

# Glen Canyon Dam

Long-Term Experimental and Management Plan  
Environmental Impact Statement



## PUBLIC DRAFT

### Volume 1—Chapters 1-8

U.S. Department of the Interior  
Bureau of Reclamation,  
Upper Colorado Region  
National Park Service,  
Intermountain Region

December 2015



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Rafters: Grand Canyon National Park

1 **GLEN CANYON DAM LONG-TERM EXPERIMENTAL AND MANAGEMENT PLAN**  
2 **DRAFT ENVIRONMENTAL IMPACT STATEMENT**  
3  
4

5 **Joint-Lead Agencies**

6 Bureau of Reclamation  
7 National Park Service  
8

9 **Cooperating Agencies**

Department of the Interior	Havasupai Tribe
Bureau of Indian Affairs	Hopi Tribe
U.S. Fish and Wildlife Service	Hualapai Tribe
U.S. Department of Energy	Kaibab Band of Paiute Indians
Western Area Power Administration	Navajo Nation
Arizona Game and Fish Department	Pueblo of Zuni
Colorado River Board of California	Salt River Project
Colorado River Commission of Nevada	Utah Associated Municipal Power Systems
Upper Colorado River Commission	

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11  
12 **ABSTRACT**  
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14

15 The U.S. Department of the Interior (DOI), through the Bureau of Reclamation and  
16 National Park Service (NPS), proposes to develop and implement a Long-Term Experimental  
17 and Management Plan (LTEMP) for operations of Glen Canyon Dam. The LTEMP would  
18 provide a framework for adaptively managing Glen Canyon Dam operations over the next  
19 20 years, consistent with the Grand Canyon Protection Act of 1992 (GCPA) and other provisions  
20 of applicable federal law. The LTEMP would determine specific options for dam operations,  
21 non-flow actions, and appropriate experimental and management actions that will meet the  
22 GCPA's requirements and minimize impacts on resources within the area impacted by dam  
23 operations, including those of importance to American Indian Tribes.  
24

25 The Draft Environmental Impact Statement (DEIS) draws on the scientific information  
26 that has been collected under the Glen Canyon Dam Adaptive Management Program over the  
27 last 20 years to identify the potential environmental effects associated with taking no action, as  
28 well as a reasonable range of alternatives to no action for implementing the proposed federal  
29 action. The alternatives addressed in this DEIS include a broad range of operations and actions  
30 that would meet the purpose, need, and objectives of the proposed federal action. The primary  
31 resources that could be affected by the proposed action include sediment resources, aquatic and  
32 terrestrial ecological resources, recreational resources, socioeconomic resources, hydropower  
33 resources, resources of importance to American Indian Tribes, and historic and cultural resources  
34 in the vicinity of the Glen and Grand Canyons. The DEIS has been developed in accordance with  
35 the National Environmental Policy Act of 1969, as amended (NEPA), and follows the  
36 implementing regulations developed by the President's Council on Environmental Quality in  
37 Title 40 *Code of Federal Regulations* (CFR) Parts 1500 to 1508 and DOI regulations

1 implementing NEPA in 43 CFR Part 46. Based on the impact analyses conducted, DOI has  
2 chosen Alternative D as the preferred alternative.

3  
4 The review period for this DEIS will end 90 days after publication of the  
5 U.S. Environmental Protection Agency Notice of Availability in the *Federal Register*. During  
6 the 90-day comment period, comments will be accepted electronically through the NPS  
7 Planning, Environment, and Public Comment website (<http://parkplanning.nps.gov/LTEMPEIS>)  
8 and in hard copy delivered by the U.S. Postal Service or other mail delivery service. Written  
9 comments will also be accepted during public meetings on the DEIS. Comments will not be  
10 accepted by fax, by e-mail, or in any format other than those specified above. Bulk comments in  
11 any format (hard copy or electronic) submitted on behalf of others will also not be accepted.

