus criteria on historic properties.

The Nevada State Historic Preservation Officer (SHPO) submitted written comments on the cultural resources section of the DEIS. The SHPO has indicated they do not agree with Reclamation's position in the DEIS that development and implementation of interim surplus criteria are undertakings without potential to affect historic properties. Therefore, compliance with the consultation requirements of the NHPA is not necessary.

The Nevada SHPO has stated that their opportunity to comment on effects to historic properties has been precluded by Reclamation and Interior's finding, and have asked that the matter be referred to the Council. Under the implementing regulations for Section 106, when there is a disagreement between an agency and a SHPO concerning the effect of an undertaking, the matter must be referred to the Council for comment and resolution. Reclamation believes the Council will agree with the Nevada SHPO that Section 106 compliance is necessary for this proposed action. Reclamation's position is that this is not an action requiring Section 106 compliance, but more appropriately falls under Section 110 of the NHPA.

Reclamation has prepared a memorandum discussing this issue and has forwarded it to the Council for review and further consultation.

5.4 TRIBAL CONSULTATION

As discussed in Section 3.14, Indian Trust Assets, Reclamation has been coordinating river operations with the Indian Tribes and Communities who have entitlements to or contracts for Colorado River water, and those that may be affected by the proposed action. Representatives of various Tribes attended the scoping meetings in May 1999, and some provided Reclamation with written comments on the proposal for interim surplus criteria. Beginning in May 1999, Reclamation has had numerous meetings with the various Tribes who have an interest in the implementation of the interim surplus criteria. The Tribes and Communities fall generally into four groups: 1) the Colorado River Basin Indian Tribes (Ten Tribes Partnership) who have diversion rights from the Colorado River mainstream and various tributaries; 2) the Tribes and Communities of central Arizona that are served by CAP facilities; 3) the Tribes in the Coachella Valley Consortium of Mission Indians; and 4) other Tribes or Indian Communities who do not have a Colorado River water entitlement but nevertheless have an interest in the availability and distribution of Colorado River water. The individual Tribes and Indian Communities in each of these groups are listed on Table 5-1 at the end of this chapter.

A primary concern of the Ten Tribes Partnership was that Tribal water rights be clearly acknowledged and that the diversion point(s) for each Tribe be included in the operational model so as to more accurately reflect Tribal diversions in the modeling. Other concerns included over-reliance on unused Tribal water allocations by non-tribal diverters and Lake Powell water level fluctuations with respect to resort development opportunity. Reclamation provided financial assistance to the Ten Tribes Partnership to assist the Tribes in cataloging their Colorado River depletion rights and conducting an active coordination process with Reclamation in connection with the interim surplus criteria. Using information provided by the Tribes, Reclamation added the diversion points to the model, as discussed in Sections 3.3 and 3.4.

5.5 STATE AND LOCAL WATER AND POWER AGENCIES COORDINATION

Since the May 18, 1999 *Federal Register* notice announcing the development of interim surplus criteria, Reclamation has had various discussions with state and local water and power agencies regarding the proposed action. However, development of surplus criteria has been the subject of discussions for many years prior to 1999. Reclamation meets regularly with representatives of the Basin States, Indian Tribes and Communities, environmental organizations and other stakeholders as part of the CRMWG. Reclamation coordinates the development of the AOP for the Colorado

River system through this group as required by federal law. It was through such coordination actions that Reclamation originally presented the alternative surplus strategies described in Section 2.2.1, Operating Strategies for Surplus Determination.

The Basin States provided Reclamation with projections of the future depletions of the Colorado River water anticipated by water agencies in each state. The Upper Colorado River Commission compiled Upper Basin depletions, and the Lower Division states compiled their respective depletions. The projections were used as input to Reclamation's operational modeling analysis, as discussed in Section 3.3.

Reclamation also conducted coordination with water agencies in southern California regarding the environmental documentation being prepared for various components of California's Colorado River Water Use Plan.

In the early summer of 2000, the seven Basin States acting as a group, independent from Reclamation, formulated the Seven States proposal for interim surplus criteria which they provided to Reclamation after the DEIS was prepared, as discussed above in Section 5.2.2. Letters of comment on the DEIS from some of the Basin States contained additional commentary on the draft proposal.

5.6 NON-GOVERNMENTAL ORGANIZATIONS COORDINATION

Several environmental organizations have expressed interest in the project and have attended one or more public and independent meetings with Reclamation. The Pacific Institute, representing a consortium of environmental organizations, submitted an interim surplus criteria proposal to Reclamation in February 2000, which is in Attachment G. As discussed in Section 2.2.3, the proposal included an additional allocation of water to Mexico for environmental purposes. The Pacific Institute's interest in the project and coordinating role among the other environmental groups contributed to the coordination with Reclamation by various other non-governmental organizations, which are cited on Table 5-1 at the end of this chapter. In addition, through the CRMWG and other mechanisms, Reclamation worked with the various non-governmental organizations during the NEPA process. Specifically, Reclamation met with members of the organizations noted in Table 5-1 at their request, to discuss environmental and technical issues.

5.7 MEXICO CONSULTATION

Pursuant to an international agreement for mandatory reciprocal consultations, the USIBWC has begun consultation with Mexico regarding the proposed interim surplus criteria. Reclamation has assisted USIBWC in conducting this consultation by providing information on the proposed interim surplus criteria and by participating in briefings with the Mexico Section of the IBWC and the Mexico National Water Commission. Meetings with representatives of Mexico were conducted in April and

May 2000, during which representatives of Mexico provided their concerns regarding the potential effects of the interim surplus criteria.

The USIBWC has prepared Terms of Reference for consultation with Mexico, which are contained in Attachment T, together with correspondence from Mexico during the scoping phase of the project. Coordination with Mexico during the DEIS review phase has consisted of several letters from the government of Mexico and public agencies in Mexico, which are reproduced in Volume III of the DEIS.

Discussion with Mexico took place on November 14, 2000 concerning comments from Mexico. There was understanding that the consultation with Mexico through IBWC in the form of technical working groups will continue a forum for technical discussion to carry out, in the context of international comity, joint cooperation projects in support of the Colorado River riparian ecology to the Gulf of California that could have a benefit to the United States and Mexico.

Executive Order 12114 instructs federal agencies to investigate the effects of federal actions in other countries. Reclamation has analyzed and documented the effects of the proposed interim surplus criteria on natural resources in Mexico. This analysis will provide an analytical tool for identifying those potential impacts that extend across the international border and affect Mexico's natural and physical environment. This approach is fully consistent with CEQ guidance on NEPA analyses for transboundary impacts, dated July 1, 1997. Detailed information on this analysis is addressed in Chapter 3.16.

5.8 SUMMARY OF COORDINATION CONTACTS

Table 5-1 lists the agencies and organizations with which Reclamation coordinated through meetings and other personal contacts during the scoping and preparation period of this FEIS.

Table 5-1
Participants With Reclamation Regarding The Interim Surplus Criteria Environmental Impact Statement Process

Agency or Organization Invited to or Requesting Meetings	Meetings
Federal Agencies	
National Park Service – ***Cooperating Agency***	Various plan formulation and evaluation meetings
United States Section of the International Boundary and Water Commission – ***Cooperating Agency***	Various plan formulation and evaluation meetings; Briefings for Mexico
Bureau of Indian Affairs	5/26/99, 12/15/99, 1/21/00, 2/24/00, 8/30/00
Environmental Protection Agency	6/15/99, 8/30/00
U.S. Fish And Wildlife Service	Various Consultation Meetings on ESA Compliance
National Marine Fisheries Service	Consultation on Special Status Species in the Sea of Cortez, 10/12/00
Geological Survey	6/15/99, 8/15/00
Western Area Power Administration	6/15/99, 8/15/00
Tribal Coordination – Ten Tribes Partnership	
Chemehuevi Tribe	5/26/99, 6/15/99, 11/16/19, 12/15/99, 2/24/00, 2/25/00, 8/4/00
Cocopah Indian Tribe	5/26/99, 6/15/99, 11/16/99, 2/15/99, 2/24/00, 2/25/00, 8/3/00
Colorado River Indian Tribes	5/26/99, 6/15/99, 11/16/1999, 12/15/99, 2/24/00, 2/25/00, 8/4/00
Fort Mojave Indian Tribe	5/26/99, 6/15/99, 11/16/19, 12/15/99, 2/24/00, 2/25/00, 8/2/00
Jicarilla Apache Tribe	5/26/99, 11/16/19, 12/15/99, 2/24/00, 2/25/00
Navajo Nation	5/26/99, 11/16/19, 12/15/99, 2/24/00, 2/25/00, 9/27/00, 8/3/00
Northern Ute Tribe	5/26/99, 11/16/19, 12/15/99, 2/24/00, 2/25/00, 8/17/00
Quechan Indian Tribe	5/26/99, 6/15/99, 11/16/19, 12/15/99, 2/24/00, 2/25/00, 8/2/00
Southern Ute Indian Tribe	5/26/99, 11/16/19, 12/15/99, 2/24/00, 2/2500
Ute Mountain Ute Tribe	5/26/99, 11/16/19, 12/15/99, 2/24/00, 2/25/00, 8/3/00

Agency or Organization Invited to or Requesting Meetings	Meetings
Tribal Coordination –Tribes And Communities In Central Arizona	
Ak-Chin Indian Community	5/26/99, 6/15/99, 1/21/00, 8/3/00
Mojave-Apache Tribe	5/26/99, 1/21/00, 8/3/00
Gila River Indian Community	5/26/99, 6/15/99, 1/21/00, 8/3/00
Pasqua-Yaqui Tribe	5/26/99, 1/21/00
Salt River Pima-Maricopa Indian Community	5/26/99, 6/15/99, 1/21/00
San Carlos Indian Tribe	5/26/99, 6/15/99, 1/21/00, 8/3/00
Tohono O'Odham Tribe	5/26/99, 6/15/99, 1/21/00, 8/15/00, 8/3/00
Tonto Apache Tribe	5/26/99, 6/15/99, 1/21/00, 8/4/00
Yavapai-Apache Indian Community	5/26/99, 6/15/99, 1/21/00, 8/3/00
Yavapai-Prescott Indian Tribe	5/26/99, 6/15/99, 1/21/00
Tribal Coordination – Coachella Valley Consortium Of Mission Indians	
Agua Caliente Band of Cahuilla Indians	8/30/00, 9/6/00
Augustine Band of Mission Indians	[Contact attempted; DEIS sent]
Cabazon Band of Mission Indians	[Contact attempted; DEIS sent]
Morongo Band of Mission Indians	8/30/00
Torres-Martinez Desert Cahuilla Tribe	1/21/00, 8/30/00
Twenty-Nine Palms Band of Mission Indians	[Contact attempted; DEIS sent]
Tribal Coordination – Other Tribes	
Havasupai Indian Tribe	6/15/99, 5/26/99, 1/21/00
Hopi Tribe	6/15/99, 5/26/99, 1/21/00, 8/4/00
Hualapai Nation	6/15/99, 5/26/99, 1/21/00, 8/3/00
Kaibab Paiute Tribe	8/3/00
San Juan Southern Paiute Tribe	8/3/00
San Luis Rey Indian Water Authority	8/16/00
Zuni Indian Tribe	8/3/00

Agency or Organization Invited to or Requesting Meetings	Meetings
State And Local Water And Power Agencies	
Arizona Department of Water Resources	6/15/99, 12/16/99
Central Arizona Water Conservation District	6/15/99, 8/15/00
Coachella Valley Water District	6/15/99, 6/6/00, 8/15/00
Colorado River Board of California	6/15/99, 12/16/99, 6/6/00, 8/15/00,11/14/00
Colorado River Commission of Nevada	6/15/99, 12/16/99
Colorado River Water Conservation District	8/15/00
Colorado Water Conservation Board	12/16/99, 8/15/00
Utah Division of Water Resources	12/16/99
Imperial Irrigation District	6/15/99, 6/6/00, 8/15/00, 11/14/00
Las Vegas Valley Water District	6/22/99
Metropolitan Water District, California	6/15/99, 6/6/00, 8/15/00
New Mexico Interstate Stream Commission	12/16/99, 8/15/00
Office of the State Engineer, Wyoming	12/16/99, 8/15/00
Parker Valley Natural Resources Conservation District	12/16/99
Upper Colorado River Commission	6/15/99, 8/15/00
San Diego County Water Authority	8/15/00
Southern Nevada Water Authority	12/16/99, 8/15/00
Non-Governmental Agencies	
Center for Biodiversity	12/15/99, 6/8/00
Defenders of Wildlife	12/15/99, 8/15/00
Environmental Defense	12/15/99, 8/15/00
Glen Canyon Action Network	8/22/00
Pacific Institute	12/15/99, 8/15/00
Southwest Rivers	12/15/99, 8/15/00

Agency or Organization Invited to or Requesting Meetings	Meetings
Agencies of Mexico	
International Boundary and Water Commission, Mexico Section	4/12/00, 5/11/00, 5/12/00, 9/30/00, 11/9/00, 11/14/00
National Water Commission	4/12/00, 5/11/00, 5/12/00, 9/30/00, 11/9/00, 11/14/00
National Institute of Ecology	4/12/00, 9/30/00, 11/9/00, 11/14/00
Secretariat of Environment, Natural Resources and Fish	9/30/00, 11/14/00

5.9 FEDERAL REGISTER NOTICES

This section contains a compilation of the *Federal Register* notices issued to inform the public about the formulation of interim surplus criteria alternatives and the preparation and availability of the DEIS. Table 5.2 lists the *Federal Register* notices, which are presented following the table. In addition to the notices issued, additional notices are planned following the publication of this FEIS to announce its availability and the Secretary's ROD based on this FEIS.

