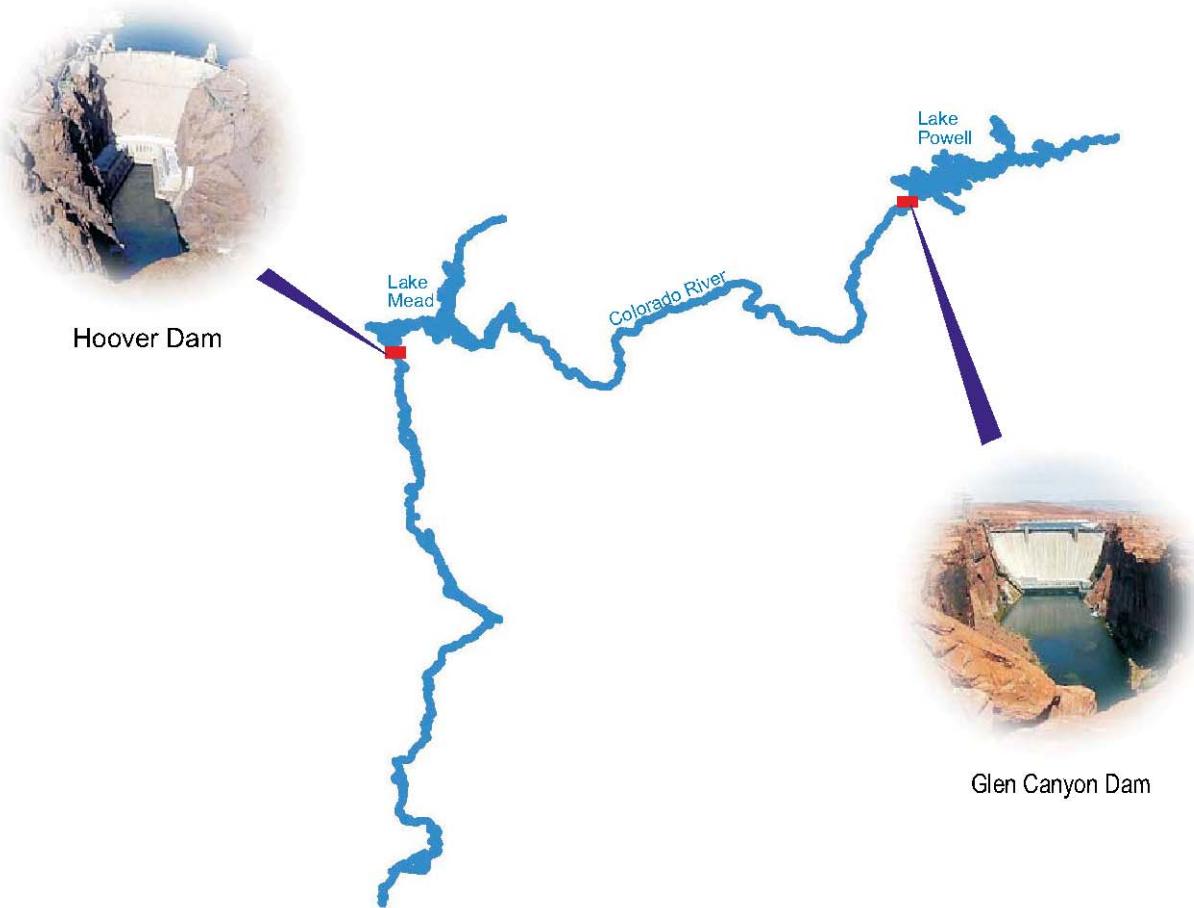


RECLAMATION

Managing Water in the West

Final Environmental Impact Statement



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

Volume I



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

October 2007

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

**Final
Environmental Impact Statement**

Volume I

U.S. Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions
October 2007

Mission Statement

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

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

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

Lead Agency:

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

Cooperating Agencies:

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

Abstract:

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

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

For further information regarding this Final EIS, contact:

Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City, Nevada 89006-1470
Fax number: (702) 293-8156
Phone number: (702) 293-8500
E-mail: strategies@lc.usbr.gov (e-mail account available through January 30, 2008)

Statement Number: FES 07-37
Filing Date: November 2, 2007

This page intentionally left blank.

Table of Contents

Volume I: Table of Contents

EXECUTIVE SUMMARY

ES.1	Background.....	ES-1
ES.1.1	Purpose and Need for Action	ES-1
ES.1.2	Proposed Federal Action	ES-2
ES.1.3	Geographic Scope	ES-3
ES.1.4	Alternatives	ES-3
ES.2	Summary of Potential Environmental Effects	ES-8
ES.2.1	Methodology	ES-8
ES.2.2	Hydrologic Resources	ES-8
ES.2.3	Water Deliveries.....	ES-11
ES.2.4	Water Quality	ES-12
ES.2.5	Air Quality.....	ES-13
ES.2.6	Visual Resources	ES-13
ES.2.7	Biological Resources.....	ES-14
ES.2.8	Cultural Resources	ES-18
ES.2.9	Indian Trust Assets.....	ES-19
ES.2.10	Electrical Power Resources	ES-19
ES.2.11	Recreation.....	ES-20
ES.2.12	Transportation	ES-21
ES.2.13	Socioeconomics.....	ES-21
ES.2.14	Environmental Justice	ES-22
ES.2.15	Indirect Effects of ICS Mechanism.....	ES-23
ES.2.16	Climate Change Considerations	ES-23
ES.3	Summary	ES-24
ES.4	Cumulative Impacts	ES-24

CHAPTER 1 PURPOSE AND NEED

1.1	Introduction.....	1-1
1.2	Proposed Federal Action.....	1-2
1.3	Purpose of and Need for Action.....	1-3
1.4	Lead and Cooperating Agencies	1-4
1.5	Scope of the EIS.....	1-6
1.5.1	Affected Region and Interests	1-7
1.5.2	Relevant Issues	1-7
1.6	Summary of Contents of this Final EIS	1-7
1.7	Water Supply Management and Allocation.....	1-9
1.7.1	Colorado River System Water Supply	1-9
1.7.2	Apportionment of Water Supply	1-11
1.7.3	System Reservoirs and Diversion Facilities.....	1-19
1.7.4	Flood Control Operation	1-21

1.7.5	Hydropower Generation	1-21
1.7.6	Annual Operating Plan and Long Range Operating Criteria	1-21
1.8	Related Actions	1-23
1.8.1	Operation of Glen Canyon Dam - Final EIS and ROD	1-24
1.8.2	Off-stream Storage of Colorado River Water and Development and Release of Intentionally Created Unused Apportionment in the Lower Division States.....	1-25
1.8.3	Interim Surplus Criteria - Final EIS and ROD - Colorado River Interim Surplus Guidelines	1-25
1.8.4	Implementation Agreement, Inadvertent Overrun and Payback Policy, and Related Federal Actions - Final EIS and ROD - Colorado River Water Delivery Agreement	1-25
1.8.5	Lower Colorado River Multi-Species Conservation Program - Final Programmatic EIS/EIR and ROD - Lower Colorado River Multi-Species Conservation Plan	1-26