12  
13 For additional information, visit <http://ltempeis.anl.gov> or contact:

14  
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**CONTENTS**

1  
2  
3  
4 ABSTRACT ..... iii  
5  
6 ACRONYMS AND ABBREVIATIONS ..... lxiii  
7  
8 1 INTRODUCTION ..... 1-1  
9  
10 1.1 Description of the Proposed Action ..... 1-4  
11 1.2 Purpose of and Need for Action ..... 1-5  
12 1.3 Lead and Cooperating Agencies and Consulting Tribes ..... 1-9  
13 1.3.1 Lead Agencies ..... 1-9  
14 1.3.2 Cooperating Agencies and Consulting Tribes ..... 1-9  
15 1.4 Objectives and Resource Goals of the LTEMP ..... 1-10  
16 1.5 Scope of the DEIS ..... 1-12  
17 1.5.1 Affected Region and Resources ..... 1-13  
18 1.5.2 Impact Topics Selected for Detailed Analysis ..... 1-14  
19 1.5.3 Impact Topics Dismissed from Detailed Analysis ..... 1-15  
20 1.6 Role of Adaptive Management ..... 1-16  
21 1.6.1 History of the Existing Adaptive Management Program ..... 1-16  
22 1.6.2 Relationship of Adaptive Management to NEPA and Changes  
23 to Operations ..... 1-17  
24 1.7 Role of Decision Analysis in the DEIS Process ..... 1-17  
25 1.8 History, Location, and Setting ..... 1-18  
26 1.8.1 History and Purpose of Glen Canyon Dam ..... 1-18  
27 1.8.2 Location of Glen Canyon Dam and LTEMP Affected Area ..... 1-19  
28 1.8.3 Operation of the Glen Canyon Dam ..... 1-20  
29 1.8.4 History, Purpose, and Significance of the National Park System  
30 Units ..... 1-22  
31 1.8.4.1 Grand Canyon National Park ..... 1-22  
32 1.8.4.2 Glen Canyon National Recreation Area ..... 1-24  
33 1.8.4.3 Lake Mead National Recreation Area ..... 1-24  
34 1.8.5 Tribal Lands ..... 1-25  
35 1.8.5.1 Navajo Nation ..... 1-26  
36 1.8.5.2 Hualapai ..... 1-26  
37 1.8.5.3 Havasupai ..... 1-26  
38 1.8.5.4 Southern Paiute Tribes ..... 1-27  
39 1.8.5.5 Hopi ..... 1-28  
40 1.8.5.6 Pueblo of Zuni ..... 1-28  
41 1.8.5.7 Fort Mojave ..... 1-29  
42 1.9 Laws and Regulations Related to Operations of Glen Canyon Dam and  
43 Park Management ..... 1-29  
44 1.9.1 Environmental Laws and Executive Orders ..... 1-29  
45 1.9.2 Cultural/Historical Laws and Executive Orders ..... 1-30  
46