Table 5-2
***Federal Register* Notices Regarding Interim Surplus Criteria**

Notice	Title
Volume 64, No. 95, Page 27008, May 18, 1999	Intent to Solicit Comments on the Development of Surplus Criteria for Management of the Colorado River and to Initiate NEPA Process.
Volume 64, No. 103, Page 29068, May 28, 1999	Public Meetings on the Development of Surplus Criteria for Management of the Colorado River and to Initiate NEPA Process
Volume 64, No. 234, Page 68373, December 7, 1999	Colorado River Interim Surplus Criteria; Notice of Intent to Prepare an Environmental Impact Statement
Volume 65, No. 131, Page 42028, July 7, 2000	Notice of Availability of a draft environmental impact statement and public hearings for the proposed adoption of Colorado River Interim Surplus Criteria
Volume 65, No. 149, Page 47516, August 2, 2000	Notice of revised dates for public hearings on the proposed adoption of Colorado River Interim Surplus Criteria
Volume 65, No. 153, Page 48531, August 8, 2000	Notice of public availability of information submitted on a draft environmental impact statement for the proposed adoption of Colorado River Interim Surplus Criteria (Colorado River Basin States: Interim Surplus Guidelines – Working Draft)
Volume 65, No. 185, Page 57371, September 22, 2000	Notice of Correction to published *Federal Register* Notice of Availability (Colorado River Basin States: Interim Surplus Guidelines – Working Draft)

MASSACHUSETTS

Middlesex County

Hosmer Homestead, 138 Baker Ave., Concord, 99000659

Worcester County

Gardner Uptown Historic District, Roughly along Central, Cross, Elm, Green, Glazier, Pearl and Woodland Sts., Gardner, 99000660

MISSOURI

Franklin County

New Haven Residential Historic District, Roughly along Wall St. and Maupin Ave., and bounded by Washington and Bates Sts., New Haven, 99000661

Lewis County

Gray, William, House (La Grange, Missouri MPS), 407 Washington, La Grange, 99000666
Hay, Dr. J.A., House (La Grange, Missouri MPS), 406 W. Monroe St., La Grange, 99000664
McKoon, John, House (La Grange, Missouri MPS), 500 W. Monroe St., La Grange, 99000665
Rhoda, Fred, House (La Grange, Missouri MPS), 200 S. Second St., La Grange, 99000662
Waltman, A.C., House (La Grange, Missouri MPS), 302 Lewis St., La Grange, 99000663

NEW HAMPSHIRE

Hillsborough County

Francestown Meetinghouse, Rte 136, Francestown, 99000667

Rockingham County

Little Boar's Head Historic District, Parts of Atlantic Ave., Chapel Rd., Ocean Blvd., Sea Rd., and Willow Ave., North Hampton, 99000668

NEW YORK

Tompkins County

First Presbyterian Church of Ulysses, Main St., Trumansburg, 99000669

NORTH CAROLINA

Mecklenburg County

McNinch, Frank Ramsay, House, 2727 Sharon Ln., Charlotte, 99000670

OKLAHOMA

Craig County

First Methodist-Episcopal Church, South, 314 W. Candian Ave., Vinita, 99000673

Lincoln County

National Guard Statistical Building, Park Rd., 1 blk W of 6th St., Chandler, 99000672

Oklahoma County

Smith and Kernke Funeral Directors, 1401 NW 23rd St., Oklahoma City, 99000671

PENNSYLVANIA

Delaware County

Pennsylvania Railroad Station at Wayne, Jct. of N. Wayne Ave. and Station Rd., Wayne, 99000674

RHODE ISLAND

Newport County

Horsehead—Marbella, 240 Highland Dr., Jamestown, 99000675

SOUTH DAKOTA

Custer County

Archeological site no. 39CU1619, Address Restricted, Custer vicinity, 99000679

Gregory County

Mitchell West Central Residential Historic District, Roughly bounded by First and Seventh Aves., Mitchell, 99000676
Tackett Underwood Building, Address Restricted, Gregory vicinity, 99000678

Jerauld County

Wessington Springs Carnegie Library (Historic Bridges in South Dakota MPS) 124 N. Main Ave., Wessington Springs, 99000677

Minnehaha County

Palisades Bridge (Historic Bridges in South Dakota MPS), 25495 485th Ave., Garretson, 99000687

Walworth County

Walworth County Courthouse (County Courthouses of South Dakota MPS), 4304 4th Ave., Selby, 99000680

VIRGINIA

Franklin County

Rocky Mount Historic District, Roughly bounded by Franklin, and Maynor Sts.; Floyd Ave.; E. Court St; and Maple Ave., Rocky Mount, 99000683

York County

Old Custom House, Jct. of Main and Read Sts., Yorktown, 99000682

WISCONSIN

Forest County

Otter Spring House, Approx. 80 meters S of Spring Pond Rd., Lincoln vicinity, 99000684

A Request for a Move has been made for the following resource:

WISCONSIN

Dane County

Crosse, Dr. Charles G., House 133 W. Main St., Sun Prairie, 93000029

A Request for a Removal has been made for the following resource:

INDIANA

Vermillion County

Brouilletts Creek Covered Bridge, Co. Rds 100 W and 1700S over Brouilletts Cr., Clinton 94000586

A Correction is hereby made for the following resouce:

For Technical reasons this nomination should not have been published and is no longer considered a pending National Register of Historic Places Nomination.

NORTH CAROLINA

Carteret County

Cape Lookout Village Historic District, Cape Lookout, from Lighthouse to Cape Point, Harkers Island, 99000599

[FR Doc. 99-12403 Filed 5-17-99; 8:45 am]
BILLING CODE 4310-70-U

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Intent to Solicit Comments on the Development of Surplus Criteria for Management of the Colorado River and to Initiate National Environmental Policy Act (NEPA) Process

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice to solicit comments and initiation of NEPA process.

SUMMARY: The Department of the Interior, Bureau of Reclamation ("Reclamation"), is considering development of specific criteria that will identify those circumstances under which the Secretary of the Interior ("Secretary") may make Colorado River water available for delivery to the States of Arizona, California, and Nevada (Lower Division States or Lower Basin) in excess of the 7,500,000 acre-foot Lower Basin apportionment.

DATES: We must receive all comments at the address below on or before June 30, 1999. In addition to accepting written comments, we will hold public scoping meetings prior to the closing of the comment period. We will hold the public scoping meetings to allow the public to comment on the need for, and content of, specific surplus criteria as part of the National Environmental Policy Act (NEPA) process initiated by this notice. We will notify you of the dates, times, and places for these meetings through the **Federal Register**, media outlets, and to all respondents to this notice.

ADDRESSES: You may submit comments to the Regional Director, Lower Colorado Region, Attention: Jayne Harkins, Bureau of Reclamation, P.O. Box 61470, Boulder City, Nevada 89006-1470.

SUPPLEMENTARY INFORMATION: The Secretary, pursuant to the Boulder Canyon Project Act of December 28, 1928, and the Supreme Court opinion rendered June 3, 1963, and decree entered March 9, 1964 (Decree), in the case of *Arizona* v. *California, et al.*, is vested with the responsibility to manage the mainstream waters of the Colorado River in the Lower Basin. As the agency that has been designated to act in the Secretary's behalf with respect to these matters, Reclamation intends to scope and, if appropriate, to develop and implement specific criteria under which "surplus" determinations will be made for the Lower Basin States.

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 twelve month period, consistent with the "Criteria for Coordinated Long-Range Operation of the Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968" (Long-Range Operating Criteria) and the Decree. 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.

In recent years, demand for Colorado River water in Arizona, California, and Nevada has exceeded the Lower Basin's 7,500,000 acre-foot basic apportionment. As a result, criteria for determining the availability of surplus has become a matter of increased importance. Under these circumstances, the Secretary believes that it may be prudent to develop specific criteria that will guide the Secretary's annual decision regarding the quantity of Colorado River water available for delivery to the Lower Basin States. Such surplus criteria would provide more predictability to States and water users. Reclamation anticipates however, that surplus criteria will be subject to change based upon new circumstances, and that such criteria may be interim in nature.

Reclamation may implement the surplus criteria by revising the Long-Range Operating Criteria set forth in Article III(3) or by developing interim implementing criteria pursuant to Article III(3) of the Long-Range Operating Criteria. Proceeding under Article III(3) may be particularly appropriate because Section 602 of the Colorado River Basin Project Act, as amended, requires that any modification to the Long-Range Operating Criteria be made "only after correspondence with the Governors of the seven Colorado River Basin States and appropriate consultation with such state representatives as each Governor may designate." This statutory reference to the special role of the Basin States in matters relating to the Long-Range Operating Criteria underscores the importance of working closely with the states in developing surplus criteria. Reclamation intends to appropriately coordinate the development of surplus criteria with the Basin States, in accordance with this mandate. In that regard, Reclamation recognizes that efforts are currently underway to reduce California's reliance on surplus deliveries.

Reclamation will take account of progress in that effort, or lack thereof, in the decision-making process regarding specific surplus criteria. Reclamation also intends to make full use of technical information and approaches that have been developed through on-going discussions with the Basin States. This information can be obtained through the Reclamation contact listed above.

As part of the process initiated by this notice, Reclamation will analyze the effects of specific surplus criteria on potential future shortage determinations on the Colorado River. The criteria would be consistent with relevant Federal law, and would recognize relevant provisions of the Law of the River, which has evolved out of a combination of Federal and State statutes, interstate compacts, court decisions and decrees, an international treaty, contracts with the Secretary, operating criteria, regulations, and administrative decisions.

Reclamation will utilize a public process pursuant to NEPA during the development of the surplus criteria. By this notice, Reclamation invites all interested parties, including the Colorado River Basin States, Indian Tribes, water users, members of the general public, organizations, and agencies to present written comments concerning the format for the criteria, the scope of specific surplus criteria, and the issues and alternatives that they suggest should be analyzed. As noted above, Reclamation will integrate the consultation requirements of Section 602 of the Colorado River Basin Project Act, as amended, into the NEPA process initiated by this notice. As part of this review, Reclamation will consult with state representatives of each of the Governors of the seven Colorado River Basin States, Indian Tribes, members of the general public, representatives of academic and scientific communities, environmental organizations, the recreation industry and contractors for the purchase of Federal power produced at Glen Canyon Dam.

Dated: May 13, 1999.

David J. Hayes,

Acting Deputy Secretary.

[FR Doc. 99-12491 Filed 5-17-99; 8:45 am]

BILLING CODE 4310-94-P

INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

Overseas Private Investment Corporation

Submission for OMB Review; Comment Request

AGENCY: Overseas Private Investment Corporation, IDCA.

ACTION: Request for comments.

SUMMARY: Under the provisions of the Paperwork Reduction Act (44 U.S.C. Chapter 35), Agencies are required to publish a Notice in the **Federal Register** notifying the public that the Agency has prepared an information collection request for OMB review and approval and has requested public review and comment on the submission. OPIC published its first Federal Register Notice on this information collection request on March 5, 1999, in 64 FR #43, p. 10721, at which time a 60-calendar day comment period was announced. This comment period ended May 5, 1999. No comments were received in response to this Notice.

This information collection submission has now been submitted to OMB for review. Comments are again being solicited on the need for the information, its practical utility, the accuracy of the Agency's burden estimate, and on ways to minimize the reporting burden, including automated collection techniques and uses of other forms of technology. The proposed form under review is summarized below.

DATES: Comments must be received on or before June 17, 1999.

ADDRESSES: Copies of the subject form and the request for review submitted to OMB may be obtained from the Agency Submitting Officer. Comments on the form should be submitted to the OMB Reviewer.

FOR FURTHER INFORMATION CONTACT:

OPIC Agency Submitting Officer: Carol Brock, Records Manager, Overseas Private Investment Corporation, 1100 New York Avenue, N.W., Washington, D.C. 20527; 202 336-8563.

OMB Reviewer: Jeff Hill, Office of Information and Regulatory Affairs, Office of Management and Budget, New Executive Office Building, Docket

Minnesota professional staff in consultation with representatives of the Bois Forte Band of the Minnesota Indian Tribe.

In 1984, human remains representing one individual from a site located on private land within the exterior boundaries of the Bois Forte Reservation near Lake Vermillion by Bois Forte Tribal Police. These human remains were turned over to the Minnesota State Archeologist and the Minnesota Indian Affairs Council. No known individual was identified. The 16 associated funerary objects include three beaver mandibles, one lynx mandible, one elk naviculocuboid, one beaver innominate, one fragement of beaver incisor, six bone awls, one harpoon awl, one hide flesher (moose or elk metatarsal), and one iron tranche (ice chisel).

Based on the associated funerary objects, this individual has been determined to be Native American from the historic period. These human remains and funerary objects were recovered within the exterior boundaries of the Bois Forte Reservation.

Based on the above mentioned information, officials of the Minnesota Indian Affairs Council have determined that, pursuant to 43 CFR 10.2 (d)(1), the human remains listed above represent the physical remains of one individuals of Native American ancestry. Officials of the Minnesota Indian Affairs Council have also determined that, pursuant to 43 CFR 10.2 (d)(2), the 16 objects listed above are reasonably believed to have been placed with or near individual human remains at the time of death or later as part of the death rite or ceremony. Lastly, officials of the Minnesota Indian Affairs Council have determined that, pursuant to 43 CFR 10.2 (e), there is a relationship of shared group identity which can be reasonably traced between these Native American human remains and associated funerary objects and the Bois Forte Band of the Minnesota Chippewa Tribe.

This notice has been sent to officials of the Bois Forte Band of the Minnesota Chippewa Tribe and the Minnesota Chippewa Tribe. Representatives of any other Indian tribe that believes itself to be culturally affiliated with these human remains and associated funerary objects should contact James L. (Jim) Jones, Cultural Resource Specialist, Minnesota Indian Affairs Council, 1819 Bemidji Ave. Bemidji, MN 56601; telephone: (218) 755-3825, before June 28, 1999. Repatriation of the human remains and associated funerary objects to the Bois Forte Band of the Minnesota Chippewa Tribe may begin after that date if no additional claimants come forward.

Dated: April 22, 1999.

Francis P. McManamon,

Departmental Consulting Archeologist, DeManager, Archeology and Ethnography Program.

[FR Doc. 99-13600 Filed 5-27-99; 8:45 am]

BILLING CODE 4310-70-F

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Public Meetings on the Development of Surplus Criteria for Management of the Colorado River and To Initiate National Environmental Policy Act (NEPA) Process

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of public meetings.

SUMMARY: The Department of the Interior, Bureau of Reclamation ("Reclamation"), is considering development of specific criteria that will identify those circumstances under which the Secretary of the Interior ("Secretary") may make Colorado River water available for delivery to the States of Arizona, California, and Nevada (Lower Division States or Lower Basin) in excess of the 7,500,000 acre-foot Lower Basin apportionment.

Reclamation published a **Federal Register** notice on Tuesday, May 18, 1999, regarding a Notice of Intent to solicit comments on the development of surplus criteria.

Reclamation invites all interested parties to present oral or written comments concerning the following: (1) The need for the development of surplus criteria, (2) the format for the criteria (either by revising the Long-Range Operating Criteria set forth in Article III(3) or by developing interim criteria pursuant to Article III(3) of the Long-Range Operating Criteria), and (3) the specific issues and alternatives to be analyzed in the National Environment Policy Act (NEPA) process.

DATES AND LOCATIONS: Written comments are requested by June 30, 1999, and should be sent to Regional Director, Lower Colorado Region, Attention: Jayne Harkins, Bureau of Reclamation, P.O. Box 61470, Boulder City, Nevada 89006-1470. Oral and written comments will be accepted at the public meetings to be held at the following locations:

Tuesday, June 15, Meeting Room 1 on Level 3, Terminal 4, Phoenix Sky Harbor Airport, Phoenix, Arizona, 6:30 p.m.-9 p.m.

Wednesday, June 16, Keller Peak Room, Doubletree Hotel, 222 N. Vineyard Ave., Ontario, California, 6:30 p.m.-9 p.m.

Tuesday, June 22, Zeus C Room, Alexis Park Resort, 375 East Harmon, Las Vegas, Nevada, 6:30 p.m.-9 p.m.

Wednesday, June 23, Hawk's Nest Conference Room, Terminal 1, Salt Lake International Airport, Salt Lake City, Utah, 6:30 p.m.-9 p.m.

FOR FURTHER INFORMATION CONTACT: Jayne Harkins, telephone (702) 293-8190; faxogram (702) 293-8042; E-mail at: jharkins@lc.usbr.gov or Randall Peterson, telephone (801) 524-3758, faxogram (801) 524-3858; E-mail at: *rpeterson@uc.usbr.gov.*

Dated: May 25, 1999.

Eluid L. Martinez,

Commissioner.

[FR Doc. 99-13667 Filed 5-27-99; 8:45 am]

BILLING CODE 4310-94-U

DEPARTMENT OF JUSTICE

[AAG/A Order No. 167-99]

Privacy Act of 1974; Notice of the Removal of a System of Records

Pursuant to the provisions of the Privacy Act of 1974 (5 U.S.C. 552a), the Procurement Policy and Review Group, Management and Planning Staff, Justice Management Division (JMD) is removing a published Privacy Act system of records entitled "Delegations of Procurement Authority (DPA), JUSTICE/JMD-018." JUSTICE/JMD-018 was last published in the **Federal Register** on October 10, 1995, (60 FR 52704).