CHAPTER 2 DESCRIPTION OF ALTERNATIVES

2.1	Development of Alternatives	2-1
2.2	No Action Alternative.....	2-3
2.2.1	Shortage Guidelines	2-3
2.2.2	Coordinated Reservoir Operations	2-6
2.2.3	Storage and Delivery of Conserved Water.....	2-7
2.2.4	Interim Surplus Guidelines.....	2-7
2.3	Basin States Alternative.....	2-8
2.3.1	Shortage Guidelines	2-8
2.3.2	Coordinated Reservoir Operations	2-9
2.3.3	Creation and Delivery of Intentionally Created Surplus	2-11
2.3.4	Interim Surplus Guidelines.....	2-11
2.4	Conservation Before Shortage Alternative	2-12
2.4.1	Shortage Guidelines	2-12
2.4.2	Coordinated Reservoir Operations	2-12
2.4.3	Storage and Delivery of Conserved Water.....	2-13
2.4.4	Interim Surplus Guidelines.....	2-13
2.4.5	Funding Mechanisms	2-14
2.5	Water Supply Alternative	2-14
2.5.1	Shortage Guidelines	2-14
2.5.2	Coordinated Reservoir Operations	2-15
2.5.3	Storage and Delivery of Conserved Water.....	2-15
2.5.4	Interim Surplus Guidelines.....	2-15
2.6	Reservoir Storage Alternative.....	2-15
2.6.1	Shortage Guidelines	2-15
2.6.2	Coordinated Reservoir Operations	2-16
2.6.3	Storage and Delivery of Conserved Water.....	2-17
2.6.4	Interim Surplus Guidelines.....	2-17
2.7	Preferred Alternative.....	2-17

2.7.1	Shortage Guidelines	2-17
2.7.2	Coordinated Reservoir Operations	2-18
2.7.3	Creation and Delivery of ICS	2-19
2.7.4	Interim Surplus Guidelines.....	2-19
2.7.5	Preferred Alternative Summary and Conclusions	2-19
2.8	Summary Comparison of Alternatives.....	2-21
2.9	Summary of Potential Effects	2-25

CHAPTER 3 AFFECTED ENVIRONMENT

3.1	Introduction.....	3-1
3.2	Geographic Scope	3-3
3.2.1	Definition of Colorado River Reaches	3-3
3.2.2	Colorado River Water User Service Areas.....	3-10
3.3	Hydrologic Resources.....	3-15
3.3.1	Hydrologic Overview	3-15
3.3.2	Lake Powell and Glen Canyon Dam	3-17
3.3.3	Glen Canyon Dam to Lake Mead.....	3-20
3.3.4	Lake Mead and Hoover Dam	3-20
3.3.5	Hoover Dam to Davis Dam.....	3-23
3.3.6	Davis Dam to Parker Dam	3-24
3.3.7	Parker Dam to Cibola Gage	3-25
3.3.8	Cibola Gage to Imperial Dam	3-26
3.3.9	Imperial Dam to NIB.....	3-26
3.3.10	NIB to SIB.....	3-28
3.4	Water Deliveries	3-31
3.4.1	Apportionments to the Upper Division States.....	3-31
3.4.2	Apportionments to the Lower Division States and Water Entitlements within Each State.....	3-32
3.4.3	Lower Division States Water Supply Determination	3-34
3.4.4	Depletion Schedules for Lower Division States (Normal and Surplus).....	3-35
3.4.5	Mexico's Allotment.....	3-37
3.4.6	Distribution of Shortages To and Within the Lower Division States	3-38
3.5	Water Quality	3-45
3.5.1	Salinity	3-45
3.5.2	Temperature	3-48
3.5.3	Sediment.....	3-50
3.5.4	Nutrients and Algae.....	3-51
3.5.5	Dissolved Oxygen	3-52
3.5.6	Metals	3-52
3.5.7	Perchlorate.....	3-53
3.6	Air Quality	3-55
3.6.1	Federal Air Quality Requirements	3-55
3.6.2	State and Local Air Quality Requirements	3-56
3.6.3	Ambient Air Quality by River Reach.....	3-57

3.7	Visual Resources.....	3-59
3.7.1	Lake Powell and Glen Canyon Dam Reach	3-59
3.7.2	Glen Canyon Dam to Lake Mead.....	3-60
3.7.3	Lake Mead and Hoover Dam	3-60
3.8	Biological Resources	3-61
3.8.1	Vegetation	3-61
3.8.2	Wildlife.....	3-65
3.8.3	Special Status Species	3-74
3.9	Cultural Resources	3-81
3.9.1	Undertaking Determination.....	3-81
3.9.2	Definition of the Area of Potential Effects and Identification Efforts	3-81
3.9.3	Lake Powell and Glen Canyon Dam	3-82
3.9.4	Glen Canyon Dam to Lake Mead.....	3-82
3.9.5	Lake Mead and Hoover Dam	3-83
3.9.6	Lake Mohave and Davis Dam	3-84
3.9.7	Davis Dam to Parker Dam	3-84
3.9.8	Parker Dam to Imperial Dam	3-86
3.9.9	Imperial Dam to SIB	3-86
3.10	Indian Trust Assets	3-87
3.10.1	Water Rights and Trust Lands.....	3-87
3.10.2	Hydroelectric Power Generation and Distribution.....	3-95
3.10.3	Cultural Resources	3-96
3.10.4	Biological Resources.....	3-96
3.10.5	Other Potentially Affected Tribes Asserting Colorado River Water Rights.....	3-96
3.11	Electrical Power Resources.....	3-99
3.11.1	Overview	3-99
3.11.2	Lake Powell and Glen Canyon Dam	3-102
3.11.3	Lake Mead and Hoover Dam	3-102
3.11.4	Parker-Davis Projects	3-103
3.11.5	Other Small Hydropower Facilities.....	3-104
3.11.6	Basin Power Funds.....	3-104
3.11.7	Water Supply System	3-106
3.12	Recreation	3-109
3.12.1	Shoreline Public Use	3-109
3.12.2	Reservoir Boating.....	3-122
3.12.3	River and Whitewater Boating.....	3-125
3.12.4	Sport Fishing	3-126
3.13	Transportation.....	3-129
3.13.1	Ferry Service	3-129
3.14	Socioeconomics	3-133
3.14.1	Study Area.....	3-133
3.14.2	Water Use	3-134
3.14.3	Recreation.....	3-139
3.15	Environmental Justice	3-141
3.15.1	Minority, Low-Income Populations, and Indian Tribes	3-141