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 1.9.3 American Indian and Tribal Consultation Laws and Executive  
 5 Orders..... 1-30  
 6 1.9.4 Law of the River ..... 1-31  
 7 1.10 Related Actions ..... 1-31  
 8 1.10.1 Biological Opinions ..... 1-31  
 9 1.10.2 Environmental Impact Statements and Related Documents..... 1-31  
 10 1.10.3 Environmental Assessments and Related Documents ..... 1-35  
 11 1.10.4 Other Actions, Programs, Plans, and Projects ..... 1-35  
 12  
 13 2 DESCRIPTION OF ALTERNATIVES ..... 2-1  
 14  
 15 2.1 Development of Alternatives..... 2-2  
 16 2.2 Descriptions of Alternatives Considered in Detail..... 2-4  
 17 2.2.1 Alternative A (No Action Alternative) ..... 2-8  
 18 2.2.2 Alternative B..... 2-19  
 19 2.2.3 Alternative C..... 2-22  
 20 2.2.3.1 Base Operations under Alternative C ..... 2-24  
 21 2.2.3.2 Experimental Framework for Alternative C..... 2-26  
 22 2.2.4 Alternative D (Preferred Alternative) ..... 2-42  
 23 2.2.4.1 Base Operations under Alternative D..... 2-42  
 24 2.2.4.2 Operational Flexibility under Alternative D ..... 2-43  
 25 2.2.4.3 Experimental Framework for Alternative D ..... 2-46  
 26 2.2.5 Alternative E ..... 2-69  
 27 2.2.5.1 Base Operations under Alternative E ..... 2-69  
 28 2.2.5.2 Experimental Framework for Alternative E..... 2-72  
 29 2.2.6 Alternative F ..... 2-77  
 30 2.2.7 Alternative G..... 2-78  
 31 2.3 Alternatives Considered and Eliminated from Detailed Study ..... 2-81  
 32 2.3.1 Modified Low Fluctuating Flows with Extended Protocols ..... 2-81  
 33 2.3.2 Naturally Patterned Flow Alternative ..... 2-82  
 34 2.3.3 Seasonal Fluctuations with Low Summer Flow Alternative ..... 2-82  
 35 2.3.4 Grand Canyon First! Alternative ..... 2-83  
 36 2.3.5 Species Community and Habitat-Based Alternative..... 2-83  
 37 2.3.6 Stewardship Alternative..... 2-83  
 38 2.3.7 Twelve-Year Experiment of Two Steady-Flow Alternatives ..... 2-84  
 39 2.3.8 Decommission Glen Canyon Dam Alternative..... 2-84  
 40 2.3.9 Fill Lake Mead First Alternative..... 2-85  
 41 2.3.10 Full-Powerplant Capacity Operations Alternative..... 2-85  
 42 2.3.11 Run-of-the-River Alternative..... 2-85  
 43 2.4 Alternative Elements Eliminated from Detailed Study ..... 2-86  
 44 2.4.1 New Infrastructure ..... 2-86  
 45 2.4.2 Flow and Non-Flow Actions..... 2-87  
 46 2.5 Summary Comparison of Alternatives ..... 2-88

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 3 AFFECTED ENVIRONMENT ..... 3-1  
 5  
 6 3.1 Project Area ..... 3-1  
 7 3.1.1 Geologic Setting ..... 3-1  
 8 3.1.2 Climatic Setting ..... 3-3  
 9 3.1.3 Colorado River Ecosystem Resource Linkages ..... 3-3  
 10 3.1.3.1 Water Release Characteristics ..... 3-4  
 11 3.2 Water Resources ..... 3-5  
 12 3.2.1 Hydrology ..... 3-5  
 13 3.2.1.1 Lake Powell Hydrology ..... 3-6  
 14 3.2.1.2 Hydrology of the Colorado River Downstream of Glen  
 15 Canyon Dam ..... 3-9  
 16 3.2.1.3 Lake Mead Hydrology ..... 3-11  
 17 3.2.1.4 Seeps and Springs ..... 3-12  
 18 3.2.2 Water Quality ..... 3-14  
 19 3.2.2.1 Lake Powell Water Quality ..... 3-14  
 20 3.2.2.2 Colorado River Water Quality ..... 3-16  
 21 3.2.2.3 Lake Mead Water Quality ..... 3-24  
 22 3.2.3 Tribal Perspectives on Water Resources ..... 3-27  
 23 3.2.4 Hydrology and Climate Change ..... 3-28  
 24 3.2.4.1 Basis for Runoff Estimates ..... 3-29  
 25 3.2.4.2 Water Variability and Availability ..... 3-29  
 26 3.2.4.3 Seasonal Timing Shifts ..... 3-31  
 27 3.2.4.4 Water Quality ..... 3-31  
 28 3.3 Sediment Resources ..... 3-32  
 29 3.3.1 Background: Geomorphology of the Colorado River ..... 3-32  
 30 3.3.1.1 Geomorphic Features of the Colorado River ..... 3-33  
 31 3.3.1.2 Glen Canyon Geomorphology ..... 3-36  
 32 3.3.1.3 Marble and Grand Canyon Geomorphology ..... 3-37  
 33 3.3.2 Sediment Characteristics and Transport Mechanisms ..... 3-39  
 34 3.3.2.1 Sediment Sources ..... 3-43  
 35 3.3.2.2 Sediment Transport and Storage ..... 3-46  
 36 3.3.2.3 Lake Deltas ..... 3-52  
 37 3.4 Natural Processes ..... 3-54  
 38 3.5 Aquatic Ecology ..... 3-55  
 39 3.5.1 Aquatic Food Base ..... 3-56  
 40 3.5.1.1 Periphyton and Rooted Aquatic Plants ..... 3-57  
 41 3.5.1.2 Plankton ..... 3-59  
 42 3.5.1.3 Macroinvertebrates ..... 3-59  
 43 3.5.1.4 Nonnative Invasive Species ..... 3-61  
 44 3.5.1.5 Food Web Dynamics ..... 3-65  
 45 3.5.2 Native Fish ..... 3-65  
 46 3.5.2.1 Special Status Fish Species ..... 3-67