The DPA is no longer being used or maintained. The system was originally used, as part of a pre-award review of contract actions above a certain threshold, to ensure contracting officers in the Department's bureaus were exercising their procurement authority in accordance with the terms of their delegations. The system was also used to track training and career progression of bureau contracting officers. On May 31, 1995, the Procurement Executive discontinued the practice of performing pre-award reviews of all contract actions, including checks of contracting officers' delegations. In addition, consistent with the Justice Acquisition Regulations (63 FR 16118-16136), which delegate the responsibility of developing and managing career development programs to the bureaus, the DPA is no longer used for career development purposes.

Adobe Road, Twentynine Palms, California 92277
Thursday, December 16, 1999 at 7 pm
Needles City Hall, 1111 Bailey Avenue, Needles, California 92363

DATES: Comments must be received in writing to the Metropolitan Water District no later than February 22, 2000.

ADDRESSES: Written comments on the Draft EIR/EIS should be mailed to: Metropolitan Water District of Southern California, Post Office Box 54153, Los Angeles, California 90054–0153, Attention: Mr. Dirk Reed.

FOR FURTHER INFORMATION CONTACT: Further information regarding the project may be obtained from Mr. Reed at (213) 217–6163 or Mr. Jack Safely at (213) 217–6981.

Dated: December 1, 1999.

Douglas Romoli,

Acting District Manager.

[FR Doc. 99–31604 Filed 12–6–99; 8:45 am]

BILLING CODE 4310–40–P

DEPARTMENT OF THE INTERIOR

National Park Service

Notice of Intent to Repatriate a Cultural Item in the Possession of the Fort Concho National Historic Landmark, San Angelo, TX

AGENCY: National Park Service, Interior.

ACTION: Notice.

Notice is hereby given under the Native American Graves Protection and Repatriation Act, 43 CFR 10.10 (a)(3), of the intent to repatriate a cultural item in the possession of the Fort Concho National Historic Landmark, San Angelo, TX which meets the definition of "unassociated funerary object" under Section 2 of the Act.

The cultural item is a large Jordano brown ceramic pot with a kill hole at the bottom.

In 1952, this item was donated to the Fort Concho National Historic Landmark by Hollen Mayes. Museum documentation indicates it was removed from a burial in the Diablo Mountains near Van Horn, Culberson County, TX. While the external finish and interior have been greatly altered due to conservation attempts, the form and style of this item is consistent with known Tigua ceramics. Oral history presented by representatives of the Ysleta del Sur Pueblo of Texas indicates this cultural item was originally in the possession of a Tigua (Ysleta del Sur Pueblo) tribal member who as killed near Van Horn, TX.

Officials of the Fort Concho National Historic Landmark have determined that, pursuant to 43 CFR 10.2 (d)(2)(ii), this cultural item is reasonably believed to have been placed with or near individual human remains at the time of death or later as part of the death rite or ceremony and is believed, by a preponderance of the evidence, to have been removed from a specific burial site of an Native American individual. Officials of the Fort Concho National Historic Landmark have also determined that, pursuant to 43 CFR 10.2 (e), there is a relationship of shared group identity which can be reasonably traced between this item and Ysleta del Sur Pueblo of Texas.

This notice has been sent to officials of Ysleta del Sur Pueblo of Texas. Representatives of any other Indian tribe that believes itself to be culturally affiliated with this object should contact Kathleen S. Roland, Curator of Collections, Fort Concho National Historic Landmark, 630 S. Oakes St., San Angelo, TX 76903; telephone: (915) 657-4440 before January 6, 2000. Repatriation of this object to Yselta del Sur Pueblo may begin after that date if no additional claimants come forward.

Dated: November 30, 1999.

Francis P. McManamon,

Departmental Consulting Archeologist, Manager, Archeology and Ethnography Program.

[FR Doc. 99–31568 Filed 12–6–99; 8:45 am]

BILLING CODE 4310–70–F

DEPARTMENT OF INTERIOR

Bureau of Reclamation

Colorado River Interim Surplus Criteria; Notice of Intent To Prepare an Environmental Impact Statement

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of intent to prepare an environmental impact statement.

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, Bureau of Reclamation ("Reclamation"), proposes to prepare an Environmental Impact Statement ("EIS") for development of interim implementing criteria pursuant to Article III (3) of the Long-Range Operating Criteria that will be used by the Secretary of the Interior ("Secretary") to determine surplus conditions for management of the Colorado River.

Reclamation previously published **Federal Register** notices on Tuesday, May 18, 1999 (64 FR 27008) and Friday May 28, 1999 (64 FR 29068) announcing its intention to consider the development of specific criteria that will identify those circumstances under which the Secretary may make Colorado River water available for delivery to the States of Arizona, California, and Nevada (Lower Division States or Lower Basin) in excess of the 7,500,000 acre-foot Lower Basin apportionment. Those notices announced four public scoping meetings and requested oral and written comments on the need for such criteria, the format for the criteria, the scope of specific surplus criteria, and the issues and alternatives that should be analyzed.

The public comment period ran from May 18, 1999 until June 30, 1999. In addition to oral comments submitted at four public scoping meetings, we received 32 letters during the comment period. The respondents included one irrigation district, three water districts, two individuals, three environmental organizations, nine state agencies, two federal organizations, three tribes, two cities, three water users associations, one corporation, one water resource organization, one conservation district and one public utility.

Based on the public comments received, Reclamation has made the decision to prepare an EIS that evaluates the potential impacts of alternative implementing interim criteria that will be used by the Secretary to determine surplus conditions for management of the Colorado River.

Supplementary information is provided in the aforementioned May 18, 1999 **Federal Register** notice.

FOR FURTHER INFORMATION CONTACT: Jayne Harkins, telephone (702) 293–8190; faxogram (702) 293–8042; E-mail at: *jharkins@lc.usbr.gov* or Tom Ryan, telephone (801) 524–3732, faxogram (801) 524–3858; E-mail at: tryan@uc.usbr.gov.

Dated: December 1, 1999.

David J. Hayes,

Acting Deputy Secretary of the Interior.

[FR Doc. 99–31681 Filed 12–6–99; 8:45 am]

BILLING CODE 4310–94–P

INTERNATIONAL TRADE COMMISSION

Sunshine Act Meeting

AGENCY HOLDING THE MEETING: United States International Trade Commission.

TIME AND DATE: December 10, 1999 at 11:00 a.m.

DEPARTMENT OF THE INTERIOR

National Park Service

National Register of Historic Places; Notification of Pending Nominations

Nominations for the following properties being considered for listing in the National Register were received by the National Park Service before July 1, 2000. Pursuant to section 60.13 of 36 CFR part 60 written comments concerning the significance of these properties under the National Register criteria for evaluation may be forwarded to the National Register, National Park Service, 1849 C St. NW, NC400, Washington, DC 20240. Written comments should be submitted by July 24, 2000.

Beth M. Boland,

Acting Keeper of the National Register.

CONNECTICUT

Hartford County

Coult, Abraham, House, 1695 Hebron Ave., Glastonbury, 00000834

Hartford Electric Light Company Maple Avenue Sub-Station, 686 Maple Ave., Hartford, 00000833

New Haven County

West Haven Green Historic District, Roughly along Main St., Campbell St., Church St. and Savin St., West Haven, 00000832

NEBRASKA

Lancaster County

Herter Farmstead, 4949 S 148th, Walton, 00000835

NEW YORK

Rensselaer County

St. Mark's Episcopal Church, Main St., Hoosick Falls, 00000836

Sullivan County

Hankins Stone Arch Bridge, (Upper Delaware Valley, New York and Pennsylvania, MPS) Sullivan Cty. Rd. 94, E., Hankins, 00000838

Manny, Anthony, House, (Upper Delaware Valley, New York and Pennsylvania, MPS) 6 Hankins Rd., Hankins, 00000840

Tusten Stone Arch Bridge, (Upper Delaware Valley, New York and Pennsylvania, MPS) Tusten Rd. at Ten Mile River, Tusten, 00000839

Westchester County

Scarsdale Railroad Station, Popham Rd. at Bronx River Pkwy., Scarsdale, 00000837

NORTH CAROLINA

Chatham County

Siler City Commercial Historic District, Roughly bounded by Second Ave., Birch Ave., Third St. and Beaver St., Siler City, 00000841

Polk County

Railway Clerks' Mountain House, US 176, 0.6 mi. Se of jct. with Ozone Rd., Saluda, 00000842

PENNSYLVANIA

Berks County

Red Men Hall, 831–833 Walnut St., Reading, 00000843

Chester County

Zook House, (West Whiteland Township MRA) 100 Exton Sq., Exton, W. Whiteland, 00000844

Dauphin County

Star Barn Complex, Nissley Dr. at PA 283, Lower Swatara, 00000845

Lancaster County

New Holland Machine Company, 146 E. Franklin St., New Holland, 00000846

Philadelphia County

Bell Telephone Company Building, 1827–35 Arch St., Philadephia, 00000849

York County

Bixler, Michael and Magdealena Farmstead, 400 Mundis Race Rd., East Manchester, 00000850

Red Lion Borough Historic District, Roughly bounded by Edgewood Ave., Windsor Twp. line, MD&PA RR., Chestnut Rd., Country Club Rd., and York Twp. line., Red Line, 00000847

Sinking Springs Farms, Roughly bounded by Church Rd., Sinking Springs Ln., N. George St., Locust Ln., Susquehanna Trail and PA 238, Manchester, 00000848

WISCONSIN

Ozaukee County

Bigelow School, 4228 W. Bonniwell Rd., Mequon, 00000851

WYOMING

Crook County

Entrance Road—Devils Tower National Monument, (Devils Tower National Monument MPS) Devils Tower National Monument, Devils Tower, 00000854

Entrance Station—Devils Tower National Monument, (Devils Tower National Monument MPS) Devils Tower National Monument, Devils Tower, 00000853

Old Headquarters Area Historic District, (Devils Tower National Monument MPS) Devils Tower National Monument, Devils Tower, 00000852

Tower Ladder—Devils Tower National Monument, (Devils Tower National Monument MPS) Devils Tower National Monument, Devils Tower, 00000855

[FR Doc. 00–17267 Filed 7–6–00; 8:45 am]

BILLING CODE 4310–70–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Colorado River Interim Surplus Criteria

AGENCY: Bureau of Reclamation, Department of the Interior.

ACTION: Notice of availability of a draft environmental impact statement and public hearings for the proposed adoption of Colorado River Interim Surplus Criteria: INT–DES 00–25.

SUMMARY: Pursuant to Section 102(2)(C) of 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 Bureau of Reclamation (Reclamation), has issued a Draft Environmental Impact Statement (DEIS) on the proposed adoption of specific criteria under which surplus water conditions may be determined in the Lower Colorado River Basin during the next 15 years. Cooperating agencies are the National Park Service and the International Boundary and Water Commission, United States Section. Information on public hearings may be found below in the **DATES** section.

ADDRESSES: Send comments on the DEIS to Ms. Jayne Harkins, Attention BCOO–4600, PO Box 61470, Boulder City, Nevada, 89006–1470, or fax comments to Ms. Harkins at (702) 293–8042. Comments must be received no later than September 8, 2000.

Our practice is to make comments, including names and home addresses of respondents, available for public review. Individual respondents may request that we withhold their home address from public disclosure, which we will honor to the extent allowable by law. There also may be circumstances in which we would withhold a respondent's identity from public disclosure, as allowable by law. If you wish us to withhold your name and/or address, you must state this prominently at the beginning of your comment. We will make all submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, available for public disclosure in their entirety.

DATES: Comments on this DEIS must be received no later than September 8, 2000.

Public hearings will be held to receive written or verbal comments on the DEIS from interested organizations and individuals on the environmental impacts of the proposal. The hearings will be held at the following times and locations:

- August 3, Meeting Room 1 on Level 3, Terminal 4, Phoenix Sky Harbor International Airport, Phoenix, Arizona, 7 p.m.
- August 8, Big Bear Room, Doubletree Hotel, 222 N. Vineyard Ave., Ontario, CA, 7 p.m.
- August 10, Jazz Room, Salt Lake City International Airport, 765 Terminal Drive, Salt Lake City, Utah, 7 p.m.
- August 15, Comfort Dental Conference Room, Las Vegas Chamber of Commerce, 3720 Howard Hughes Parkway, Las Vegas, NV, 7 p.m.

In addition to the public hearings, a separate hydrologic modeling meeting will be held on the same day as the public hearing in Las Vegas, NV. Reclamation will provide detailed assumptions and respond to questions regarding the model runs, use schedules, and post-processing analysis that was completed for this DEIS. The time and location for this technical meeting is as follows:

- August 15, Comfort Dental Conference Room, Las Vegas Chamber of Commerce, 3720 Howard Hughes Parkway, Las Vegas, NV, 9 a.m. to 5 p.m.

The hearings and the hydrologic modeling meeting will accommodate those with hearing impairments or other special requirements upon request by calling Janet Steele at (702) 293–8551 at least 48 hours prior to the hearing.

The DEIS is available for viewing on the Internet at *http://www.lc.usbr.gov* and *http://www.uc.usbr.gov.* Copies of the DEIS, in the form of a printed document or on compact disk, are available upon written request to the following address: Ms. Janet Steele, Attention BCOO–4601, PO Box 61470, Boulder City, Nevada 89006–1470, Telephone: (702) 293–8785, or by fax at (702) 293–8042.

See **SUPPLEMENTARY INFORMATION** section for a list of libraries where the DEIS is available for public inspection and review.

FOR FURTHER INFORMATION CONTACT: For additional information, contact Ms. Jayne Harkins at the above address or telephone Ms. Harkins at (702) 293–8785.

SUPPLEMENTARY INFORMATION: The Secretary of the Interior (Secretary) currently manages the lower Colorado River system in accordance with federal law (including the provisions of the 1964 U.S. Supreme Court decree, as supplemented, in *Arizona* v. *California* (the Decree)), the Colorado River Basin Project Act of 1968 (CRBPA) and Long Range Operating Criteria (LROC) pursuant to the CRBPA. Within this legal framework, the Secretary makes annual determinations regarding the availability of surplus water from Lake Mead by considering various factors, including the amount of water in storage and predictions for natural runoff. The Decree provides that if there exists sufficient water available in a single year for release from Lake Mead to satisfy annual consumptive use in the states of Arizona, California, and Nevada in excess of 7.5 million-acre feet, such water may be determined by the Secretary to be made available as surplus water.

The purpose of and need for establishing interim surplus criteria is to assist the Secretary in making annual determinations of surplus conditions, and will afford entities that have contracted for surplus water a greater degree of predictability with respect to the annual existence of surplus water available for diversion. This greater predictability would assist these entities in the management of their water resources.

The DEIS presents four possible alternatives for implementation, plus a "No Action Alternative." The DEIS does not include a preferred alternative. The interim surplus criteria alternatives have been formulated to be consistent with applicable federal law and the LROC, described above.

The four potential action alternatives are: a "Flood Control Alternative," which would provide surplus water only when flood control releases from Lake Mead are needed, based on the current criteria for making such releases; the "Six States Alternative" and "California Alternative," both of which specify various Lake Mead water surface elevations to be used as "triggers" to indicate when surplus conditions exist; and the "Shortage Protection Alternative," which would permit surplus conditions to be determined above a specific elevation positioned to ensure enough water remains in Lake Mead to provide a one-year water supply to Arizona, California, Nevada, and Mexico, and to protect against dropping the lake's water level below a specified elevation.