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

4.1	Introduction.....	4-1
4.2	Methodology	4-3
4.2.1	Alternatives Modeled	4-3
4.2.2	Period of Analysis	4-3
4.2.3	Model Description.....	4-4
4.2.4	Model Uncertainty.....	4-6
4.2.5	Future Hydrology	4-7
4.2.6	Post-processing and Interpretation Procedures	4-15
4.2.7	Modeling Assumptions Common to All Alternatives.....	4-16
4.2.8	Modeling Assumptions Specific to Alternatives.....	4-22
4.3	Hydrologic Resources.....	4-23
4.3.1	Methodology	4-23
4.3.2	Lake Powell and Glen Canyon Dam	4-24
4.3.3	Glen Canyon Dam to Lake Mead.....	4-39
4.3.4	Lake Mead and Hoover Dam	4-49
4.3.5	Hoover Dam to Davis Dam.....	4-68
4.3.6	Davis Dam to Parker Dam	4-74
4.3.7	Parker Dam to Cibola Gage and Cibola Gage to Imperial Dam	4-80
4.3.8	Imperial Dam to NIB.....	4-89
4.3.9	NIB to SIB.....	4-89
4.3.10	Summary	4-94
4.4	Water Deliveries	4-97
4.4.1	Methodology	4-97
4.4.2	Apportionments to the Upper Division States.....	4-98
4.4.3	Apportionments to the Lower Division States and Water Entitlements within Each State.....	4-98
4.4.4	Lower Division States Water Supply Determination	4-98
4.4.5	Total Water Deliveries to the Lower Division States.....	4-123
4.4.6	Water Deliveries to Mexico	4-138
4.4.7	Distribution of Shortages to and within the Lower Division States.....	4-141
4.4.8	Summary	4-150
4.5	Water Quality.....	4-153
4.5.1	Introduction	4-153
4.5.2	Methodology	4-153
4.5.3	Salinity	4-155
4.5.4	Temperature	4-157
4.5.5	Sediment and Dissolved Oxygen	4-166
4.5.6	Nutrients and Algae.....	4-169
4.5.7	Metals	4-170
4.5.8	Perchlorate.....	4-170
4.5.9	Summary	4-170
4.6	Air Quality	4-173
4.6.1	Methodology	4-173
4.6.2	Lake Powell and Glen Canyon Dam	4-173

4.6.3	Glen Canyon Dam to Lake Mead, Lake Mead and Hoover Dam	4-177
4.6.4	Summary	4-180
4.7	Visual Resources.....	4-181
4.7.1	Methodology	4-181
4.7.2	Lake Powell and Glen Canyon Dam	4-181
4.7.3	Glen Canyon Dam to Lake Mead.....	4-182
4.7.4	Lake Mead and Hoover Dam	4-183
4.7.5	Summary	4-183
4.8	Biological Resources	4-185
4.8.1	Related Environmental Programs.....	4-185
4.8.2	Methodology	4-186
4.8.3	Effects on Vegetation and Wildlife	4-189
4.8.4	Special Status Species	4-200
4.8.5	Summary	4-237
4.9	Cultural Resources	4-243
4.9.1	Methodology	4-243
4.9.2	Lake Powell and Glen Canyon Dam.....	4-243
4.9.3	Glen Canyon Dam To Lake Mead	4-244
4.9.4	Lake Mead and Hoover Dam.....	4-244
4.9.5	Hoover Dam to Davis Dam.....	4-245
4.9.6	Davis Dam to Parker Dam	4-246
4.9.7	Parker Dam to Imperial Dam	4-246
4.9.8	Sacred Sites and Other Issues of Tribal Concern.....	4-247
4.9.9	Summary	4-248
4.10	Indian Trust Assets	4-249
4.10.1	Water Rights and Trust Lands	4-249
4.10.2	Hydroelectric Power Generation and Distribution	4-249
4.10.3	Cultural Resources	4-250
4.10.4	Biological Resources	4-250
4.10.5	Summary	4-250
4.11	Electrical Power Resources.....	4-251
4.11.1	Methodology	4-251
4.11.2	Electrical Power Generation Facilities.....	4-253
4.12	Recreation	4-279
4.12.1	Methodology	4-279
4.12.2	Recreation at Lake Powell	4-283
4.12.3	Recreation from Glen Canyon Dam to Lake Mead	4-285
4.12.4	Recreation at Lake Mead	4-289
4.12.5	Recreation from Hoover Dam to SIB	4-291
4.12.6	Summary	4-292
4.13	Transportation.....	4-295
4.13.1	Methodology	4-295
4.13.2	Lake Powell Ferry Service.....	4-295
4.13.3	Laughlin River Taxis and Tour Boats.....	4-297
4.13.4	Lake Havasu Ferry Service.....	4-297
4.13.5	Summary	4-297

4.14	Socioeconomics	4-299
4.14.1	Methodology	4-299
4.14.2	Potential Impacts to Agriculture	4-307
4.14.3	Potential Impacts to Municipal and Industrial Water Users	4-321
4.14.4	Potential Impacts to Recreation	4-323
4.14.5	Potential Impacts of Multi-Year Shortages.....	4-325
4.14.6	Potential Impacts of a Voluntary Conservation Program	4-326
4.14.7	Summary	4-326
4.15	Environmental Justice	4-329
4.15.1	Methodology	4-329
4.15.2	Hydrology, Water Deliveries, and Socioeconomics	4-329
4.15.3	Water Quality	4-330
4.15.4	Air Quality	4-330
4.15.5	Visual Resources.....	4-330
4.15.6	Biological Resources	4-330
4.15.7	Cultural Resources	4-330
4.15.8	Indian Trust Assets	4-330
4.15.9	Electrical Power Resources.....	4-331
4.15.10	Recreation	4-331
4.15.11	Transportation	4-331
4.15.12	Summary	4-331
4.16	Indirect Effects of Intentionally Created Surplus Mechanism.....	4-333
4.16.1	ICS Projects Directly Related to Creation of ICS Mechanism.....	4-334
4.16.2	Impacts by Resource	4-336

CHAPTER 5 OTHER CONSIDERATIONS AND CUMULATIVE IMPACTS

5.1	Federal Statutes and Policies	5-1
5.1.1	Endangered Species Act of 1973, as Amended (16 U.S.C. Sections §§ 1531-1544)	5-1
5.1.2	Fish and Wildlife Coordination Act of 1934, as Amended (16 U.S.C. §§ 661-667d)	5-1
5.1.3	National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd).....	5-1
5.1.4	Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§ 1271-1287)	5-2
5.1.5	Migratory Bird Treaty Act of 1918 (16 U.S.C. §§ 703-712)	5-2
5.1.6	Migratory Bird Conservation Act of 1929 (16 U.S.C. § 715).....	5-3
5.1.7	Bald Eagle Protection Act of 1940 (16 U.S.C. § 668)	5-3
5.1.8	Clean Air Act of 1963, as Amended (42 U.S.C. § 7506).....	5-3
5.1.9	Federal Water Pollution Control Act (Clean Water Act) of 1972, as Amended (33 U.S.C. Chapter 26)	5-3
5.1.10	River and Harbors Act of 1899 (33 U.S.C. §§ 401-403)	5-3
5.1.11	National Historic Preservation Act of 1966, as Amended (16 U.S.C. § 470).....	5-4
5.1.12	Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. §§ 3001-3013)	5-4

5.1.13	Archaeological Resources Protection Act of 1979 (16 U.S.C. § 470)	5-4
5.1.14	Farmland Protection Policy Act of 1981 (7 U.S.C. §§ 4201-4209)	5-4
5.1.15	Executive Order No. 11988, Floodplain Management, May 24, 1977	5-4
5.1.16	Executive Order No. 11990, Protection of Wetlands, May 24, 1977.....	5-5
5.1.17	Executive Order No. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, February 11, 1994	5-5
5.1.18	Executive Order No. 13007, Indian Sacred Sites, May 24, 1996	5-5
5.1.19	Executive Order No. 12114, Environmental Impacts Abroad of Major Federal Actions, January 4, 1979	5-5
5.1.20	Secretarial Order No. 3206, American Indian Tribal Rights, Federal- Tribal Trust Responsibility, and the Endangered Species Act, June 7, 1997	5-6
5.2	Cumulative Impacts	5-6
5.2.1	SNWA Clark, Lincoln, and White Pine Counties Groundwater Development Project	5-7
5.2.2	SNWA Lake Mead Intake No. 3 Project.....	5-7
5.2.3	Systems Conveyance and Operations Program.....	5-8
5.2.4	Lower Colorado River Multi-Species Conservation Program	5-8
5.2.5	All-American Canal Lining Project	5-9
5.2.6	Long-Term Experimental Plan for the Operation of Glen Canyon Dam and Other Associated Management Activities	5-10
5.2.7	Cumulative Impacts by Resource.....	5-11
5.3	Relationship Between Short-term Uses of the Environment and Long-term Productivity.....	5-14
5.4	Irreversible and Irretrievable Commitments of Resources	5-14