**CONTENTS (Cont.)**

1  
2  
3  
4 3.5.2.2 Other Native Species ..... 3-81  
5 3.5.3 Nonnative Fish ..... 3-85  
6 3.5.3.1 Coldwater Nonnative Species ..... 3-89  
7 3.5.3.2 Warmwater Nonnative Species ..... 3-95  
8 3.5.3.3 Interactions with Native Species ..... 3-97  
9 3.5.3.4 Nonnative Fish Control Activities and Effects of Flow  
10 Conditions ..... 3-99  
11 3.6 Vegetation ..... 3-104  
12 3.6.1 Historic and Remnant Riparian Plant Communities ..... 3-104  
13 3.6.2 Existing Riparian Vegetation Downstream from Glen Canyon Dam ..... 3-106  
14 3.6.2.1 Tribal Perspectives on Vegetation ..... 3-114  
15 3.6.3 Special Status Plant Species ..... 3-115  
16 3.7 Wildlife ..... 3-115  
17 3.7.1 Invertebrates ..... 3-118  
18 3.7.2 Amphibians and Reptiles ..... 3-120  
19 3.7.3 Birds ..... 3-121  
20 3.7.4 Mammals ..... 3-122  
21 3.7.4.1 Tribal Perspectives on Wildlife Species ..... 3-125  
22 3.7.5 Special Status Wildlife Species ..... 3-126  
23 3.7.5.1 Invertebrates ..... 3-126  
24 3.7.5.2 Amphibians and Reptiles ..... 3-129  
25 3.7.5.3 Birds ..... 3-131  
26 3.7.5.4 Mammals ..... 3-137  
27 3.8 Cultural Resources ..... 3-137  
28 3.8.1 Area of Potential Effect ..... 3-139  
29 3.8.2 Description of Cultural Resources and Site Types ..... 3-140  
30 3.8.2.1 Archaeological Resources ..... 3-142  
31 3.8.2.2 Historic Resources ..... 3-146  
32 3.8.2.3 Cultural Landscapes ..... 3-147  
33 3.8.2.4 Traditional Cultural Properties and Ethnographic  
34 Resources ..... 3-148  
35 3.9 Tribal Cultural Resources ..... 3-149  
36 3.9.1 Havasupai ..... 3-149  
37 3.9.2 Hualapai ..... 3-150  
38 3.9.3 Southern Paiute Tribes ..... 3-153  
39 3.9.4 Hopi ..... 3-153  
40 3.9.5 Navajo Nation ..... 3-154  
41 3.9.6 Zuni ..... 3-156  
42 3.9.7 Fort Mojave Indian Tribe ..... 3-159  
43 3.9.8 Indian Trust Assets and Trust Responsibility ..... 3-160  
44 3.10 Recreation, Visitor Use, and Experience ..... 3-160  
45 3.10.1 Glen Canyon Reach of the Colorado River in Glen Canyon National  
46 Recreation Area ..... 3-160