Libraries Where the Draft EIS is Available for Public Inspection and Review:

- Department of the Interior, Natural Resources Library, 1849 C Street, NW, Washington, DC 20240.
- Lower Colorado Regional Office, PO Box 61470, Boulder City, Nevada 89006–1470.
- Phoenix Area Office, Concorde Commerce Center, 2222 West Dunlap Ave., Suite 100, Phoenix, Arizona 85069–1169.
- Yuma Area Office, 7301 Calle Aqua Salada, Yuma, Arizona, 85366–7504.
- Upper Colorado Regional Office, 125 South State St., Room 6107, Salt Lake City, Utah 84138–1102.
- Boulder City Library, 813 Arizona, Boulder City, NV 89005. Henderson District Public Library, 280 South Water St., Henderson, NV 89015.
- Los Angeles Central Library, 630 W 5th St. Los Angeles, CA 90071.
- San Diego Central Library, 820 E St., San Diego, CA 92101.
- Salt Lake City Public Library, 209 E 500 S., Salt Lake City, UT 84111.
- Albuquerque Public Library, 501 Copper Ave. NW, Albuquerque, NM 87102.
- Denver Public Library, 10 W 14th Ave. Pkwy, Denver, CO 80204.
- Laramie County Library, 2800 Central Ave., Cheyenne, WY 82001.
- Phoenix Public Library (Burton Barr Central), 1221 N. Central Ave., AZ 85004.
- Government Reference Library, City Hall, 9th Floor, Tucson, AZ 85701.
- Mohave County Library, 1170 Hancock Rd., Bullhead City, AZ 86442.
- San Bernardino County Library, 1111 Bailey Ave., Needles, CA 92363.
- Lake Havasu City Library, 1787 McCulloch Blvd. North, Lake Havasu City, AZ, 86403.
- Parker Public Library, 1001 South Navajo Ave., Parker, AZ 85344.
- Palo Verde Valley Library, 125 W. Chanslor Way, Blythe, CA 92225.
- Yuma County Library, 350 S. 3rd Ave., Yuma, AZ 85364.

Dated: June 30, 2000.

Willie R. Taylor,

Director, Office of Environmental Policy and Compliance, Department of the Interior.

[FR Doc. 00–17194 Filed 7–6–00; 8:45 am]

BILLING CODE 4310–MN–P

INTERNATIONAL TRADE COMMISSION

[Investigations Nos. 731–TA–872–883 (Preliminary)]

Certain Steel Concrete Reinforcing Bars From Austria, Belarus, China, Indonesia, Japan, Korea, Latvia, Moldova, Poland, Russia, Ukraine, and Venezuela

AGENCY: United States International Trade Commission.

ACTION: Institution of antidumping investigations and scheduling of preliminary phase investigations.

of the Gettysburg National Military Park located at 97 Taneytown Road, Gettysburg, Pennsylvania 17325.

Dated: July 20, 2000.

John A. Latschar,

Superintendent, Gettysburg NMP/Eisenhower NHS.

[FR Doc. 00–19473 Filed 8–1–00; 8:45 am]

BILLING CODE 4310–70–M

DEPARTMENT OF THE INTERIOR

National Park Service

Notice of Availability of the Draft Revision of the Vacation Cabin Site Policy at Lake Mead National Recreation Area

AGENCY: National Park Service, Interior.

ACTION: Notice of availability.

SUMMARY: The National Park Service announces the availability for public review of the draft revision of the Vacation Cabin Site policy at Lake Mead National Recreation Area.

COMMENTS: Written comments must be postmarked or transmitted by September 1, 2000.

If individuals submitting comments request that their name and/or address be withheld from public disclosure, it will be honored to the extent allowable by law. Such requests must be stated prominently in the beginning of the comments. There also may be circumstances wherein the NPS will withhold a respondent's identity as allowable by law. As always: NPS will make available to public inspection all submissions from organizations or businesses and from persons identifying themselves as representatives or officials of organizations and businesses; and, anonymous comments may not be considered.

ADDRESSES: The draft revision of the Vacation Cabin Site policy is available on the Internet at *http://www.nps.gov/lame/concessions/vcs.html*. Requests for copies and written comments should be sent to Superintendent, Lake Mead National Recreation Area, 601 Nevada Highway, Boulder City, Nevada 89005

FOR FURTHER INFORMATION CONTACT: Concessions Program Management at 702/293–8923.

SUPPLEMENTARY INFORMATION: The last revision of the Lake Mead National Recreation Area Vacation Cabin Site policy occurred in 1992. Cabin site lease extensions expired in 1999 and 2000 and are being reauthorized for a one-year extension upon expiration. When the revised cabin site policy is finalized new permits will be issued for a five year period, the maximum length of time allowed by law. The finalized policy will become part of the permit.

There are three vacation cabin site areas within Lake Mead National Recreation Area. Stewart's Point (54 sites), located along Lake Mead in Nevada, approximately two miles northeast of Rogers Spring. Temple Bar (32 sites), located along Lake Mead in Arizona, approximately one mile southeast of Temple Bar Resort. Katherine (35 sites), located along Lake Mohave in Arizona, approximately two miles north of Katherine Landing.

Dated: July 14, 2000.

Alan O'Neill,

Superintendent, Lake Mead National Recreation Area.

[FR Doc. 00–19474 Filed 8–1–00; 8:45 am]

BILLING CODE 4310–70–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Colorado River Interim Surplus Criteria

AGENCY: Bureau of Reclamation, Department of the Interior.

ACTION: Notice of revised dates for public hearings on the proposed adoption of Colorado River Interim Surplus Criteria: INT–DES 00–25.

SUMMARY: Pursuant to Section 102(2)(C) of 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 Bureau of Reclamation (Reclamation), has issued a Draft Environmental Impact Statement (DEIS) on the proposed adoption of specific criteria under which surplus water conditions may be determined in the Lower Colorado River Basin during the next 15 years.

This notice updates the **Federal Register** notice published on July 7, 2000 (65 FR 42028) and provides notice of revised dates for public hearings on the proposed adoption of Colorado River Interim Surplus Criteria. Information on revised dates and locations for public hearings may be found below in the **DATES** section.

ADDRESSES: The comment period on the DEIS remains unchanged. Send comments on the DEIS to Ms. Jayne Harkins, Attention BCOO–4600, PO Box 61470, Boulder City, Nevada, 89006–1470, or fax comments to Ms. Harkins at (702) 293–8042. As provided in the **Federal Register** notice published on July 7, 2000 (65 FR 42028), comments on the DEIS must be received no later than September 8, 2000.

Our practice is to make comments, including names and home addresses of respondents, available for public review. Individual respondents may request that we withhold their home address from public disclosure, which we will honor to the extent allowable by law. There also may be circumstances in which we would withhold a respondent's identity from public disclosure, as allowable by law. If you wish us to withhold your name and/or address, you must state this prominently at the beginning of your comment. We will make all submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, available for public disclosure in their entirety.

DATES: The public comment period on the DEIS remains unchanged and comments on this DEIS must be received no later than September 8, 2000.

Public hearings will be held to receive written or verbal comments on the DEIS from interested organizations and individuals on the environmental impacts of the proposal. The public hearings identified in the **Federal Register** notice published on July 7, 2000 (65 FR 42028) will not be held. Instead, a revised schedule for the hearings follows. The hearings will be held at the following times and locations:

- August 21, Big Bear Room, Doubletree Hotel, 222 N. Vineyard Ave., Ontario, CA, 7 p.m.
- August 22, Comfort Dental Conference Room, Las Vegas Chamber of Commerce, 3720 Howard Hughes Parkway, Las Vegas, NV, 7 p.m.
- August 23, Jazz Room, Salt Lake City International Airport, 765 Terminal Drive, Salt Lake City, Utah, 7 p.m.
- August 24, Meeting Room 1 on Level 3, Terminal 4, Phoenix Sky Harbor Airport, Phoenix, Arizona, 7 p.m.

In addition to the public hearings, a separate hydrologic modeling meeting will be held in Las Vegas, NV. Reclamation will provide detailed assumptions and respond to questions regarding the model runs, use schedules, and post-processing analysis that was completed for this DEIS. The time and location for the hydrologic modeling meeting has not changed from the information provided in the **Federal Register** notice published on July 7, 2000 (65 FR 42028). The time and location for this technical meeting is as follows:

- August 15, Comfort Dental Conference Room, Las Vegas Chamber of Commerce, 3720 Howard Hughes Parkway, Las Vegas, NV, 9 a.m. to 5 p.m.

The hearings and the hydrologic modeling meeting will accommodate those with hearing impairments or other special requirements upon request by calling Janet Steele at (702) 293–8551 at least 48 hours prior to the hearing.

The DEIS remains available for viewing on the Internet at *http://www.lc.usbr.gov* and *http://www.uc.usbr.gov.* Copies of the DEIS, in the form of a printed document or on compact disk, remain available upon written request to the following address: Ms. Janet Steele, Attention BCOO–4601, PO Box 61470, Boulder City, Nevada 89006–1470, Telephone: (702) 293–8785, or by fax at (702) 293–8042.

FOR FURTHER INFORMATION CONTACT: For additional information, contact Ms. Jayne Harkins at the above address or telephone Ms. Harkins at (702) 293–8785.

Dated: July 28, 2000.

Erica Petacchi,

Federal Register Liaison.

[FR Doc. 00–19580 Filed 8–1–00; 8:45 am]

BILLING CODE 4310–MN–P

INTERNATIONAL TRADE COMMISSION

[Investigation No. 731–TA–527 (Review)]

Extruded Rubber Thread From Malaysia

Determination

On the basis of the record [1] developed in the subject five-year review, the United States International Trade Commission determines, pursuant to section 751(c) of the Tariff Act of 1930 (19 U.S.C. 1675(c)) (the Act), that revocation of the antidumping duty order on extruded rubber thread from Malaysia would likely to lead to continuation or recurrence of material injury to an industry in the United States within a reasonably foreseeable time.

Background

The Commission instituted this review on August 2, 1999 (64 FR 41954) and determined on November 4, 1999 that it would conduct a full review (64 FR 62689, November 17, 1999). Notice of the scheduling of the Commission's review and of a public hearing to be held in connection therewith was given by posting copies of the notice in the Office of the Secretary, U.S. International Trade Commission, Washington, DC, and by publishing the notice in the **Federal Register** on January 20, 2000 (65 F.R. 3246). The hearing was held in Washington, DC, on June 1, 2000, and all persons who requested the opportunity were permitted to appear in person or by counsel.

The Commission transmitted its determinations in this investigation to the Secretary of Commerce on July 27, 2000. The views of the Commission are contained in USITC Publication 3327 (July 2000), entitled *Extruded Rubber Thread from Malaysia (Inv. No. 731–TA–527 (Review)).*

Issued: July 27, 2000.

By order of the Commission.

Donna R. Koehnke,

Secretary.

[FR Doc. 00–19570 Filed 8–1–00; 8:45 am]

BILLING CODE 7020–02–P

[1] The record is defined in sec. 207.2(f) of the Commission's Rules of Practice and Procedure (19 CFR § 207.2(f)).

INTERNATIONAL TRADE COMMISSION

[Investigations Nos. 731–TA–639 and 640 (Review)]

Forged Stainless Steel Flanges From India and Taiwan

Determination

On the basis of the record [1] developed in the subject five-year reviews, the United States International Trade Commission determines, pursuant to section 751(c) of the Tariff Act of 1930 (19 U.S.C. 1675(c)), that revocation of the antidumping duty orders on forged stainless steel flanges from India and Taiwan would be likely to lead to continuation or recurrence of material injury to an industry in the United States within a reasonably foreseeable time.

Background

The Commission instituted these reviews on December 1, 1999 (64 FR 67313, December 1, 1999) and determined on March 3, 2000 that it would conduct expedited reviews (65 FR 15009, March 20, 2000). The Commission transmitted its determinations in these reviews to the Secretary of Commerce on July 26, 2000. The views of the Commission are contained in USITC Publication 3329 (July 2000), entitled *Forged Stainless Steel Flanges from India and Taiwan: Investigations Nos. 731–TA-639 and 640 (Review).*

Issued: July 27, 2000.

By order of the Commission.

Donna R. Koehnke,

Secretary.

[FR Doc. 00–19568 Filed 8–1–00; 8:45 am]

BILLING CODE 7020–02–P

[1] The record is defined in sec. 207.2(f) of the Commission's Rules of Practice and Procedure (19 C.F.R. § 207.2(f)).

INTERNATIONAL TRADE COMMISSION

[Investigations Nos. 701–TA–309–A–B and 731–TA–528 (Review)]

Magnesium From Canada

Determinations

On the basis of the record [1] developed in the subject five-year reviews, the United States International Trade Commission determines, pursuant to section 751(c) of the Tariff Act of 1930 (19 U.S.C. § 1675(c)) (the Act), that revocation of the countervailing duty orders [2] and the antidumping duty order on magnesium from Canada would be likely to lead to continuation or recurrence of material injury to an industry in the United States within a reasonably foreseeable time.

Background

The Commission instituted these reviews on August 2, 1999, (64 FR 41961) and determined on November 4, 1999, that it would conduct full reviews (64 FR 62690, November 17, 1999). Notice of the scheduling of the Commission's reviews and of a public hearing to be held in connection therewith was given by posting copies of the notice in the Office of the Secretary, U.S. International Trade Commission, Washington, DC, and by publishing the notice in the **Federal Register** on February 10, 2000 (65 FR 6628). The hearing was held in Washington, DC, on May 31, 2000, and all persons who requested the opportunity were permitted to appear in person or by counsel.

The Commission transmitted its determinations in these investigations to the Secretary of Commerce on July 25, 2000. The views of the Commission are contained in USITC Publication 3324 (July 2000), entitled *Magnesium from Canada: Investigations Nos. 701–TA–309–A–B and 731–TA–528 (Review).*

Issued: July 26, 2000.

[1] The record is defined in sec. 207.2(f) of the Commission's Rules of Practice and Procedure (19 CFR § 207.2(f)).

[2] Commissioner Thelma J. Askey dissenting.

Street, NW., Room 7418, Washington, D.C. 20240.

FOR FURTHER INFORMATION CONTACT: Dr. Wes Henry at 202/208–5211 or Dr. William Schmidt at 202/501–9269.

Maureen Finnerty,

Associate Director, Park Operations and Education.

[FR Doc. 00–19955 Filed 8–7–00; 8:45 am]

BILLING CODE 4310–70–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Colorado River Interim Surplus Criteria

AGENCY: Bureau of Reclamation, Department of the Interior.

ACTION: Notice of public availability of information submitted on a draft environmental impact statement for the proposed adoption of Colorado River Interim Surplus Criteria: INT–DES 00–25.

SUMMARY: Pursuant to Section 102(2)(C) of 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 Bureau of Reclamation (Reclamation) has issued a Draft Environmental Impact Statement (DEIS) on the proposed adoption of specific criteria under which surplus water conditions may be determined in the Lower Colorado River Basin during the next 15 years. A notice of availability and public comment period was provided in a **Federal Register** notice published on July 7, 2000 (65 FR 42028).