CHAPTER 6 CONSULTATION AND COORDINATION

6.1	Introduction.....	6-1
6.2	General Public Involvement Activities	6-1
6.3	Cooperating Agency Involvement	6-3
6.3.1	Bureau of Indian Affairs	6-3
6.3.2	Fish and Wildlife Service	6-3
6.3.3	National Park Service.....	6-3
6.3.4	Western Area Power Administration	6-4
6.3.5	United States Section of the International Boundary and Water Commission.....	6-4
6.4	Tribal Consultation	6-4
6.5	State and Local Water and Power Agency Coordination	6-4
6.6	Non-Governmental Organizations Coordination	6-5
6.7	Other Consultations	6-5
6.8	Consultation with Mexico.....	6-6
6.9	Summary of Coordination and Consultation Contacts	6-6
6.10	Federal Register Notices	6-9

INDEX.....	IND-1
REFERENCES CITED	REF-1
ACRONYMS	ACR-1
GLOSSARY.....	GLO-1
LIST OF PREPARERS	LOP-1
DISTRIBUTION LIST	DST-1

List of Figures

Figure ES-1 Geographic Scope	ES-4
Figure 1.7-1 The Colorado River Basin	1-10
Figure 1.7-2 Lees Ferry Gaging Station and Lee Ferry Compact Point	1-11
Figure 1.7-3 Upper and Lower Division States of the Colorado River	1-15
Figure 1.7-4 Colorado River Reservoirs and Diversions.....	1-17
Figure 1.7-5 Lower Basin Dams and Reservoirs.....	1-20
Figure 2.2-1 Lake Mead Level 1 Shortage Trigger Lake Mead Elevations Under the No Action Alternative.....	2-4
Figure 3.2-1 Geographic Scope	3-4
Figure 3.2-2 Colorado River Reaches	3-5
Figure 3.2-3 CAP Service Area.....	3-11
Figure 3.2-4 SNWA Service Area.....	3-13
Figure 3.2-5 MWD Service Area.....	3-14
Figure 3.3-1 Natural Flow of the Colorado River at Lees Ferry Gaging Station, Arizona, 1906 through 2005	3-16
Figure 3.3-2 Historic Annual Flow of the Colorado River at Lees Ferry Gaging Station, Arizona, 1922 through 2005	3-17
Figure 3.3-3 Historic Annual Lake Powell Water Elevations (Annual Highs and Lows)	3-18
Figure 3.3-4 Historic Annual Lake Mead Elevations (Annual Highs and Lows)	3-21
Figure 3.3-5 Water Routing from Imperial Dam to NIB Deliveries to Mexico Pursuant to the 1944 Treaty	3-27
Figure 3.4-1 Upper Basin Scheduled Depletions 2008 to 2060	3-32
Figure 3.4-2 Arizona's Projected Colorado River Water Depletion Schedules Under the No Action Alternative.....	3-35
Figure 3.4-3 California's Projected Colorado River Water Depletion Schedules Under the No Action Alternative	3-36
Figure 3.4-4 Nevada's Projected Colorado River Water Depletion Schedules Under the No Action Alternative.....	3-37
Figure 3.5-1 Historic Colorado River Salinity Concentrations and Flows Downstream of Hoover Dam 1941 through 2005.....	3-47

Figure 3.5-2	Historic Colorado River Salinity Concentrations and Flows Downstream of Parker Dam 1941 through 2005	3-47
Figure 3.5-3	Historic Colorado River Salinity Concentrations and Flows at Imperial Dam 1941 through 2005	3-48
Figure 3.5-4	Historic Elevation and Dam Release Temperatures at Lake Powell	3-49
Figure 3.5-5	Historic Elevation and Dam Release Temperatures at Lake Mead	3-50
Figure 3.12-1	Lake Powell Shoreline Access Points.....	3-111
Figure 3.12-3	Lake Mead Shoreline Access Points.....	3-117
Figure 3.12-3	Lake Mohave Shoreline Access Points.....	3-119
Figure 3.13-1	John Atlantic Burr Ferry Route – Lake Powell	3-130
Figure 3.13-2	Laughlin River Taxi and Tour Boat Crossing.....	3-131
Figure 3.13-3	Lake Havasu Ferry Route	3-132
Figure 3.15-1	Minority Population by County	3-142
Figure 3.15-2	Low Income Population by County	3-143
Figure 4.2-1	Colorado River Simulation System Location of Hydrologic Inputs Sites within the Colorado River Basin.....	4-5
Figure 4.2-2	Lake Mead End-of-December Elevations Under the No Action Alternative 90 th , 50 th and 10 th Percentile Values	4-9
Figure 4.3-1	Lake Powell End-of-July Elevations Under the No Action Alternative 90 th , 50 th and 10 th Percentile Values	4-25
Figure 4.3-2	Lake Powell End-of-July Elevations Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values	4-26
Figure 4.3-3	Lake Powell End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Greater Than or Equal to Elevation 3,695 feet msl.....	4-28
Figure 4.3-4	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,650 feet msl	4-29
Figure 4.3-5	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,626 feet msl	4-30
Figure 4.3-6	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,620 feet msl	4-32
Figure 4.3-7	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,588 feet msl	4-33
Figure 4.3-8	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,560 feet msl	4-34
Figure 4.3-9	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,555 feet msl	4-36

Figure 4.3-10	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,550 feet msl	4-37
Figure 4.3-11	Lake Powell End-of-March Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,490 feet msl	4-38
Figure 4.3-12	Glen Canyon Dam Water Year Releases Comparison of Action Alternatives to No Action Alternative 90 th , 50 th and 10 th Percentile Values	4-42
Figure 4.3-13	Glen Canyon Dam Water Year Releases Comparison of Action Alternatives to No Action Alternative Water Years 2008 through 2026....	4-43
Figure 4.3-14	Glen Canyon Dam Water Year Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2060	4-44
Figure 4.3-15	Glen Canyon Dam 10-Year Running Total of Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2060	4-48
Figure 4.3-16	Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative 90 th , 50 th and 10 th Percentile Values	4-49
Figure 4.3-17	Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Greater Than or Equal to Elevation 1,200 feet msl.....	4-51
Figure 4.3-18	Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,178 feet msl	4-52
Figure 4.3-19	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,175 feet msl	4-53
Figure 4.3-20	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,170 feet msl	4-55
Figure 4.3-21	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,125 feet msl	4-56
Figure 4.3-22	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,080 feet msl	4-58
Figure 4.3-23	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,050 feet msl	4-59
Figure 4.3-24	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,000 feet msl	4-61
Figure 4.3-25	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Minimum Water Elevation Values (feet msl)	4-62