**CONTENTS (Cont.)**

1  
2  
3  
4 3.10.1.1 Recreational Fishery..... 3-161  
5 3.10.1.2 Day-Rafting, Boating, and Camping in the Glen Canyon  
6 Reach..... 3-166  
7 3.10.2 The Colorado River in Grand Canyon National Park..... 3-169  
8 3.10.3 Recreation Use on Lakes Mead and Powell ..... 3-178  
9 3.10.3.1 Lake Mead National Recreation Area..... 3-178  
10 3.10.3.2 Lake Powell, Glen Canyon National Recreation Area..... 3-179  
11 3.11 Wilderness..... 3-180  
12 3.11.1 Law and Policy ..... 3-180  
13 3.11.2 Defining Wilderness Character..... 3-181  
14 3.12 Visual Resources..... 3-184  
15 3.12.1 Glen Canyon National Recreation Area ..... 3-185  
16 3.12.2 Grand Canyon and the Colorado River..... 3-185  
17 3.12.3 Lake Mead National Recreation Area..... 3-190  
18 3.13 Hydropower..... 3-190  
19 3.13.1 Power Operations..... 3-191  
20 3.13.1.1 Hydropower Generation..... 3-191  
21 3.13.1.2 Basin Fund..... 3-192  
22 3.13.1.3 Operational Flexibility ..... 3-192  
23 3.13.1.4 Scheduling..... 3-194  
24 3.13.1.5 Load/Generation Following and Regulation ..... 3-194  
25 3.13.1.6 Capacity Reserves ..... 3-196  
26 3.13.1.7 Disturbances and Emergencies and Outage Assistance..... 3-196  
27 3.13.1.8 Transmission System..... 3-197  
28 3.13.2 Power Marketing..... 3-197  
29 3.13.2.1 Wholesale Rates ..... 3-200  
30 3.13.2.2 Retail Rates..... 3-201  
31 3.14 Socioeconomics and Environmental Justice ..... 3-201  
32 3.14.1 The Six-County Region of Influence..... 3-201  
33 3.14.1.1 Population..... 3-202  
34 3.14.1.2 Income..... 3-202  
35 3.14.1.3 Employment ..... 3-204  
36 3.14.1.4 Unemployment..... 3-206  
37 3.14.1.5 Environmental Justice ..... 3-206  
38 3.14.2 The Seven-State Region of Influence ..... 3-213  
39 3.14.2.1 Population..... 3-213  
40 3.14.2.2 Income..... 3-214  
41 3.14.2.3 Employment ..... 3-215  
42 3.14.2.4 Unemployment..... 3-217  
43 3.14.2.5 Environmental Justice ..... 3-217  
44 3.15 Air Quality..... 3-219  
45 3.15.1 Local Air Quality ..... 3-220  
46 3.15.2 Regional Air Quality..... 3-221