As noted in the **Federal Register** notice published on May 18, 1999 (64 FR 27008), during this NEPA process Reclamation is consulting with state representatives of each of the Governors of the seven Colorado River Basin States, Indian Tribes, members of the general public, representatives of academic and scientific communities, environmental organizations, the recreation industry and contractors for the purchase of Federal power produced at Glen Canyon Dam. Reclamation has received information from the Colorado River Basin States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming during the public comment period on the proposed adoption of Colorado River Interim Surplus Criteria. The information provided to Reclamation is the product of significant effort on the part of the representatives of the Governors of the Colorado River Basin States. As noted in the **Federal Register** notice published on May 18, 1999 (64 FR 27008), the statutory framework for operation of Colorado River Reservoirs underscores the importance of working with the Colorado River Basin States in developing interim surplus criteria. Reclamation has made a preliminary review of the specific surplus criteria in the information presented by the Basin States and has made a preliminary determination that such criteria are within the range of alternatives and impacts analyzed in the DEIS. The information provided by the States does contain details regarding proposed surplus criteria that may be helpful to others preparing comments in response to the **Federal Register** notice published on July 7, 2000 (65 FR 42028). Accordingly, Reclamation is providing this information for public consideration during the public comment period on this action. That period will not be extended. Reclamation will be analyzing the issues and information presented in this submission, along with all other public comments on the Draft Environmental Impact Statement (DEIS) on the proposed adoption of Colorado River Interim Surplus Criteria. Reclamation, along with the Department of the Interior, will utilize this information, along with all other public comments, as appropriate, during its preparation of a Final Environmental Impact Statement and accompanying Record of Decision. The information provided by the representatives of the Colorado River Basin States may be found below in the **SUPPLEMENTARY INFORMATION** section.

The DEIS, and the information provided in the **SUPPLEMENTARY INFORMATION** section below are available for viewing on the Internet at http://www.lc.usbr.gov and http://www.uc.usbr.gov.

ADDRESSES: The comment period on the DEIS remains unchanged. Send comments on the DEIS to Ms. Jayne Harkins, Attention BCOO–4600, PO Box 61470, Boulder City, Nevada, 89006–1470, or fax comments to Ms. Harkins at (702) 293–8042. As provided in the **Federal Register** notice published on July 7, 2000 (65 FR 42028), comments on the DEIS must be received no later than September 8, 2000.

Our practice is to make comments, including names and home addresses of respondents, available for public review. Individual respondents may request that we withhold their home address from public disclosure, which we will honor to the extent allowable by law. There also may be circumstances in which we would withhold a respondent's identity from public disclosure, as allowable by law. If you wish us to withhold your name and/or address, you must state this prominently at the beginning of your comment. We will make all submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, available for public disclosure in their entirety.

Copies of the DEIS, in the form of a printed document or on compact disk, remain available upon written request to the following address: Ms. Janet Steele, Attention BCOO–4601, PO Box 61470, Boulder City, Nevada 89006–1470, Telephone: (702) 293-8785, or by fax at (702) 293–8042.

DATES: The public comment period on the DEIS remains unchanged and comments on this DEIS must be received no later than September 8, 2000.

FOR FURTHER INFORMATION CONTACT: For additional information, contact Ms. Jayne Harkins at the above address or telephone Ms. Harkins at (702) 293–8785.

SUPPLEMENTARY INFORMATION: The following information was received from the Colorado River Basin States:

Interim Surplus Guidelines—Working Draft

I. Background

A. The Boulder Canyon Project Act of 1928 (28 Stat. 1057) (the "BCPA"), authorized the Secretary of the Interior (the "Secretary") to construct Hoover Dam and the All-American Canal, and to contract for the delivery and use of water from such facilities for irrigation and domestic uses. The effectiveness of the BCPA was contingent upon ratification of the Colorado River Compact of 1922 (the "Compact") by the Colorado River Basin States, or, in the alternative, upon ratification by six of said states, including California. The effectiveness of the BCPA was further contingent upon agreement by the state of California, by act of its legislature, irrevocably and unconditionally with the United States and for the benefit of the other Colorado River Basin States, as an express covenant and in consideration of the passage of the BCPA, to limit the aggregate annual consumptive use (diversions less returns to the river) of water of and from the Colorado River for use in California, to no more than 4.4 million acre-feet ("maf") per year of the waters apportioned to the Lower Basin States by Article III(a) of the Compact, plus not more than one-half of any excess or surplus waters unapportioned by the

Compact, such use to be always subject to the terms of the Compact.

Six states, including California, ratified the Compact by 1929. The California Legislature also passed the California Limitation Act (Act of March 4, 1929; Ch. 16, 48th Sess.). Thus, the conditions of the BCPA were satisfied, the President proclaimed the BCPA effective on June 25, 1929 and the Secretary thereafter constructed Hoover Dam and the All-American Canal and executed contracts for the delivery and use of water from such facilities. Arizona ratified the Compact in 1944.

Before the Secretary entered into water delivery contracts with California agencies, he requested such agencies to agree to relative priorities of rights among them. This was accomplished by the California Seven-Party Agreement of August 18, 1931, incorporated into the water delivery contracts (the "California Seven Party Agreement"), which established the following priorities within California:

CALIFORNIA SEVEN-PARTY AGREEMENT

Priority	Description	Acre-feet annually
1	Palo Verde Irrigation District—gross area of 104,500 acres	
2	Yuma Project (Reservation Division)—not exceeding a gross area of 25,000 acres	
3(a)	Imperial Irrigation District and lands in Imperial and Coachella Valleys to be served by the All-American Canal.	3,850,000
3(b)	Palo Verde Irrigation District—16,000 acres of mesa lands	
4	Metropolitan Water District and/or City of Los Angeles and/or others on coastal plain.	550,000
5(a)	Metropolitan Water District and/or City of Los Angeles and/or others on coastal plain.	550,000
5(b)	City and/or County of San Diego[1]	112,000
6(a)	Imperial Irrigation District and lands in Imperial and Coachella Valley	
6(b)	Palo Verde Irrigation District—16,000 acres of mesa lands	300,000
7	Agricultural Use in the Colorado River Basin in California	
Total		5,362,000

[1] In 1946, the City of San Diego, San Diego County Water Authority, Metropolitan Water District and the Secretary entered into a contract in which the right to storage and delivery of Colorado River water vested in the City of San Diego was merged with and added to the rights of the Metropolitan Water District under conditions since satisfied.

The California Seven-Party Agreement thus allocated water both within California's limitation of 4.4 maf per year, as well as surplus water above that amount. Only about one-half of the water under Priorities 4, 5(a) and 5(b) diverted by the Metropolitan Water District of Southern California (the "MWD") through its Colorado River Aqueduct is within the 4.4 maf limitation. Diversions under Priorities 5(a) and (b) are dependent upon surplus water being made available. The amounts of water allocated to Priorities 1, 2, 3(a) and 3(b) were not quantified by priority, but were aggregated to not exceed 3.85 maf.

In 1964, the U.S. Supreme Court entered its Decree in *Arizona* v. *California,* 376 U.S. 340 (1964) (the "Decree"), pursuant to its Opinion in the same case, 373 U.S. 546 (1963). The Decree and the Court's Opinion confirmed and ordered the apportionment by the BCPA of water available for release from water controlled by the United States in the mainstream of the Colorado River downstream from Lee Ferry and within the United States to the states of Arizona (2.8 maf per year); California (4.4 maf per year); and Nevada (0.3 maf per year). The Decree also established certain federal reserved rights, and provided for the quantification of present perfected rights, all to be supplied from the apportionments decreed to each of the respective states. The Decree enjoins the Secretary from releasing mainstream water controlled by the United States for irrigation and domestic use in the Lower Division States (Arizona, California and Nevada) except in the following circumstances:

1. If sufficient mainstream water is available for release to satisfy 7.5 maf of annual consumptive use in the three Lower Division States, such water shall be made available in accordance with the basic apportionments set forth above. This is referred to as a "Normal Year." (Article II(B)(1)).

2. If sufficient mainstream water is available for release to satisfy in excess of 7.5 maf of annual consumptive use in the three Lower Division States, water in excess of 7.5 maf shall be apportioned 50% for use in Arizona and 50% for use in California; provided, however, that in the event the United States so contracts with Nevada (which it has) then 46% of such surplus is apportioned for use in Arizona and 4% of such surplus is apportioned for use in Nevada. This is referred to as a "Surplus Year." (Article II(B)(2)).

3. If insufficient mainstream water is available for release to satisfy 7.5 maf of annual consumptive use in the three Lower Division States, then after satisfying present perfected rights in order of priority, such water shall be apportioned consistent with the BCPA and the opinion of the Court, but in no event shall more that 4.4 maf be apportioned for use in California including all present perfected rights. Under § 301(b) of the Colorado River Basin Project Act of 1968, 82 Stat. 885, diversions from the Colorado River for the Central Arizona Project (the "CAP") shall be so limited as to assure the availability of water in quantities sufficient to provide for the aggregate annual consumptive use by holders of present perfected rights, by other users in the State of California served under existing contracts with the United States by diversion works theretofore constructed, and by other existing Federal reservations in that State, of 4.4 maf, and by users of the same character in Arizona and Nevada. This is referred to as a "Shortage Year." (Article II(B)(3)).

4. If, in any one year, water apportioned for consumptive use in a State will not be consumed in that State, the Secretary may make available such apportioned but unused water during such year for consumptive use in another Lower Division State. No rights to the recurrent use of such water shall accrue by reason of the use thereof. (Article II(B)(6))

In the *Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado*

River Basin Project Act of September 30, 1968 (P.L. 90–537) (the "Criteria"), the Secretary adopted Criteria implementing his authorities under the BCPA, as enjoined by the Decree. Article III of the Criteria provides for the determination of Normal, Surplus and Shortage conditions for the release from Lake Mead of mainstream water downstream from Lee Ferry for use in the Lower Division States.

B. California's basic annual mainstream apportionment of Colorado River water is 4.4 maf, whereas its use of Colorado River water has ranged from 4.2 to 5.2 maf since 1975. In the past, California was able to consumptively use water above its basic annual apportionment because the water use by both Arizona and Nevada was below their basic annual apportionments.

In 1991 and 1992, as California faced its fifth and sixth consecutive years of severe drought, entities in California were able to divert all of the water that they requested or could transport from the Colorado River within the Lower Basin's apportionment. However, Nevada's Colorado River water use was forecasted to exceed its basic apportionment of 300,000 acre-feet ("af") in the first decade of the 21st century, and Arizona's water use was projected to reach its basic annual apportionment of 2.8 maf. This meant that, in the future, without the Secretary declaring a Surplus condition, California's use of Colorado River water would be limited to its 4.4 maf basic apportionment, some 750,000 af less than its forecasted use of Colorado River water. The bulk of any mandated reduction in California's water use would occur within the priorities held by MWD, which serves the coastal plain of southern California through its Colorado River Aqueduct.

Since 1964, California has made significant investments to offset the eventual reduction in available Colorado River water. These investments have included: developing additional sources of imported water, conservation (demand reduction and use efficiency improvements), surface and groundwater storage, local supplies, conjunctive use programs, reclaimed water projects, and recovery and treatment of contaminated groundwater. While these investments have significantly increased supplies and reduced demand for imported water, they have not been adequate to offset the reduction of Colorado River water to 4.4 maf per year, when considered in conjunction with population increases and the reduction in dependable State Water Project (the "SWP") and Los Angeles Aqueduct supplies. This reality has fueled further efforts to maximize the beneficial use of Colorado River water in California through cooperative conservation programs and transfers of conserved water.

C. Nevada is quickly approaching full use of its 0.3 maf basic apportionment. Nevada's basic apportionment is projected to meet its domestic needs (excluding groundwater recharge) until approximately 2007. Also, Nevada has a need for additional water above its basic apportionment before 2007 for groundwater recharge in local groundwater basins.

Nevada's long-term options for additional water supply include surplus Colorado River water, participation in the Arizona groundwater bank, a number of in-state options such as the Muddy and Virgin Rivers, recovery and treatment of poor quality shallow groundwater, import of groundwater from basins within Nevada, and recovery of water from local groundwater banks. Nevada projects that even with an aggressive water conservation program it will need additional water for domestic needs in about 2007 and the need will steadily increase to almost 40,000 af in 2016. Nevada also projects it could use an additional 30,000 to 50,000 af per year for local groundwater recharge when surplus supplies are available.

D. Arizona's Lower Basin apportionment is divided among a number of major agricultural, Indian, and municipal contractors. Geographically, there are numerous diversions by contractors located along the River corridor and there is the singular diversion by the CAP which delivers water through a series of aqueducts to the interior portion of the State.

Arizona's uses of Colorado River water are increasing rapidly, but primarily because the CAP, which was declared substantially complete in the early 1990's, is becoming more fully utilized. In contrast, uses by contractors located along the Colorado River in the Yuma and Parker areas have been developed for many years and their consumption has been stable. Increased municipal growth in the Yuma and Mohave County areas will gradually increase water demands over a period of many years, but some of the growth will result in a corresponding decrease in agricultural demand as farm lands are subdivided and urbanized. On-reservation uses by Indian Tribes located in proximity to the River are also well established, although the potential for increased consumptive use exists, especially on the Colorado River Indian Tribes (the "CRIT") Reservation.

CAP water uses will increase over time as municipal and Indian contractors complete necessary water treatment and delivery infrastructure. In the meantime, the CAP will deliver significant quantities of water to irrigation districts who will use the water to displace groundwater supplies. Arizona has also developed a major capability to use CAP water that would otherwise be unordered, for groundwater recharge activities. The largest purchaser of water for recharge purposes is the Arizona Water Banking Authority (the "AWBA"), whose primary purpose is to firm municipal CAP water deliveries.

E. In January 1986, the Bureau of Reclamation (Reclamation) issued a special report titled *Colorado River—Alternative Operating Strategies for Distributing Surplus Water and Avoiding Spills.* This report suggested operating strategies for avoiding Lake Mead spills that went beyond the *Field Working Agreement between the Bureau of Reclamation and the Army Corps of Engineers for Flood Control Operation of Hoover Dam and Lake Mead,* but were, in essence, based on similar principles. Under one of these strategies, limited surpluses would be determined based on the need to provide adequate storage capacity for an assumed runoff rather than the actual yearly forecast in order to reduce the probability of reservoir spills.

One of the alternatives considered assumed that runoff to be the value of the 70th percentile of exceedance based on the historic record, which is equivalent to about 17.331 maf runoff above Lake Powell. This strategy was named OS 0.70 ("70R") or "space building to avoid reservoir spills" in the 1986 report. This and other strategies have been utilized for long-range operation projections since 1986.

F. On October 18, 1999, the respective boards of Coachella Valley Water District ("CVWD"), Imperial Irrigation District ("IID"), MWD and the State of California released the Key Terms for Quantification Settlement (the "Key Terms") as the basis for obtaining public input and completing a Quantification Settlement Agreement ("Settlement Agreement") among the districts. The Settlement Agreement provides the basis for California to reduce its reliance on Colorado River water above its basic apportionment. The agreement further will quantify the rights and uses of Colorado River water by designating water budgets for CVWD, IID, and MWD. The quantification of the rights and uses of water with respect to priorities 3 and 6 of the 1931 California Seven Party Agreement is designed to help facilitate implementation of cooperative water supply programs, and provide a quantified baseline from which conservation and transfer programs can be measured. The Settlement Agreement is expected to be fully executed in January 2001, after the conditions precedent contained in the Key Terms have been satisfied.