Figure 4.3-26	Lake Mead End-of-July Elevations Comparison of Action Alternatives Percent of Values Less Than or Equal to Shortage Trigger Elevations of Lake Mead	4-64
Figure 4.3-27	Lake Mead End-of-December Elevations Comparison of Action Alternatives With Storage and Delivery Mechanism Removed to No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-66
Figure 4.3-28	Lake Mead End-of-December Elevations Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism 10 th , 50 th , and 90 th Percentile Values	4-67
Figure 4.3-29	Hoover Dam Annual Releases Comparison of Action Alternatives to No Action Alternative 90 th , 50 th and 10 th Percentile Values.....	4-70
Figure 4.3-30	Hoover Dam Cumulative Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2026	4-71
Figure 4.3-31	Hoover Dam Cumulative Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2060	4-72
Figure 4.3-32	Davis Dam Annual Releases Comparison of Action Alternatives to No Action Alternative 90 th , 50 th and 10 th Percentile Values.....	4-75
Figure 4.3-33	Davis Dam Cumulative Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2026	4-76
Figure 4.3-34	Davis Dam Cumulative Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2060	4-76
Figure 4.3-35	Colorado River Annual Flow Near Havasu NWR - RM 242.3 Comparison of Action Alternatives to No Action Alternative 90 th , 50 th and 10 th Percentile Values.....	4-77
Figure 4.3-36	Davis Dam Annual Releases Comparison of Action Alternatives to No Action Alternative Annual Median (50 th Percentile) Values.....	4-79
Figure 4.3-37	Parker Dam Annual Releases Comparison of Action Alternatives to No Action Alternative 90 th , 50 th and 10 th Percentile Values.....	4-81
Figure 4.3-38	Parker Dam Cumulative Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2026	4-82
Figure 4.3-39	Parker Dam Cumulative Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2060	4-83
Figure 4.3-40	Colorado River Annual Flow Upstream of CRIR Diversion - RM 180.8 Comparison of Action Alternatives to No Action Alternative 90 th , 50 th and 10 th Percentile Values	4-84
Figure 4.3-41	Colorado River Annual Flow Downstream of Palo Verde Diversion Dam - RM 133.8 Comparison of Action Alternatives to No Action Alternative 90 th , 50 th and 10 th Percentile Values	4-86
Figure 4.3-42	Parker Dam Annual Releases Comparison of Action Alternatives to No Action Alternative Annual Median (50 th Percentile) Values.....	4-88
Figure 4.3-43	Colorado River Annual Flow Below Mexico Diversion at Morelos Diversion Dam - RM 21.1 Comparison of Action Alternatives to No Action Alternative 90th, 50 th , and 10th Percentile Values	4-90
Figure 4.3-44	Excess Flows Below Mexico Diversion at Morelos Diversion Dam Comparison of Action Alternatives to No Action Alternative Cumulative Distribution - Years 2008 through 2026	4-92

Figure 4.3-45	Excess Flows Below Mexico Diversion at Morelos Diversion Dam Comparison of Action Alternatives to No Action Alternative Cumulative Distribution - Years 2008 through 2060	4-93
Figure 4.4-1	Involuntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Probability of Occurrence of Any Involuntary Shortage Volume	4-100
Figure 4.4-2	Involuntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Probability of Occurrence of Any Shortage Volume.....	4-101
Figure 4.4-3	Involuntary and Voluntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Average Shortage Volumes.....	4-103
Figure 4.4-4	Involuntary and Voluntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Years 2006 through 2026	4-104
Figure 4.4-5	Involuntary and Voluntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Years 2027 through 2060	4-105
Figure 4.4-6	Involuntary and Voluntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Maximum Shortage Volumes.....	4-109
Figure 4.4-7	Involuntary and Voluntary Lower Basin Shortages Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism Probability of Occurrence of Any Shortage Volumes	4-111
Figure 4.4-8	Consecutive Shortages of Two Years or Greater Comparison of Action Alternatives to No Action Alternative Probability of Shortage per Year Greater Than or Equal to 400 kaf	4-112
Figure 4.4-9	Consecutive Shortages of Five Years or Greater Comparison of Action Alternatives to No Action Alternative Probability of Shortage per Year Greater Than or Equal to 400 kaf	4-112
Figure 4.4-10	Consecutive Shortages of Ten Years or Greater Comparison of Action Alternatives to No Action Alternative Probability of Shortage per Year Greater Than or Equal to 400 kaf	4-113
Figure 4.4-11	Consecutive Shortages of 15 Years or Greater Comparison of Action Alternatives to No Action Alternative Probability of Shortage per Year Greater Than or Equal to 400 kaf	4-113
Figure 4.4-12	Surplus Conditions Comparison of Action Alternatives to No Action Alternative Probability of Occurrence	4-116
Figure 4.4-13	Partial Domestic Surplus Deliveries to Lower Basin States Comparison of Action Alternatives to No Action Alternative Probability of Occurrence	4-117
Figure 4.4-14	Full Domestic Surplus Deliveries to Lower Basin States Comparison of Action Alternatives to No Action Alternative Probability of Occurrence.	4-118
Figure 4.4-15	Quantified Surplus (70R Strategy) Deliveries to Lower Basin States Comparison of Action Alternatives to No Action Alternative Probability of Occurrence.....	4-119
Figure 4.4-16	Flood Control Surplus Deliveries to Lower Basin States Comparison of Action Alternatives to No Action Alternative Probability of Occurrence	4-120

Figure 4.4-17	Surplus Deliveries to Lower Basin States Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism Probability of Occurrence	4-121
Figure 4.4-18	Normal Conditions Comparison of Action Alternatives to No Action Alternative Probability of Occurrence	4-121
Figure 4.4-19	Surplus, Normal, and Shortage (Involuntary and Voluntary) Conditions Comparison of Action Alternatives to No Action Alternative	4-122
Figure 4.4-20	Arizona Modeled Annual Depletions No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-124
Figure 4.4-21	Arizona Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2008 through 2026.....	4-125
Figure 4.4-22	Arizona Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2027 through 2060.....	4-126
Figure 4.4-23	Arizona Modeled Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism Years 2008 through 2026.....	4-127
Figure 4.4-24	Arizona Modeled Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism Years 2027 through 2060.....	4-128
Figure 4.4-25	California Modeled Annual Depletions No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-129
Figure 4.4-26	California Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2008 through 2026.....	4-130
Figure 4.4-27	California Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2027 through 2060.....	4-131
Figure 4.4-28	California Modeled Annual Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism Years 2008 through 2026.....	4-132
Figure 4.4-29	California Modeled Annual Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism Years 2027 through 2060.....	4-133
Figure 4.4-30	Nevada Modeled Annual Depletions No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-134
Figure 4.4-31	Nevada Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2008 through 2026.....	4-135
Figure 4.4-32	Nevada Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2027 through 2060.....	4-136
Figure 4.4-33	Nevada Modeled Annual Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism-Years 2008 through 2026.....	4-137