**CONTENTS (Cont.)**

1  
2  
3  
4           3.15.3 Regional Air Emissions ..... 3-224  
5       3.16 Climate Change ..... 3-226  
6  
7 4 ENVIRONMENTAL CONSEQUENCES ..... 4-1  
8  
9       4.1 Overall Analysis and Assessment Approach..... 4-1  
10      4.2 Water Resources..... 4-7  
11          4.2.1 Analysis Methods..... 4-8  
12              4.2.1.1 Hydrology..... 4-8  
13              4.2.1.2 Water Quality ..... 4-11  
14          4.2.2 Summary of Impacts ..... 4-12  
15              4.2.2.1 Hydrology..... 4-12  
16              4.2.2.2 Water Quality ..... 4-34  
17          4.2.3 Alternative-Specific Impacts ..... 4-44  
18              4.2.3.1 Alternative A (No Action Alternative)..... 4-44  
19              4.2.3.2 Alternative B ..... 4-46  
20              4.2.3.3 Alternative C ..... 4-49  
21              4.2.3.4 Alternative D (Preferred Alternative)..... 4-52  
22              4.2.3.5 Alternative E..... 4-54  
23              4.2.3.6 Alternative F..... 4-56  
24              4.2.3.7 Alternative G ..... 4-59  
25      4.3 Sediment Resources ..... 4-61  
26          4.3.1 Analysis Methods..... 4-62  
27          4.3.2 Summary of Impacts ..... 4-66  
28          4.3.3 Alternative-Specific Impacts ..... 4-68  
29              4.3.3.1 Alternative A (No Action Alternative)..... 4-71  
30              4.3.3.2 Alternative B ..... 4-73  
31              4.3.3.3 Alternative C ..... 4-76  
32              4.3.3.4 Alternative D (Preferred Alternative)..... 4-77  
33              4.3.3.5 Alternative E..... 4-80  
34              4.3.3.6 Alternative F..... 4-81  
35              4.3.3.7 Alternative G ..... 4-82  
36      4.4 Natural Processes ..... 4-83  
37          4.4.1 Analysis Methods..... 4-84  
38          4.4.2 Summary of Impacts ..... 4-84  
39          4.4.3 Alternative-Specific Impacts ..... 4-92  
40              4.4.3.1 Alternative A (No Action Alternative)..... 4-92  
41              4.4.3.2 Alternative B ..... 4-92  
42              4.4.3.3 Alternative C ..... 4-93  
43              4.4.3.4 Alternative D (Preferred Alternative)..... 4-94  
44              4.4.3.5 Alternative E..... 4-94  
45              4.4.3.6 Alternative F..... 4-95  
46              4.4.3.7 Alternative G ..... 4-96

**CONTENTS (Cont.)**

1  
2  
3  
4 4.5 Aquatic Ecology ..... 4-97  
5 4.5.1 Analysis Methods..... 4-97  
6 4.5.1.1 Aquatic Food Base ..... 4-97  
7 4.5.1.2 Nonnative Fish ..... 4-98  
8 4.5.1.3 Native Fish ..... 4-100  
9 4.5.1.4 Aquatic Parasites ..... 4-101  
10 4.5.2 Summary of Impacts ..... 4-102  
11 4.5.2.1 Aquatic Food Base ..... 4-102  
12 4.5.2.2 Nonnative Fish ..... 4-112  
13 4.5.2.3 Native Fish ..... 4-120  
14 4.5.2.4 Aquatic Parasites ..... 4-128  
15 4.5.3 Alternative-Specific Impacts on Aquatic Resources ..... 4-129  
16 4.5.3.1 Alternative A (No Action Alternative)..... 4-129  
17 4.5.3.2 Alternative B ..... 4-132  
18 4.5.3.3 Alternative C ..... 4-135  
19 4.5.3.4 Alternative D (Preferred Alternative)..... 4-138  
20 4.5.3.5 Alternative E..... 4-142  
21 4.5.3.6 Alternative F..... 4-145  
22 4.5.3.7 Alternative G ..... 4-148  
23 4.6 Vegetation ..... 4-151  
24 4.6.1 Analysis Methods..... 4-151  
25 4.6.2 Summary of Impacts ..... 4-157  
26 4.6.2.1 Impacts on Old High Water Zone Vegetation..... 4-157  
27 4.6.2.2 Impacts on New High Water Zone..... 4-165  
28 4.6.2.3 Wetlands ..... 4-170  
29 4.6.2.4 Special Status Plant Species ..... 4-172  
30 4.6.3 Alternative-Specific Impacts ..... 4-175  
31 4.6.3.1 Alternative A (No Action Alternative)..... 4-175  
32 4.6.3.2 Alternative B ..... 4-176  
33 4.6.3.3 Alternative C ..... 4-178  
34 4.6.3.4 Alternative D (Preferred Alternative)..... 4-179  
35 4.6.3.5 Alternative E..... 4-181  
36 4.6.3.6 Alternative F..... 4-183  
37 4.6.3.7 Alternative G ..... 4-184  
38 4.7 Wildlife..... 4-186  
39 4.7.1 Analysis Methods..... 4-186  
40 4.7.2 Summary of Impacts ..... 4-187  
41 4.7.2.1 Terrestrial Invertebrates ..... 4-188  
42 4.7.2.2 Amphibians and Reptiles..... 4-193  
43 4.7.2.3 Birds ..... 4-195  
44 4.7.2.4 Mammals ..... 4-197  
45 4.7.2.5 Special Status Species ..... 4-198  
46 4.7.3 Alternative-Specific Impacts on Wildlife ..... 4-210