California's Colorado River Water Use Plan (the "Plan"), is a framework by which programs, projects, actions, policies and other activities would be coordinated and cooperatively implemented allowing California to meet its Colorado River water needs within its basic apportionment in Normal years.

The Plan describes resource and financial investments and provides overall coordination on important initiatives undertaken by the Colorado River Board of California member agencies and others. The diverse components of the Plan are designed to help protect and optimize California's Colorado River resources. Some of these are associated components, meaning that they don't directly involve Colorado River water but are needed by implementing entities to meet their water needs within California's Colorado River water apportionment. The components of the Plan are broad in scope addressing both quantity and quality of California's share of Colorado River water.

The California agencies with Colorado River rights and contractual interests are the principal implementing entities for the programs and projects described in the Plan, and for obtaining the necessary program and project approvals, conducting appropriate environmental reviews, and ensuring compliance with endangered species acts (federal and state).

The Plan is intended to be dynamic and flexible enough to allow for modifications in, and periodic updates to, the framework when and where appropriate, and to allow for the substitution of programs and projects within the Plan's components when they have been found to be more cost effective and/or appropriate. Programs undertaken by the California agencies to transition California's use of Colorado River water to its basic apportionment without potential major water supply and economic disruptions include:

- Further quantification of rights and use of Colorado River water in California where helpful to facilitate the optimum use of California's Colorado River resources;
- Cooperative core water supply programs and voluntary transfers;
- Increased efficiencies in water conveyance and use;
- Water storage and conjunctive use programs to increase normal and dry year water supplies;
- Voluntary water exchanges;
- Administrative actions necessary for effective use and management of water supplies;
- Improved reservoir management and operations;
- Drought and surplus water management plans;
- Coordinated project operations for increased water supply yield; and
- Groundwater management.

The State of California has supported Plan implementation from the General Fund. Most notably, $235 million was appropriated in 1998 for lining portions of the All American and Coachella Canals ($200 million) and for groundwater storage and conjunctive use programs ($35 million) identified in the Plan. Also, between 1996 and 2000, California voters approved historic levels of general obligation bond financing for improving California water supply reliability, water quality and for restoring watershed ecosystems. The funding support provided by the $995 million Safe, Clean, Reliable Water Supply Act in 1996; the $2.1 billion Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Act in 2000; and the $1.97 billion Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act in 2000 extend to the implementation of the Plan.

The proposed Settlement Agreement, other proposed interagency agreements and associated implementation agreement(s) with the Secretary, together with the Secretary's administration of water rights and use below Glen Canyon Dam, constitute the principal binding and enforceable provisions of the Plan. Provisions regarding third and sixth priority use provide the mechanisms needed to help facilitate the voluntary shift of approximately 380,000 af per year from agricultural use to urban use on the coastal plain of Southern California and the needed quantified baseline by which such programs can be measured.

The Settlement Agreement, when fully executed, provides the basis for California to meet its Colorado River water supply needs from within its annual apportionment of Colorado River water. Specific terms of the settlement include:

- A shift of 380,000 acre-feet per year from agriculture to urban use, through water acquisitions from IID and CVWD to MWD and SDCWA and forbearance of the use of 38,000 acre-feet per year of 6th priority water by IID and CVWD for MWD's use;
- Caps on use of water by IID and CVWD under the third priority at 3.1 maf and 0.33 maf, respectively;
- The exclusive right for MWD to utilize all water below 420,000 acre-feet per year unused by the Palo Verde Irrigation District and the Yuma Project-Reservation Division collectively;
- A permanent water supply of 16,000 acre-feet per year for the San Luis Rey (the "SLR") Indian Water Rights Settlement, from the All American and Coachella Canal Lining Projects;
- Deductions from IID, CVWD, and MWD's supplies to permit the Secretary to satisfy use of miscellaneous and Indian present perfected rights by holders of those rights as they were not addressed in the 1931 Seven-Party Agreement, the majority of the rights having been quantified in 1979; and
- A net yield of up to 90,000 acre-feet per year from the IID–MWD Conservation Program for MWD over a period of up to approximately 75 years.

Table 1 summarizes the yields and estimated start dates of the core cooperative voluntary water conservation/transfer projects and associated exchanges:

TABLE 1.—COOPERATIVE WATER CONSERVATION/TRANSFER PROJECTS

Cooperative water conservation/transfer projects	Annual yield (af)	Estimated start date
MWD/IID 1988 Water Conservation Program	100,000–110,000[2]	([1])
SDCWA/IID Transfer and SDCWA/MWD Exchange	130,000–200,000[3]	2002
MWD/CVWD SWP Water Transfer/Colorado River Water Exchange	35,000	2003
Coachella Canal Lining-MWD/SLR[4]	26,000	[5] 2005
All American Canal Lining-MWD/SLR[3]	367,700	[4] 2006

TABLE 1.—COOPERATIVE WATER CONSERVATION/TRANSFER PROJECTS—Continued

Cooperative water conservation/transfer projects	Annual yield (af)	Estimated start date
IID/CVWD/MWD Conservation Program	100,000 [6]	2007

[1] Complete.
[2] Yield to MWD, except for 20,000 af per year to be made available to CVWD.
[3] Yield to SDCWA.
[4] Yield to MWD and San Luis Rey Indian Water Rights Settlement Parties.
[5] Date by which full conservation benefits will be achieved.
[6] Yield to CVWD, MWD has an option to acquire water CVWD does not need. MWD assumes responsibility for 50,000 af per year to CVWD after year 45 of the Settlement Agreement.

The agencies' Colorado River entitlement water use budgets are adjusted for each increment of transfer, resulting in an overall reduced use of Colorado River water by California. There is approximately a 20-year transition period before the core water conservation/transfers are fully implemented. All of the core conservation/transfers to the coastal plain of southern California are proposed to occur within a ten-year implementation period.

The agencies responsible for implementing the components of the Plan intend to move forward as quickly as possible. In a number of cases, environmental documentation must be prepared and, in certain cases, permits and approvals must be secured from state and/or federal agencies to permit projects to move forward. It should be understood that some components and/or associated components may be modified but would still produce the same conceptual results, or that other options may be substituted if they are found to be more effective and appropriate. There are also related activities, such as the Salton Sea (the "Sea") restoration efforts. Congress specified in Public Law 105–372 that alternatives to restore the Sea should not include importation of any new or additional water from the Colorado River and should account for the transfer of water out of the Salton Sea Basin.

The Plan also includes consideration of environmental factors. Implementation of the Plan will reduce California's reliance on the Colorado River without severe dislocations in either urban or agricultural areas. Fundamentally, programs and projects in the Plan are not designed to increase water supplies to accommodate increased population growth. Thus, their implementation will not stimulate new growth, foster unplanned urban development, affect demands on local or regional transportation systems, require new public services and utilities, or create long-term increases in ambient noise levels. Their implementation will make a *de minimis* contribution to cumulative land use impacts and have a *de minimis* effect on associated socioeconomic resources, such as employment, earnings, and housing. The Plan and the accompanying Settlement Agreement programs and projects are designed to preserve the ability to meet existing needs while diverting less water from the Colorado River.

In accordance with the Plan, California's use of Colorado River water during the Interim Period will decline over time. During the Interim Period (2002–2016), MWD will use surplus water, when available, to meet direct water supply demands on the coastal plain while programs and projects in the Plan are implemented, as well as to provide a source of water for conjunctive use and storage programs. Following the Interim Period, beyond 2016, MWD's water supply demands will be met from occasional years of surplus water, conjunctive use and storage withdrawals, dry year transfers, and other water acquisitions.

California expects to have the projects shown in Table 1 yield the following amounts of water in the years shown:

Date	Acre feet
2006	340,000
2011	460,000
2016	490,000
2021	510,000
2026	540,000

II. Authority and Purpose

The purpose of these Guidelines is to provide direction for an Interim Period for the annual determination by the Secretary of Normal, Surplus, and Shortage conditions for the pumping or release from Lake Mead of mainstream water downstream from Lee Ferry for use in the Lower Division States. These Guidelines are used under the authority of the Boulder Canyon Project Act of 1928 (28 Stat. 1057) (the "BCPA"), the Decree in *Arizona* v. *California,* 376 U. S. 340 (1964) (the "Decree") and in furtherance of 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 (P.L. 90–537)* (the "Criteria"). Additionally, these Guidelines rely on the authority of the Secretary to make apportioned but unused water in one Lower Division State available for use for irrigation and domestic uses in another state under Article II(B)(6) of the Decree. These Guidelines are adopted for the purpose of providing enhanced domestic water supply reliability in the Lower Division States during a transition period ending December 31, 2016 (the "Interim Period"), in accordance with the priorities contained in water delivery contracts or agreements.

These Guidelines become effective only when the Settlement Agreement becomes effective. The Guidelines include triggers that will implement Normal, Surplus or Shortage deliveries at specified target elevations of storage in Lake Mead. They also include benchmarks, reporting mechanisms and reviews by which California and agencies within California will demonstrate measurable and defined progress in meeting the goals of the California's Plan described herein. If sufficient progress is not being made, these Guidelines will automatically terminate.

The State of California and its affected agencies have recognized and agreed upon, and the Secretary has agreed with, the plan for implementation of agreements that will increase the efficiency of use within Priorities 1 through 3 of the California Seven-Party Agreement of August 18, 1931, and thereby reduce the amount of water required for irrigation and potable uses under such priorities. Savings shall be made available for use on the coastal plain of Southern California within California's basic annual apportionment of 4.4 maf.

These Guidelines include measures to be undertaken by MWD to provide reparation to Arizona for increased water supply shortages associated with interim operations, both during the effective period and for so long thereafter as such risk is present. During the Interim Period and after the termination of these Guidelines, the Secretary will withhold, deliver and account for water in accordance with such described reparation.

These Guidelines are not intended to, and do not:

• Guarantee or assure any water user a firm supply for any specified period;

• Change or expand existing authorities under the body of law known as the "Law of the River";

• Address intrastate storage or intrastate distribution of water;

• 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 Compact;

• Affect any obligation of any Upper Division State under the Colorado River Compact;

• Affect any right of any State or of the United States under § 14 of the Colorado River Storage Project Act of 1956 (70 Stat. 105); § 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 the "Law of the River"; or

• 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 in accordance with the Decree.

For purposes of these guidelines, the following definitions do apply:

"Domestic" use shall have the meaning defined in the Compact. "Direct Delivery Domestic Use" shall mean direct delivery of water to domestic end users of 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. "Direct Delivery Domestic Use" for MWD 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. "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.

III. Allocation of Unused Apportionment Water Under Article II(B)(6)

Article II(B)(6) of the 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. Historically, this provision of the Decree has been used to allocate Arizona's and Nevada's apportioned but unused water to California.

Water use projections made for the analysis of these interim Guidelines indicate that neither California nor Nevada is likely to have significant volumes of apportioned but unused water during the Interim Period. Depending upon the requirements of the AWBA for intrastate and interstate Off-Stream Banking, Arizona may have significant amounts of apportioned but unused water.

Before making a determination of an interim 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 Metropolitan Water District of Southern California ("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 Settlement Agreement.

IV. Determination of Lake Mead Operation During the Interim Period

A. Normal

In years when available Lake Mead storage is projected to be at or below elevation 1,125 ft. and above the Shortage triggering level on January 1, the Secretary shall determine a Normal year.

B. Surplus

1. *Partial Domestic Surplus:* In years when Lake Mead storage is projected to be between elevation 1125 ft. and elevation 1145 ft. on January 1, the Secretary shall determine a Partial Domestic Surplus. The amount of such Surplus shall equal:

a. For Direct Delivery Domestic Use by MWD, 1.212 maf reduced by: 1.) the amount of basic apportionment available to MWD and 2.) the amount of its domestic demand which MWD offsets in such year by offstream groundwater withdrawals or other options. The amount offset under 2.) shall not be less than 400,000 af in 2001 and will be reduced by 20,000 af/yr over the Interim Period so as to equal 100,000 af in 2016.

b. For use by SNWA, one-half of the Direct Delivery Domestic Use within the SNWA service area in excess of the State of Nevada's basic apportionment.

c. For Arizona, one-half of the Direct Delivery Domestic Use in excess of the State of Arizona's basic apportionment.

2. *Full Domestic Surplus:* In years when Lake Mead content is projected to be above elevation 1145 ft., but less than the amount which would initiate a Surplus under B.3 or B.4 hereof on January 1, the Secretary shall determine a Full Domestic Surplus. The amount of such Surplus shall equal:

a. For Direct Delivery Domestic Use by MWD, 1.250 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.

3. *Quantified Surplus:* 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 OS 0.70 alternative strategy ("70R") as described in the Bureau of Reclamation's *CRSSez Annual Colorado River System Simulation Model Overview and Users Manual,* revised May 1998, the Secretary shall determine and allocate a Quantified Surplus sequentially as follows:

a. Establish the volume of the Quantified Surplus.

b. Allocate and distribute the Quantified Surplus 50% to California, 46% to Arizona and 4% to Nevada, subject to c. through g. that follow.

c. Distribute California's share first to meet basic apportionment demands and MWD's Direct Delivery Domestic Use and Off-stream Banking 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 Direct Delivery Domestic Use and Off-stream Banking 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 III, *Allocation of Unused 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 Section IV.B.2., *Full Domestic Surplus* if a Quantified Surplus had not been declared. If they have not, then determine and meet all demands provided for in Section IV.B.2. (a), (b) and (c).

f. Any remaining water shall remain in storage in Lake Mead.

4. *Flood Control Surplus:* In years in which the *Field Working Agreement between the Bureau of Reclamation and the Army Corps of Engineers for Flood Control Operation of Hoover Dam and Lake Mead* requires releases greater than the downstream beneficial consumptive use demands, the Secretary shall determine a Flood Control Surplus in 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 groundwater banking, and section 215 deliveries under the Reclamation Reform Act of 1982 (96 Stat. 1263) (the "RRA"). After all beneficial uses within the United States have been met, the Secretary shall notify the United States Section of the International Boundary and Water Commission that there may be a surplus of water as provided in Article 10 of the Mexican Water Treaty of 1944.

C. Shortage

In a year when the Secretary projects that future water supply and demands would create a 20% or greater probability that Lake Mead would drop below elevation 1050 feet in a year prior to or in the year 2050, the Secretary shall determine a Shortage. This strategy is defined in the Bureau of Reclamation's *CRSSez Annual Colorado River System Simulation Model Overview and Users Manual*, revised May 1998. In any year when a shortage is declared, the Secretary shall deliver no more than 4.4 maf for consumptive use in California and no more than 2.3 maf for consumptive use in Arizona. Nevada shall share in shortages as required by law. If reservoir conditions continue to deteriorate, the Secretary may require additional reductions in accordance with the Decree and law.

V. Determination of 602(a) Storage in Lake Powell During the Interim Period

During the Interim Period, 602(a) storage requirements determined in accordance with Article II (1) of the Criteria shall utilize a value of not less than 14.85 maf (elevation 3630 feet) for Lake Powell.

VI. Implementation of Guidelines

During the Interim Period the Secretary shall utilize the currently established process for development of the Annual Operating Plan for the Colorado River System Reservoirs ("AOP") and use these Guidelines to make determinations regarding Normal, Surplus, and Shortage conditions for the operation of Lake Mead and to allocate apportioned but unused water. The Secretary also shall apply, as appropriate, the provisions of these Guidelines related to reparation and termination. 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, the Criteria, and other applicable laws.