Figure 4.4-34 Nevada Modeled Annual Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism-Years 2027 through 2060.....	4-138
Figure 4.4-35 Mexico Modeled Annual Depletions No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-139
Figure 4.4-36 Mexico Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2008 through 2026.....	4-140
Figure 4.4-37 Mexico Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2027 through 2060.....	4-141
Figure 4.5-1 Historic Data and CE-QUAL-W2 Model Results for Lake Powell Release Temperatures by Reservoir Elevation.....	4-157
Figure 4.6-1 Lake Powell End-of-March Elevations Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values	4-174
Figure 4.6-2 Lake Mead End-of-July Water Elevations Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values	4-177
Figure 4.11-1 Glen Canyon Powerplant Average Values of Annual Electrical Energy Production	4-255
Figure 4.11-2 Hoover Powerplant Average Values of Annual Electrical Energy Production	4-258
Figure 4.11-3 Davis Powerplant Average Values of Annual Electrical Energy Production	4-262
Figure 4.11-4 Parker Powerplant Average Values of Annual Electrical Energy Production	4-262
Figure 4.11-5 Headgate Rock Powerplant Average Values of Electrical Energy Production	4-265
Figure 4.11-6 Lake Powell End-of-March Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,490 feet msl	4-268
Figure 4.11-7 Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,050 feet msl	4-268
Figure 4.14-1 Steps in Analyzing Changes in Agricultural Production and Resulting Changes in Employment, Income, and Tax Revenue	4-300
Figure 4.14-2 Lake Powell End-of-September Elevations Compairson of Action Alternatives to No Action Alternative, 90 th , 50 th and 10 th Percentile Values	4-306
Figure 4.14-3 Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative, 90 th , 50 th and 10 th Percentile Values.....	4-307

List of Tables

Table ES-1	Matrix of Alternatives.....	ES-6
Table ES-2	Summary of Potential Effects of the Alternative.....	ES-25
Table 1.5-1	Relevant Issues.....	1-8
Table 1.7-1	Selected Documents Included in the Law of the River.....	1-14
Table 2.2-1	Modeling Assumptions for Distribution of Shortages.....	2-5
Table 2.3-1	Basin States Alternative Lake Powell Equalization Elevations.....	2-10
Table 2.3-2	Basin States Alternative Volume Limitations of ICS	2-11
Table 2.4-1	Conservation Before Shortage Alternative Volume Limitations of ICS	2-13
Table 2.6-1	Reservoir Storage Alternative Volume Limitations of Storage and Delivery Mechanism.....	2-17
Table 2.7-1	Preferred Alternative Volume Limitations of ICS.....	2-19
Table 2.8-1	Matrix of Alternatives.....	2-22
Table 2.8-2	Lake Powell Comparison of Alternatives Coordinated Reservoir of Operations Element of the Proposed Federal Action.....	2-23
Table 2.8-3	Lake Mead Comparison of Alternatives Coordinated Reservoir of Operations Element of the Proposed Federal Action.....	2-24
Table 2.9-1	Summary of Potential Effects of the Alternatives	2-26
Table 3.2-1	Colorado River Reaches and Reach Limits	3-6
Table 3.2-2	CAP Water Users.....	3-12
Table 3.3-1	Glen Canyon Dam Release Constraints	3-19
Table 3.4-1	Upper Division States Apportionment.....	3-31
Table 3.4-2	Lower Division States Apportionment	3-33
Table 3.4-3	Colorado River Water Apportioned to PPRs in the Lower Division States	3-33
Table 3.4-4	Arizona Priority System for Mainstream Colorado River	3-39
Table 3.4-5	California's Seven-Party Agreement for Mainstream Colorado River.....	3-41
Table 3.4-6	Nevada's Priority System for Mainstream Colorado River	3-43
Table 3.5-1	Numeric Salinity Criteria for the Colorado River.....	3-46
Table 3.6-1	Clean Air Act Prevention of Significant Deterioration Designations.....	3-55
Table 3.6-2	Clean Air Act Allowable Particulate Matter Concentration Increases over the Baseline Concentrations.....	3-56
Table 3.6-3	National and State Ambient Air Quality Standards for Particulate Matter.....	3-56
Table 3.6-4	State and Local Air Pollution Control Agencies Having Jurisdiction within the Lake Powell and Lake Mead Areas	3-57
Table 3.8-1	Summary of Vegetation Cover Types from Lake Mead to the SIB	3-63
Table 3.8-2	Summary of Vegetation Cover Types from Lake Mead to the NIB (acres).....	3-64
Table 3.8-3	Summary of Vegetation Cover Types in the United States from NIB to SIB	3-65
Table 3.8-4	Native and Non-Native Fish Species Present in the Study Area by Reach.....	3-66
Table 3.8-5	The Fifteen Generally Most Common Terrestrial Breeding Bird Species Found in Riparian Habitats Along the Colorado River in Grand Canyon	3-71

Table 3.8-6	The Ten Generally Most Common Overwintering Aquatic Bird Species Encountered During Surveys Along the Colorado River Downstream of Glen Canyon Dam.....	3-71
Table 3.8-7	Special Status Species Potentially Affected by the Proposed Federal Action.....	3-76
Table 3.10-1	Colorado River Mainstream Diversion Entitlement (Water Rights) in Favor of Indian Reservations	3-88
Table 3.10-2	Central Arizona Project Indian Tribal Diversion Entitlements (Water Rights).....	3-92
Table 3.11-1	Generation Capability in WECC Areas	3-102
Table 3.12-1	Glen Canyon National Recreation Area Recreational Visitors.....	3-110
Table 3.12-2	Glen Canyon National Recreation Area Visits by Visitor Segment for 2003.....	3-110
Table 3.12-3	Critical Elevations for Lake Powell by Boating Facility	3-112
Table 3.12-4	Number of Camping Beaches by Camp Size for High- and Low-Water Camps	3-114
Table 3.12-5	Lake Mead National Recreation Area Recreational Visitors.....	3-115
Table 3.12-6	Lake Mead National Recreation Area Visits by Visitor Segment for 2003	3-115
Table 3.12-7	Critical Elevations for Lake Mead by Recreational Facility	3-116
Table 3.12-8	Visitation at Arizona's Lake Havasu and Cattail Cove State Parks	3-120
Table 3.12-9	Estimates of Watercraft Use in Glen Canyon National Recreation Area by Month and Annually in 2001	3-124
Table 3.14-1	Central Arizona Irrigated Agricultural Lands in 2002.....	3-135
Table 3.14-2	Southern California Agricultural Land in the Six-County Study Area in 2004	3-136
Table 3.14-3	Southern Nevada (Clark County) Agricultural Land in 2002.....	3-138
Table 3.14-4	Glen Canyon National Recreation Area Economic Impacts of Visitor Spending by Sector for 2003.....	3-139
Table 3.14-5	Lake Mead National Recreation Area Economic Impacts of Visitor Spending by Sector for 2003.....	3-140
Table 4.2-1	Modeling Assumptions for Distribution of Stage 1 Shortages	4-20
Table 4.2-2	Modeling Assumptions for Distribution of Stage 2 Shortages	4-21
Table 4.2-3	Comparison of Shortage Allocation to Arizona and Nevada for the Specified Lower Basin Shortage Differences Between Modeling Assumptions and Arizona-Nevada Shortage Sharing Agreement	4-22
Table 4.3-1	Lake Powell End-of-July Elevations (feet msl) Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values	4-27
Table 4.3-2	Lake Powell End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Greater Than or Equal to Elevation 3,695 feet msl.....	4-28
Table 4.3-3	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,650 feet msl	4-30