**CONTENTS (Cont.)**

1			
2			
3			
4		4.7.3.1	Alternative A (No Action Alternative)..... 4-210
5		4.7.3.2	Alternative B ..... 4-211
6		4.7.3.3	Alternative C ..... 4-212
7		4.7.3.4	Alternative D (Preferred Alternative)..... 4-213
8		4.7.3.5	Alternative E..... 4-214
9		4.7.3.6	Alternative F..... 4-215
10		4.7.3.7	Alternative G ..... 4-216
11	4.8		Cultural Resources ..... 4-217
12		4.8.1	Compliance with Federal Regulations ..... 4-217
13		4.8.2	Analysis Methods..... 4-217
14		4.8.3	Summary of Impacts ..... 4-220
15		4.8.4	Alternative-Specific Impacts ..... 4-226
16		4.8.4.1	Alternative A (No Action Alternative)..... 4-226
17		4.8.4.2	Alternative B ..... 4-227
18		4.8.4.3	Alternative C ..... 4-228
19		4.8.4.4	Alternative D (Preferred Alternative)..... 4-228
20		4.8.4.5	Alternative E..... 4-229
21		4.8.4.6	Alternative F..... 4-230
22		4.8.4.7	Alternative G ..... 4-230
23	4.9		Tribal Resources..... 4-231
24		4.9.1	Tribal Resource Goals..... 4-231
25		4.9.1.1	Increase the Health of the Ecosystem in Glen, Marble, and
26			Grand Canyons ..... 4-232
27		4.9.1.2	Protect and Preserve Sites of Cultural Importance..... 4-235
28		4.9.1.3	Preserve and Enhance Respect for Canyon Life ..... 4-236
29		4.9.1.4	Preserve and Enhance the Sacred Integrity of Glen,
30			Marble, and Grand Canyons..... 4-238
31		4.9.1.5	Maintain and Enhance Healthy Stewardship Opportunities
32			and Maintain and Enhance Tribal Connections to the
33			Canyons ..... 4-239
34		4.9.1.6	Economic Opportunity ..... 4-240
35		4.9.1.7	Maintain Tribal Water Rights and Supply ..... 4-240
36		4.9.1.8	LTEMP Process..... 4-241
37		4.9.2	Analysis Methods..... 4-241
38		4.9.3	Summary of Impacts ..... 4-242
39		4.9.4	Alternative-Specific Impacts ..... 4-247
40		4.9.4.1	Alternative A (No Action Alternative)..... 4-247
41		4.9.4.2	Alternative B ..... 4-249
42		4.9.4.3	Alternative C ..... 4-250
43		4.9.4.4	Alternative D (Preferred Alternative)..... 4-251
44		4.9.4.5	Alternative E..... 4-253
45		4.9.4.6	Alternative F..... 4-254
46		4.9.4.7	Alternative G ..... 4-255