In order to allow for better overall water management during the Interim Period, the Secretary shall undertake a "mid-year review" allowing for the revision of the current AOP, as appropriate based on actual runoff conditions which are greater than projected, or demands which 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 may occur only after a re-initiation of the AOP consultation process as required by law.

As part of the AOP process during the Interim Period, California shall report to the Secretary on its progress in implementing the Plan.

VII. Reparation for Increased Water Supply Shortages

It is possible that the operation of Lake Mead under these Guidelines will result in the Secretary determining a shortage condition more frequently, or for a shortage to be more severe, or for a shortage to be longer in duration than would otherwise have occurred, during the Interim Period or thereafter. During the Interim Period, if the Secretary makes a shortage determination in which deliveries to Arizona would be reduced, and if MWD has diverted water under IV. B.1 and/or IV. B.2 herein, MWD has agreed to forbear the delivery off the River of 500,000 af per year, unless otherwise agreed by MWD and Arizona. The holders of Priorities 6 and 7 under the California Seven-Party Agreement and Nevada have waived any claim to such water. After the Interim Period, if the Secretary makes a shortage determination in which deliveries to Arizona would be reduced and, if MWD has diverted water under IV. B.1 and/or IV. B.2 herein, MWD has agreed to forbear the delivery off the river of an amount of water equal to such reductions to Arizona, unless otherwise agreed by MWD and Arizona. The holders of Priorities 6 and 7 under the California Seven-Party Agreement and Nevada have waived any claim to such water.

The total amount of water forborne by MWD during or after the Interim Period pursuant to these guidelines shall not exceed one maf.

The reparation obligation of MWD shall terminate at such time after the Interim Period that the Secretary determines a Surplus based on the Flood Control strategy or as otherwise agreed by MWD and Arizona.

VIII. Termination of Guidelines

These Guidelines shall terminate:

A. On December 31, 2016, or

B. In the event California has not implemented conservation measures as set forth in the Settlement Agreement, which actually reduce its need for surplus Colorado River water by the following amounts by the date indicated:

Date	Acre feet
January 1, 2006	280,000
January 1, 2011	380,000

In such event, the Bureau of Reclamation shall account for the total volume of Colorado River water diverted into underground storage from the Colorado River Aqueduct by and for the benefit of MWD under any Full Domestic Surplus determination. MWD has agreed to forbear diversions in an amount equal to such volume in the next following Normal or Shortage year(s) in an amount not to exceed 200,000 af per year, and the holders of Priorities 6 and 7 under the California Seven-Party Agreement have waived any claim to such water. Such obligation shall be terminated in the first year that the Secretary determines a Surplus under a 70R strategy or a Flood Control strategy.

Upon termination, Lake Mead operations, for the purpose of determining Surplus, shall immediately revert to 70R. Note: We will prepare a separate document describing inadvertent overruns and average decree accounting that may be incorporated into the criteria or adopted separately."

Dated: August 3, 2000.

Eluid L. Martinez,

Commissioner, Bureau of Reclamation.

[FR Doc. 00–20033 Filed 8–7–00; 8:45 am]

BILLING CODE 4310–MN–P

DEPARTMENT OF JUSTICE

Lodging of Consent Decrees Under the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA")

Notice is hereby given that nine proposed consent decrees in *United States* v. *Mountain Metal Company, et al.*, Civil Action No. CV–98–C–2562–S, and consolidated action *Exide Corporation and Johnson Controls, Inc.* v. *Aaron Scrap Metals, et al.*, Civil Action No. CV–98–J–2886–S, were lodged on August 1, 2000 with the United States District Court for the Northern District of Alabama, Southern Division.

In these actions, the United States has sought recovery of response costs under section 107 of CERCLA, 42 U.S.C. 9607, and Exide Corporation and Johnson Controls, Inc. have sought recovery of response costs under section 113 of CERCLA, 42 U.S.C. 9613, against over forty defendants with respect to the Interstate Lead Company ("ILCO") Superfund Site, located in Leeds, Jefferson County, Alabama ("the Site").

The United States has now agreed to settlement of its claims under sections 106 and 107 of CERCLA, 42 U.S.C. 9606 and 9607, for existing contamination at the Site with respect to nine defendants: (1) Arch Metals, Inc.; (2) Del's Metals Co., Inc.; (3) Harry Gordon Scrap Materials, Inc.; (4) Kar-Life Battery Company, Inc.; (5) Lead Products Co., Inc.; (6) Mixon, Inc.; (7) Mountain Metal Company, Inc.; (8) T.A. Pollack Co., Inc.; and (9) Wooster Iron & Metal Company f/k/a Metallics Recycling, Inc. Under the consent decrees, the companies will pay the following amounts to the United States: (1) $17,000 for Arch Metals, Inc.; (2) $20,400 for Del's Metals, Inc.; (3) $83,640 for Harry Gordon Scrap Materials, Inc.; (4) $11,560 for Kar-Life Battery Company, Inc.; (5) $90,870 for Lead Products Co., Inc.; (6) $17,820 for Mixon, Inc.; (7) $170,000 for Mountain Metal Company, Inc.; (8) $14,500 for T.A. Pollack Co., Inc. and (9) $63,933 for Wooster Iron & Metal Company f/k/a Metallics Recycling, Inc.

The Department of Justice will receive, for a period of thirty (30) days from the date of this publication, comments relating to the proposed consent decrees. Comments should be addressed to the Assistant Attorney General of the Environment and Natural Resources Division, P.O. Box 7611, Department of Justice, Washington, D.C. 20044, and should refer to *United States* v. *Mountain Metal Company, et al.*, Civil Action No. CV–98–C–2562–S, and consolidated action *Exide Corporation and Johnson Controls, Inc.*, v. *Aaron Scrap Metals, et al.*, Civil Action No. CV–98–J–2886–S, and DOJ # 90–11–2–108/2.

Any of the proposed consent decrees may be examined at the Office of the United States Attorney, Northern District of Alabama, 200 Robert S. Vance Federal Building & Courthouse, 1800 5th Ave. N., Room 200, Birmingham, AL 35203–2198, and at U.S. EPA Region 4, Atlanta Federal Center, 61 Forsyth Street, S.W. Atlanta, Georgia 30303. A copy of any of the proposed Consent Decrees also may be obtained by mail from the Department of Justice Consent Decree Library, P.O. Box 7611, Washington, D.C. 20044. In requesting a copy, please enclose a check in the amount of $8.00 (25 cents per page reproduction costs) per Consent Decree, payable to the Consent Decree Library.

Bruce S. Gelber,

Deputy Chief, Environmental Enforcement Section, Environment and Natural Resources Division.

[FR Doc. 00–19950 Filed 8–7–00; 8:45 am]

BILLING CODE 4410–15–M

NUCLEAR REGULATORY COMMISSION

[Docket No. 040–08778]

Finding of No Significant Impact Related to Amendment of Source Materials License SMB–1393 Molycorp. Inc., Washington, PA, Facility

The U.S. Nuclear Regulatory Commission (NRC) is considering issuing an amendment to Source Materials License No. SMB–1393 issued to Molycorp, Inc. (Molycorp or licensee), to authorize decommissioning of its facility in Washington, Pennsylvania. In preparation for cleanup of the site, Molycorp submitted its initial decommissioning plan (DP) to the NRC in July 1995. The DP has been supplemented twice: (1) First on June 30, 1999, (DP Part 1) to reflect the licensee's intent to decommission a portion of the site using cleanup criteria contained in NRC's "Action Plan to Ensure Timely Cleanup of Site Decommissioning Management Plan Sites" (SDMP Action Plan) (57 **Federal Register** 13389); and (2) on July 14, 2000, (DP part 2) for that portion of the site intended to meet the requirements of the License Termination Rule (LTR) in 10 CFR part 20, Subpart E, "Radiological Criteria for License Termination," published in July 1997 (62 **Federal Register** 39057).

Environmental Assessment Summary

This Environmental Assessment (EA) addresses only the part 1 decommissioning. Part 2 will be the subject of a separate evaluation. Under the Part 1 DP (hereafter, decommissioning plan) Molycorp, Inc., will remediate contaminated soils on the main facility grounds and at a separate location where slag materials have been concentrated by past operations (*i.e.*, slag pile) to unrestricted release levels. The decision to dispose of the materials on site will be addressed in part 2.

This EA reviews the environmental impacts of the decommissioning actions proposed by Molycorp, Inc. in the decommissioning plan (part 1) for its facility located in Washington, Pennsylvania. In connection with the review of plans for the proposed action, NRC staff is preparing a safety evaluation report (SER), that evaluates compliance of the proposed action with NRC regulations. On issuance, the SER will be available in NRC's Electronic Reading Room, on NRC's Web site *http://www.nrc.gov/adams/index.html.*

Proposed Action

The decommissioning activities proposed by Molycorp include:

- Identify the location, depth, and thickness of areas containing greater than 10 picoCuries per gram (0.37 Becquerels per gram) total thorium.
- Mobilize equipment, set up decontamination facilities, and implement erosion control measures in preparation for excavation activities.
- Survey the site area to establish spatial coordinates of contaminated areas identified from site characterization radiological surveys.
- Excavate clean overburden and stockpile onsite.
- Excavate all soil and slag containing average contamination levels in excess of the unrestricted use criteria.
- Stockpile excavated material in preparation for loading onto transports. Stockpiling duration is estimated at two weeks. Excavation and stockpiling of waste will not occur until NRC has approved a disposal location for the waste.

- Imperial Public Library, 200 W. 9th Street, Imperial, California; telephone: (760) 355–1332
- Indio Branch Library, 200 Civic Center Mall, Indio, California; telephone: (760) 347–2383
- Palm Springs Library, 300 S. Sunrise Way, Palm Springs, California; telephone: (760) 322–7323
- San Diego Central Library, 820 E Street, San Diego, California; telephone: (619) 236–5800
- Los Angeles Public Library, 630 W. Fifth Street, Los Angeles, California 90071; telephone: (213) 228–7000

SUPPLEMENTARY INFORMATION: This DEIS/DEIR is a revised and updated version of a DEIS/DEIR for the Coachella Canal Lining Project filed by Reclamation and the CVWD and issued for public comment on January 11, 1994. At that time, because of funding constraints, construction of the project was deferred, and a Final EIS/EIR was not completed. The proposed action evaluated in the revised DEIS/DEIR is the same as in the previous document—to install a concrete lining within the existing cross-section of unlined portions of the canal (33.2 miles) using conventional construction methods and diverting water around each section while it is being lined. Alternatives evaluated in the DEIS/DEIR, also the same as in the original DEIS/DEIR, include No Action, Underwater Lining, and Parallel Canal Construction.

The purpose of this federal action is to conserve 30,850 acre-feet annually of water presently being lost as seepage from the earthen reaches of the Coachella Canal. A specific quantity of conserved water would be assigned to the Department of the Interior to facilitate implementation of the San Luis Rey Indian Water Rights Settlement Act (Public Law 100–675, November 17, 1988). Remaining quantities of conserved water would be distributed to southern California to meet present water demand and to assist the State in attaining the goals of California's Colorado River Water Use Plan. The federal action includes approval of transfers and exchanges of conserved Coachella canal water among California's Colorado River water contractors.

Dated: September 13, 2000.

Robert W. Johnson,

Regional Director.

[FR Doc. 00–24425 Filed 9–21–00; 8:45 am]

BILLING CODE 4310–MN–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Colorado River Interim Surplus Criteria; Correction

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of correction to published **Federal Register** notice of availability.

SUMMARY: The Bureau of Reclamation is correcting information published in the **Federal Register** issue date of Tuesday, August 8, 2000 (Vol. 65, No. 153).

FOR FURTHER INFORMATION CONTACT: For additional information, contact Ms. Jayne Harkins at (702) 293–8785.

SUPPLEMENTARY INFORMATION: On page 48534, in Table 1., "Cooperative Water Conservation/Transfer Projects", under the column labeled "Cooperative water conservation/transfer projects", the footnote for "All American Canal Lining-MWD/SLR" should be "4" instead of "3." In the "Estimated start date" column of the same table, the footnote for year "2006" should be "5" instead of "4."

On page 48536, in the far right column, subsection "IV.B.3.b." should read "Allocate and distribute the Quantified Surplus 50% to California, 46% to Arizona and 4% to Nevada subject to c. though f. that follow." instead of "* * * subject to c. though g. that follow."

Dated: September 15, 2000.

Robert W. Johnson,

Regional Director.

[FR Doc. 00–24424 Filed 9–21–00; 8:45 am]

BILLING CODE 4310–MN–P

DEPARTMENT OF THE INTERIOR

Office of Surface Mining Reclamation and Enforcement

Notice of Proposed Information Collection

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 renew its authority to collect information for the permanent program inspection and enforcement procedures at 30 CFR Part 840.

DATES: Comments on the proposed information collection must be received by November 21, 2000, 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 210–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 form, contact John A. Trelease, at (202) 208–2783.

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 extension. This collection is contained in 30 CFR 840.

OSM has received burden estimates, where appropriate, to reflect current reporting levels or adjustments based on reestimates of burden or respondents. OSM will request a 3-year term of approval for this 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.

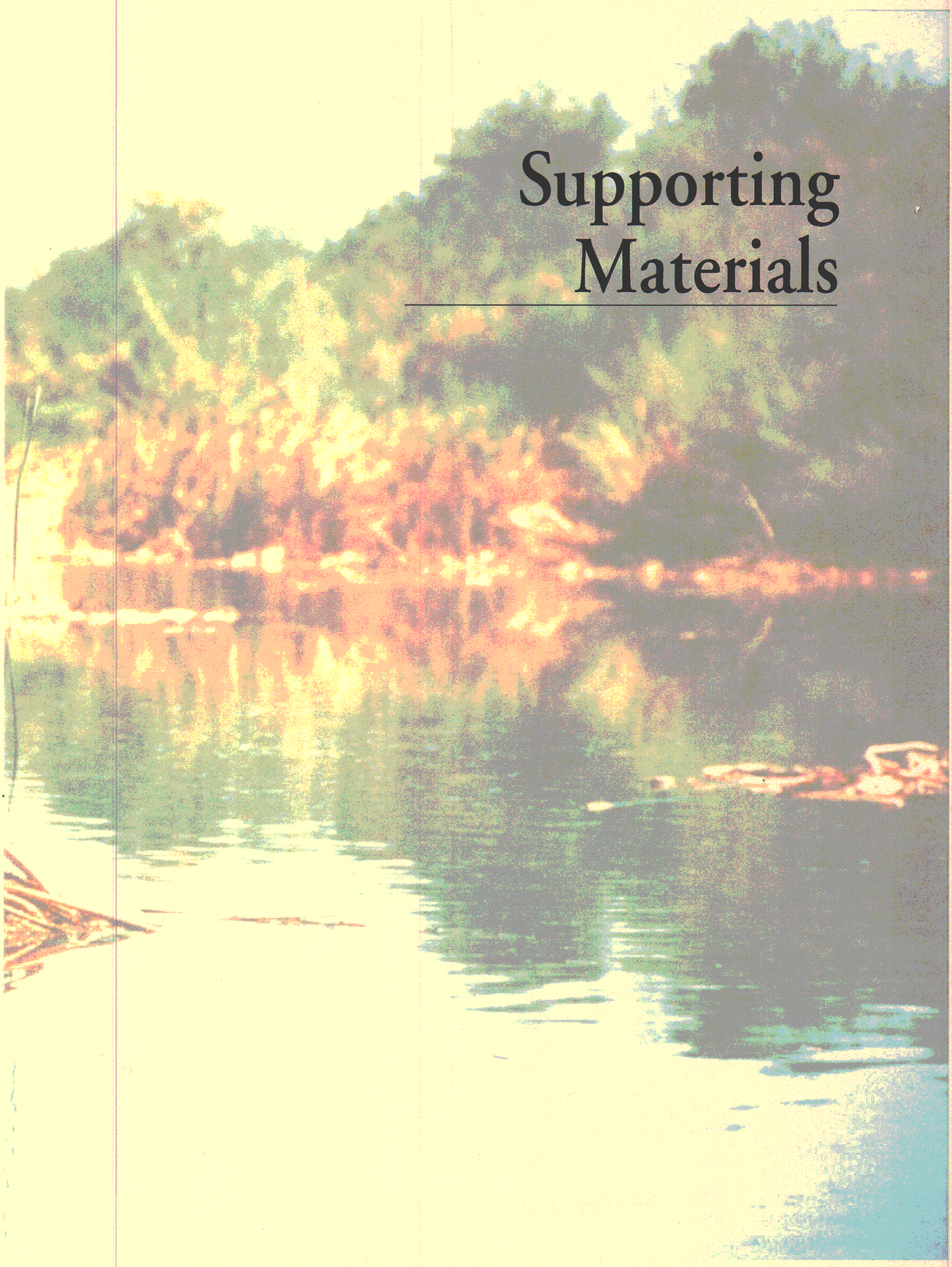
This notice provides the public with 60 days in which to comment on the following information collection activity:

Title: Permanent Program Inspection and Enforcement Procedures, 30 CFR Part 840.