Table 4.3-4	Lake Powell End-of- September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,626 feet msl	4-31
Table 4.3-5	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,620 feet msl	4-32
Table 4.3-6	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,588 feet msl	4-34
Table 4.3-7	Lake Powell End-of- September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,560 feet msl	4-35
Table 4.3-8	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,555 feet msl	4-36
Table 4.3-9	Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,550 feet msl	4-38
Table 4.3-10	Lake Powell End-of-March Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,490 feet msl	4-39
Table 4.3-11	Glen Canyon Dam Annual Water Releases Probability of Occurrence of Different Release Volumes (percent) Comparison of Action Alternatives to No Action Alternative Water Years 2008 through 2026....	4-32
Table 4.3-12	Glen Canyon Dam Annual Water Releases Probability of Occurrence of Different Release Volumes (percent) Comparison of Action Alternatives to No Action Alternative Water Years 2008 through 2060....	4-32
Table 4.3-13	Average Daily Glen Canyon Dam Releases (cfs) Corresponding to Various Annual Release Volumes	4-46
Table 4.3-14	Minimum Hourly Glen Canyon Dam Release (cfs) Corresponding to Various Annual Release Volumes	4-46
Table 4.3-15	Maximum Hourly Glen Canyon Dam Release (cfs) Corresponding to Various Annual Release Volumes	4-47
Table 4.3-16	Lake Mead End-of-December Elevations (feet msl) Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , and 10 th Percentile Values	4-50
Table 4.3-17	Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Greater Than or Equal to Elevation 1,200 feet msl.....	4-51
Table 4.3-18	Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less than or Equal to Elevation 1,178 feet msl	4-53
Table 4.3-19	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,175 feet msl	4-54

Table 4.3-20	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,170 feet msl	4-55
Table 4.3-21	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,125 feet msl	4-57
Table 4.3-22	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,080 feet msl	4-58
Table 4.3-23	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,050 feet msl	4-60
Table 4.3-24	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,000 feet msl	4-61
Table 4.3-25	Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Minimum Elevation Values (feet msl).....	4-63
Table 4.3-26	Lake Mead End-of-July Elevations Comparison of Action Alternatives Percent of Values Less Than or Equal to Elevation 1,075 feet msl.....	4-65
Table 4.3-27	Lake Mead End-of-July Elevations Comparison of Action Alternatives Percent of Values Less Than or Equal to Elevation 1,050 feet msl.....	4-65
Table 4.3-28	Lake Mead End-of-July Elevations Comparison of Action Alternatives Percent of Values Less Than or Equal to Elevation 1,025 feet msl.....	4-65
Table 4.3-29	Lake Mead End-of-December Elevations Increase / Decrease () in Lake Mead Elevations (feet) Resulting From a Storage and Delivery Mechanism Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism 90 th , 50 th , and 10 th Percentile Values....	4-68
Table 4.3-30	Hoover Dam Annual Releases Probability of Occurrence of Different Annual Release Volumes (percent) Comparison of Action Alternatives to No Action Alternative Years 2008 through 2026.....	4-73
Table 4.3-31	Hoover Dam Annual Releases Probability of Occurrence of Different Annual Release Volumes (percent) Comparison of Action Alternatives to No Action Alternative Years 2008 through 2060.....	4-73
Table 4.3-32	Colorado River Annual Flow Near Havasu NWR - RM 242.3 (maf) Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-78
Table 4.3-33	Davis Dam Annual Median Releases Differences of Action Alternatives Compared to No Action Alternative (cfs)	4-79
Table 4.3-34	Colorado River Annual Flow Upstream of CRIR Diversion - RM 180.8 (maf) Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , and 10 th Percentile Values	4-85
Table 4.3-35	Colorado River Annual Flow Downstream of Palo Verde Diversion Dam - RM 133.8 (maf) Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-87
Table 4.3-36	Parker Dam Annual Median Releases Differences of Action Alternatives Compared to No Action Alternative, (cfs)	4-88

Table 4.3-37	Colorado River Annual Flow Below Mexico Diversion at Morelos Diversion Dam - RM 21.1 (maf) Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-91
Table 4.4-1	First Year of Involuntary Shortage and Probability of Occurrence Comparison of Action Alternatives to No Action Alternative	4-100
Table 4.4-2	Probability of Occurrence of Any Amount of Involuntary Shortage for Specific Years (percent) Comparison of Action Alternatives to No Action Alternative.....	4-100
Table 4.4-3	First Year of Involuntary or Voluntary Shortage and Probability of Occurrence Comparison of Action Alternatives to No Action Alternative.....	4-102
Table 4.4-4	Probability of Occurrence of Involuntary and Voluntary Shortages of Any Amount for Specific Years (percent) Comparison of Action Alternatives to No Action Alternative	4-102
Table 4.4-5	Distribution of Shortages, Year 2017 (percent).....	4-106
Table 4.4-6	Distribution of Shortages, Year 2026 (percent).....	4-106
Table 4.4-7	Distribution of Shortages, Year 2027 (percent).....	4-107
Table 4.4-8	Distribution of Shortages, Year 2040 (percent).....	4-107
Table 4.4-9	Distribution of Shortages, Year 2060 (percent).....	4-108
Table 4.4-10	Maximum Volume of Involuntary and Voluntary Shortage to the Lower Basin for Specific Years (af) Comparison of Action Alternatives to No Action Alternative.....	4-109
Table 4.4-11	Multi-year Shortages with Durations of Two or More Years, Five or More Years, Ten or More Years, and 15 or More Years Comparison of Action Alternatives to No Action Alternative, Probability of Shortage per Year Greater Than or Equal to 400 kaf.....	4-115
Table 4.4-12	Probability of Occurrence of Shortages Less Than or Equal to, Years 2008 through 2026 (percent)	4-142
Table 4.4-13	Probability of Occurrence of Shortages Less Than or Equal to, Years 2027 through 2060 (percent)	4-142
Table 4.4-14	Shortage Allocation to Arizona (af).....	4-143
Table 4.4-15	Maximum Observed Reductions in Water Deliveries to Arizona for Selected Years (af).....	4-143
Table 4.4-16	Distribution of Shortages Among Arizona Entities (af), Year 2017	4-144
Table 4.4-17	Distribution of Shortages Among Arizona Entities (af), Year 2026	4-145
Table 4.4-18	Distribution of Shortages Among Arizona Entities (af), Year 2027	4-145
Table 4.4-19	Distribution of Shortages Among Arizona Entities (af), Year 2040	4-146
Table 4.4-20	Distribution of Shortages Among Arizona Entities (af), Year 2060	4-146
Table 4.4-21	Shortage Allocation to California (af)	4-147
Table 4.4-22	Maximum Observed Reductions in Water Deliveries to California for Selected Years (af).....	4-148