OMB Control Number: 1029–0051.

Abstract: This provision requires the regulatory authority to conduct periodic inspections of coal mining activities, and prepare and maintain inspection reports for public review. This information is necessary to meet the requirements of the Surface Mining Control and Reclamation Act of 1977 and its public participation provisions. Public review assures the public that the State is meeting the requirements for the

Supporting Materials



GLOSSARY

A

abutment	A structure that supports the ends of a dam or bridge.
accretion	Gradual increase in flow of a stream due to seepage, ground-water discharge, or tributary inflow.
acre-foot	Volume of water (43,560 cubic feet) that would cover one acre to a depth of one foot.
active storage	Reservoir capacity that can be used for authorized purposes.
aerate	To supply or charge with gas, usually air.
affected environment	Existing biological, physical, social, and economic conditions of an area subject to change, both directly and indirectly, as the result of a proposed human action.
aggradation	Process of filling and raising the level of a streambed, flood plain, or sandbar by deposition of sediment. The opposite of degradation.
algae	Simple plants containing chlorophyll; most live submerged in water.

allocation, allotment — Refers to a distribution of water through which means 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. The 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.

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 (i.e., salamanders, frogs and 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.

apportionment — Refers to the distribution of water available to each Lower Division state in normal, surplus or shortage years, as set forth, respectively in Articles II (B)(1), II (B)(2) and II (B)(3) or the Decree in *Arizona v. California.*

arroyo — A gully or channel cut by an ephemeral stream.

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.
baseload plant	Powerplant normally operated to carry base load; consequently, it operates essentially at a constant load.
Basin States	The seven states referred to in the Compact as making up the Colorado River watershed; Wyoming, Colorado, Utah, Nevada, Arizona, New Mexico and California.
benthic	Bottom of rivers, lakes, or oceans; organisms that live on the bottom of water bodies.
biological opinion	Document stating the U.S. Fish and Wildlife Service and 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.
bright line	A groundwater term; the interface between surface water and groundwater.

C

candidate species	Plant or animal species not yet officially listed as threatened or endangered, but which is undergoing status review by the Service.
catch	At a recreational fishery, refers to the number of fish captured, whether they are kept or released. *(See harvest.)*
channel margin bar	Narrow sand deposits which continuously or discontinuously line the riverbank.

cladophora	Filamentous green alga important to the food chain in the Colorado River below Glen Canyon Dam.
Colorado River Basin	The drainage basin of the Colorado River in the United States.
Colorado River Basin Salinity Control Forum	The organization dedicated to controlling Colorado River salinity consisting of representatives of the seven Basin States
Colorado River Simulation System	An operational model of the Colorado River system based on a monthly timestep.
commercial river trip	Trip organized by a boating company that conducts tours for paying passengers.
Compact	The Colorado River Compact of 1922
compact point	The reference point designated by the Colorado River compact dividing the Upper and Lower Colorado River basins – Lee Ferry, Arizona.
Congress	United States Congress
consumptive use	The total water diversions from the Colorado River, less return flows to the river.
Cooperating Agency	With respect to the NEPA process, an agency having jurisdiction by law or special expertise concerning an aspect of a proposed project action that is requested by the Lead Agency to participate in the preparation of an Environmental Impact Statement.
coordinated operation	Generally, the operation of two or more interconnected electrical systems to achieve greater reliability and economy. As applied to hydropower resources, the operation of a group of hydropower plants to obtain optimal power benefits with due consideration for all other uses.

Court United States Supreme Court

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.

CRSSez A simplified version of CRSS based on a yearly timestep.

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 storage Reservoir space from which stored water cannot be evacuated by gravity.

Decree Decree entered in *Arizona v. California*

delta Sediment deposit formed at the mouths 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 document in cfs.

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 seven and nine mg/l; most fish cannot survive when DO falls below 3 mg/l.

drawdown Lowering of a reservoir's water level; process of depleting reservoir or groundwater storage.

E

excess flow to Mexico Flow at NIB in excess of Mexico's scheduled delivery.

ecosystems Complex system composed of a community of fauna and flora and that system's chemical and physical environments.

eddy Current of water moving against the main current in a circular pattern.

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.

energy Electric capacity generated and/or delivered over time.

entitlement — Refers to an authorization to beneficially consume Colorado River water pursuant to (1) a decreed right, (2) a contract with the United States through the Secretary of the Interior or (3) a Secretarial reservation of water.

epilimnion — *See stratification.*

euphotic — Of, relating to, or constituting the upper layers of a body of water into which sufficient light penetrates to permit growth of green plants.

eutrophic — A body of water, often shallow, containing high concentrations of dissolved nutrients with periods of oxygen deficiency.

excess capacity — Power generation capacity available on a short-term basis in excess of the firm capacity available through long-term contracts.

F

firm energy or power — Non-interruptible energy and power guaranteed by the supplier to be available at all times except for reasons of uncontrollable forces or "continuity of service" contract provisions.

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.

flow — Volume of water passing a given point per unit of time expressed in cfs.

peak flow – Maximum instantaneous flow in a specified period of time.

return flow – Portion of water previously diverted from a stream and subsequently returned to that stream or to another body of water.

forage fish Generally, small fish that reproduce prolifically and are consumed by predators.

forebay 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.

fuel replacement energy Electrical energy generated at a hydroelectric plant as a substitute for energy that would have been generated by a thermal electric plant.

full pool Volume of water in a reservoir at maximum design elevation.

G

gamete Mature egg.

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.

herbivore Animal that feeds on plants.

heterogeneous Consisting of dissimilar ingredients or constituents.

hydrology Science dealing with natural runoff and its effect on streamflow.

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 *See stratification.*

I

impoundment Body of water created by a dam.

inflow Water flowing into a lake or reservoir from a river and/or its tributaries; or water entering a river from tributaries.

J-K

jeopardy opinion United States Fish and Wildlife Service or National Marine Fisheries Service opinion that an action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat. The opinion includes reasonable and prudent alternatives, if any.

juvenile Young fish older than 1 year but not having reached reproductive age.

L

larval fish An immature stage that develops from the fertilized egg before assuming the characteristics of the adult.

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, a combination of federal and state statutes, interstate compacts, court decisions and decrees, federal contracts, an international treaty with Mexico and formally determined operating criteria.
Lead Agency	The agency initiating and overseeing the preparation of an environmental impact statement.
Lee Ferry	A reference point marking division between the Upper and Lower Colorado River Basins. The point is located in the mainstream of the Colorado River 1 mile below the mouth of the Paria River in Arizona.
Lees Ferry	Location of Colorado River ferry crossings (1873 to 1928) and site of the USGS stream gage above the Paria River confluence.
limnology	Scientific study of the 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	The part of the Colorado River watershed below Lee Ferry, Arizona; covers parts of Arizona, California, Nevada, New Mexico and Utah.
Lower Division	A division of the Colorado River system that includes the states of Arizona, Nevada and California.

Lower Division states	Arizona, California and Nevada as defined by Article II of the *Colorado River Compact of 1922*.

M

magnitude	A number characteristic of a quantity and forming a basis for comparison with similar quantities such as flows. A number representing the intrinsic or apparent brightness of a celestial body on a logarithmic scale in which an increase of one unit corresponds to a reduction in the brightness of light by a factor of 2.512.
mean monthly flow	Average flow for the month, usually expressed in cfs.
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.
mesotrophic	The intermediate level of a lake or reservoir trophic state, less productive with respect to algal biomass and nutrient levels than a eutrophic water body, but more productive than an oligotrophic lake or reservoir.
milligram per liter	Equivalent to one part per million.
Minute 242	Minute 242, August 30, 1973 of the International Boundary and Water Commission United States and Mexico pursuant to the Mexican Water Treaty. Similar to an amendment.
morphometry	A branch of limnology that deals with the morphological measurements of a lake and its basin.

N

no jeopardy opinion
United States Fish and Wildlife Service or National Marine Fisheries Service opinion that an action is not likely to jeopardized the; continued existence of a listed species or result in the destruction or adverse modification of critical habitat.

O

off-peak energy
Electric energy supplied during periods of relatively low system demand.

oligotrophic
A body of water characterized by low dissolved plant nutrient and organic matter, and rich in oxygen at all depths.

on-peak energy
Electric energy supplied during periods of relatively high system demand.

P-Q

Pacific Institute
Pacific Institute for Studies in Development, Environment and Security.

peak load
Maximum electrical demand in a stated period of time.

pelagic
Of, relating to, or living or occurring in open water.

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 10 percent of the values are less than or equal to the 10^{th} percentile.

permeability (soil) — Ease with which gasses, liquids, or plant roots penetrate or pass through a layer of soil.

$PM_{2.5}$ — Particulate matter less than 2.5 microns in mean diameter.

PM_{10} — Particulate matter less than 10 microns in mean diameter.

power — Electrical capacity generated, transferred or used.

probability — In this EIS, the relative frequency with which a range of modeled values occurs. For example, the probability of Lake Mead elevation exceeding 1180 ft msl in June 2005 is equal to the number of modeled elevations greater than 1180 ft in June 2005, divided by the total number of modeled elevations in June 2005 (equal to 85 due to 85 traces being modeled).

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 range 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 stream, channel, or other water conveyance.

recruitment — Survival of young plants and animals from birth to a life stage less vulnerable to environmental change.

redd — Depression in river or lake bed dug by fish for the deposition of eggs.

return flow credit — Water returned to the Colorado River that can be rediverted in the same year. Diverted Colorado River water that is returned to the river 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.

riparian obligate — A species dependent upon riparian habitat.

RiverWare — A commercial river system simulation computer program that was configured to simulate operation of the Colorado River for this EIS.

S

salinity — A term used to refer to the dissolved minerals in water, also referred to as total dissolved solids.

Secchi disk — Instrument used to determine the depth to which light penetrates lake water. Used as an aid to establish the euphotic zone, which marks that area of a lake where primary productivity (energy production by photosynthesis) occurs.

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.

spawn To lay eggs, especially fish.

spawning beds Places in which eggs of aquatic animal's lodge or are placed during or after fertilization.

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 water surface 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 Water surface elevation.

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.

T

tailwater Water immediately downstream of the outlet from a dam or hydroelectric powerplant.

thermocline The zone of maximum change in temperature in a water body, separating upper (epilimnetic) from lower (hypolimnetic) zones.

total dissolved solids (TDS) — A measure of the inorganic or mineral content of water, commonly expressed in milligrams per liter.

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.

tributary — River or stream flowing into a larger river or stream.

turbidity — Cloudiness of water, measure by how deeply light can penetrate into the water from the surface.

U-V

Upper Basin — The part of the Colorado River watershed above Lee Ferry, Arizona; that covers parts of Arizona, Colorado, New Mexico, Utah and Wyoming.

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 — A division of the Colorado River system that includes the states of Colorado, New Mexico, Utah and Wyoming.

W-X

watershed — The drainage area upstream of a specified point on a stream.

Y-Z

young-of-year — Small fish hatched from eggs spawned in the current year.

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Defenders of Wildlife
Pacific Institute for Studies in Development, Environment and Security
Southwest Rivers

Water User Agencies & Organizations

Central Arizona Water Conservation District (Central Arizona Project)
Coachella Valley Water District
Colorado River Energy Distributors Association
Colorado River Water Conservation District
Cottonwood Creek Consolidated Irrigation Company
Emery Water Conservancy District
Grand Water & Sewer
Imperial Irrigation District
Irrigation and Electrical District Association of Arizona
Metropolitan Water District of Southern California
Mohave County Water Authority
Ouray Park Irrigation Company
Salt River Project
San Diego County Water Authority
Southern California Edison Company
Southern Nevada Water Authority

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Union Park Water Authority
Upper Colorado River Commission
Wellton-Mohawk Irrigation and Drainage District

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Grand County Council, Utah

State Agencies

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Arizona Power Authority (Mulholland)
Arizona Department of Water Resources
Arizona Game and Fish Department
Colorado River Board of California
California Regional Water Quality Control Board
Colorado Department of Natural Resources
Nevada Department of Transportation
Nevada State Historic Preservation Office
New Mexico Environmental Department
New Mexico Interstate Stream Commission
Colorado River Commission of Nevada
Utah Department of Natural Resources, Division of Water Resources
Office of Federal Land Policy (State of Wyoming)

Tribes

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Hualapai Nation
Navajo Nation Dept of Justice
Navajo Tribal Utility Authority
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Federal Agencies

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Bureau of Indian Affairs, Navajo Region, Gallup
Environmental Protection Agency, San Franscico
Fish and Wildlife Service, Phoenix
International Boundary and Water Commission - U.S. Section, El Paso
National Park Service, Washington, DC
Western Area Power Administration, Phoenix (Counsil)
Western Area Power Administration, Phoenix (Montoya)
Western Area Power Administration, Salt Lake City

Mexican Agencies/Organizations

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International Boundary and Water Commission - Mexico Section
Mexicali Business Coordinating Council
Mexicali Economic Development Council
Mexico - National Water Commission

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Gila River Indian Community
Havasupai Tribal Council
Hopi Tribe
Mohave Apache Community Council
Paiute Indian Tribe of Utah
Pascua Yaqui Tribe
Pueblo of Zuni
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San Juan Southern Paiute Tribe
Tohono Oodham Nation
Tonto Apache Tribal Council
Yavapai Apache Nation
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U.S. Senate, CA, Senator Barbara Boxer
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U.S. House of Representatives, CA, Joe Baca
U.S. House of Representatives, CA, Brian Bilbray
U.S. House of Representatives, CA, Mary Bono
U.S. House of Representatives, CA, Ken Calvert
U.S. House of Representatives, CA, Randy Cunningham
U.S. House of Representatives, CA, Bob Filner
U.S. House of Representatives, CA, Duncan L. Hunter
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U.S. House of Representatives, CA, Ron Packard
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Salt Lake City Public Library
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Upper Colorado Regional Office Library
Yuma Area Office Library
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