Table 4.4-23	Shortage Allocation to Nevada (af)	4-148
Table 4.4-24	Maximum Observed Reductions in Water Deliveries to Nevada for Selected Years (af).....	4-149
Table 4.4-25	Water Reductions to Mexico (af).....	4-150
Table 4.4-26	Maximum Observed Reductions in Water Deliveries to Mexico for Selected Years (af).....	4-150
Table 4.5-1	Projected Colorado River Salinity (mg/L) Comparison of Action Alternatives to No Action Alternative	4-156
Table 4.5-2	Lake Powell End-of-July Elevations and Release Temperatures Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , 10 th Percentile Values	4-159
Table 4.5-3	Lake Powell End-of-October Elevations and Release Temperatures Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , 10 th Percentile Values	4-160
Table 4.5-4	Colorado River at Little Colorado River Confluence July Water Temperatures Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , and 10 th Percentile Values	4-162
Table 4.5-5	Colorado River at Little Colorado River Confluence October Water Temperatures Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , and 10 th Percentile Values	4-163
Table 4.5-6	Colorado River Near Diamond Creek July Water Temperatures Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-164
Table 4.5-7	Colorado River Below Diamond Creek October Water Temperatures Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-165
Table 4.5-8	Relationship of Glen Canyon Dam Annual Release Volumes to Sediment Transport from Grand Canyon.....	4-167
Table 4.5-9	Sediment Transport (normalized to 8.23 maf annual release volume) Comparison of Action Alternatives to No Action Alternative 90 th , 50 th , and 10 th Percentile Values.....	4-168
Table 4.6-1	Lake Powell End-of-March 10 th Percentile Elevation and Exposed Shoreline (rounded to nearest whole number).....	4-175
Table 4.6-2	Lake Mead End-of-July 10 th Percentile Elevation and Exposed Shoreline (Rounded to Nearest Whole Number).....	4-178
Table 4.8-1	Vegetation and Wildlife Impact Summary	4-199
Table 4.8-2	Lake Powell Special Status Species Impact Summary	4-204
Table 4.8-3	Months When Average Water Temperatures may be Adequate to Support Growth of Fish Under the No Action Alternative.....	4-207
Table 4.8-4	Glen Canyon Dam to Lake Mead Reach Special Status Species Impact Summary	4-220
Table 4.8-5	Lake Mead Special Status Species Impact Summary	4-227
Table 4.8-6	Davis Dam to Lake Havasu Reach Special Status Species Impact Summary	4-231
Table 4.8-7	Parker Dam to NIB Special Status Species Impact Summary	4-235

Table 4.8-8	NIB to SIB Reach Special Status Species Impact Summary	4-238
Table 4.11-1	No Action Alternative Values at Glen Canyon Powerplant	4-253
Table 4.11-2	Change in Glen Canyon Powerplant Annual Energy Generation (MWh).....	4-254
Table 4.11-3	Change in Glen Canyon Powerplant Annual Generation (percent).....	4-254
Table 4.11-4	Change in Glen Canyon Powerplant Generation Capacity (MW).....	4-255
Table 4.11-5	Change in Glen Canyon Powerplant Generation Capacity (percent)	4-256
Table 4.11-6	Change in Glen Canyon Powerplant Total Economic Value of Electrical Power Generation	4-256
Table 4.11-7	Change in Glen Canyon Powerplant Total Economic Value of Electrical Power Generation (percent).....	4-256
Table 4.11-8	No Action Alternative Values at Hoover Powerplant.....	4-257
Table 4.11-9	Change in Hoover Powerplant Annual Electrical Energy Generation (MWh).....	4-257
Table 4.11-10	Change in Hoover Powerplant Annual Electrical Energy Generation (percent)	4-257
Table 4.11-11	Change in Hoover Powerplant Monthly Generation Capacity (MW)	4-258
Table 4.11-12	Change in Hoover Powerplant Monthly Generation Capacity (percent)...	4-259
Table 4.11-13	Change in Hoover Powerplant Total Economic Value of Electrical Power Generated.....	4-259
Table 4.11-14	Change in Hoover Powerplant Total Economic Value of Electrical Power Generated (percent)	4-259
Table 4.11-15	No Action Alternative Values at Parker and Davis Powerplants	4-260
Table 4.11-16	Change in Parker and Davis Powerplants Annual Electrical Energy Generation (MWh).....	4-260
Table 4.11-17	Change in Parker and Davis Powerplants Annual Electrical Energy Generation (percent)	4-261
Table 4.11-18	Change in Parker and Davis Powerplants Monthly Generation Capacity (MW)	4-261
Table 4.11-19	Change in Parker and Davis Powerplants Total Economic Value of Electrical Power Generation	4-263
Table 4.11-20	Change in Parker and Davis Powerplants Total Economic Value of Electrical Power Generated (percent)	4-263
Table 4.11-21	No Action Alternative Values at Headgate Rock Power Plant.....	4-264
Table 4.11-22	Change in Headgate Rock Powerplant Annual Electrical Energy Generation (MWh).....	4-264
Table 4.11-23	Change in Headgate Rock Powerplant Annual Electrical Energy Generation (percent)	4-264
Table 4.11-24	Change in Headgate Rock Powerplant Total Economic Value of Electrical Power Generated.....	4-265
Table 4.11-25	Change in Headgate Rock Powerplant Total Economic Value of Electrical Power Generated (percent)	4-266
Table 4.11-26	Change in Navajo Generating Station Intake Electrical Power Requirements at Lake Powell	4-273
Table 4.11-27	Change in City of Page Intake Electrical Power Requirements at Lake Powell	4-273

Table 4.11-28 Change in Estimated SNWA Pumping Costs	4-274
Table 4.11-29 Glen Canyon Powerplant Summary Comparison of Action Alternatives to No Action Alternative Mean Values for Electrical Energy Generation, Generation Capacity, and Economic Value.....	4-275
Table 4.11-30 Hoover Powerplant Summary Comparison of Action Alternatives to No Action Alternative Mean Values for Electrical Energy Generation, Generation Capacity, and Economic Value	4-275
Table 4.11-31 Parker and Davis Powerplant Summary Comparison of Action Alternatives to No Action Alternative Mean Values for Electrical Energy Generation, Generation Capacity, and Economic Value.....	4-276
Table 4.11-32 Headgate Rock Powerplant Summary Comparison of Action Alternatives to No Action Alternative Mean Values for Electrical Energy Generation, Generation Capacity, and Economic Value.....	4-276
Table 4.12-1 Water Temperature Tolerances of Rainbow Trout (°C).....	4-282
Table 4.12-2 Life History of the Rainbow Trout, Phases by Months	4-282
Table 4.13-1 Range of Probabilities (percent) of Lake Powell Elevations Less Than or Equal 3,550 feet msl	4-295
Table 4.14-1 Estimate of Involuntarily Fallowed Acres in Arizona under Various Levels of Shortage for Various Years.....	4-308
Table 4.14-2 Estimated Reduction in Agricultural Production Value Resulting from Involuntary Land Fallowing in Arizona under Various Levels of Shortage for Various Years.....	4-309
Table 4.14-3 Estimated Reduction in Employment as a Result of Shortages to Agricultural Lands for the Action Alternatives and the No Action Alternative by Selected Years and Shortage Amounts	4-310
Table 4.14-4 Estimated Reduction in Tax Revenues as a Result of Shortages to Agricultural Lands Under the Action Alternatives and the No Action Alternative by Selected Year and Shortages.....	4-317
Table 6.9-1 Consultation and Coordination Regarding the EIS.....	6-6
Table 6.10-1 Federal Register Notices Regarding the Proposed Federal Action.....	6-9

Volume II: Appendices A through L

See Volume II Table of Contents

Volume III: Appendices M through U

See Volume III Table of Contents

Volume IV: Responses to Comments

See Volume IV Table of Contents