**CONTENTS (Cont.)**

1  
2  
3  
4 4.10 Recreation, Visitor Use, and Experience..... 4-257  
5 4.10.1 Analysis Methods..... 4-257  
6 4.10.2 Summary of Impacts..... 4-258  
7 4.10.2.1 Glen Canyon Fishing..... 4-264  
8 4.10.2.2 Glen Canyon Day Rafting..... 4-266  
9 4.10.2.3 Glen Canyon Recreational Facilities..... 4-266  
10 4.10.2.4 Whitewater Boating..... 4-267  
11 4.10.2.5 Lake Activities and Facilities..... 4-268  
12 4.10.2.6 Tribal Recreation Operations..... 4-268  
13 4.10.2.7 Pearce Ferry..... 4-269  
14 4.10.2.8 Park Operations and Management..... 4-270  
15 4.10.3 Alternative-Specific Impacts..... 4-270  
16 4.10.3.1 Alternative A (No Action Alternative)..... 4-270  
17 4.10.3.2 Alternative B..... 4-272  
18 4.10.3.3 Alternative C..... 4-273  
19 4.10.3.4 Alternative D (Preferred Alternative)..... 4-275  
20 4.10.3.5 Alternative E..... 4-276  
21 4.10.3.6 Alternative F..... 4-277  
22 4.10.3.7 Alternative G..... 4-278  
23 4.11 Wilderness..... 4-280  
24 4.11.1 Analysis Methods..... 4-280  
25 4.11.2 Summary of Impacts..... 4-281  
26 4.11.3 Alternative-Specific Impacts..... 4-286  
27 4.11.3.1 Alternative A (No Action Alternative)..... 4-286  
28 4.11.3.2 Alternative B..... 4-287  
29 4.11.3.3 Alternative C..... 4-288  
30 4.11.3.4 Alternative D (Preferred Alternative)..... 4-288  
31 4.11.3.5 Alternative E..... 4-289  
32 4.11.3.6 Alternative F..... 4-290  
33 4.11.3.7 Alternative G..... 4-291  
34 4.12 Visual Resources..... 4-292  
35 4.13 Hydropower..... 4-294  
36 4.13.1 Analysis Methods..... 4-294  
37 4.13.1.1 Hydropower Resource and Capacity Expansion Impacts..... 4-295  
38 4.13.1.2 Wholesale Rate Impacts..... 4-301  
39 4.13.1.3 Retail Rate Impacts..... 4-303  
40 4.13.1.4 Hoover Dam Impacts..... 4-305  
41 4.13.2 Summary of Hydropower Impacts..... 4-306  
42 4.13.2.1 Monthly Water Release Impacts..... 4-306  
43 4.13.2.2 Hydropower Power Generation and Capacity Impacts..... 4-310  
44 4.13.2.3 Economic Impacts..... 4-312  
45 4.13.2.4 Change in FES Wholesale Rates..... 4-315  
46 4.13.2.5 Retail Rate and Bills Impacts..... 4-315

**CONTENTS (Cont.)**

1  
2  
3  
4 4.13.2.6 Impacts of LTEMP Alternatives on Hoover Dam Power  
5 Economics ..... 4-316  
6 4.13.3 Alternative-Specific Impacts ..... 4-317  
7 4.13.3.1 Alternative A (No Action Alternative)..... 4-317  
8 4.13.3.2 Alternative B ..... 4-318  
9 4.13.3.3 Alternative C ..... 4-319  
10 4.13.3.4 Alternative D (Preferred Alternative)..... 4-320  
11 4.13.3.5 Alternative E..... 4-321  
12 4.13.3.6 Alternative F..... 4-322  
13 4.13.3.7 Alternative G ..... 4-323  
14 4.14 Socioeconomics and Environmental Justice ..... 4-324  
15 4.14.1 Analysis Methods..... 4-324  
16 4.14.1.1 Recreational Use Values ..... 4-325  
17 4.14.1.2 Recreational Economic Impacts ..... 4-326  
18 4.14.1.3 Electricity Bill Increase and Generation Capacity  
19 Expansion Impacts ..... 4-326  
20 4.14.1.4 Environmental Justice ..... 4-327  
21 4.14.2 Summary of Impacts on Socioeconomics and Environmental Justice ... 4-327  
22 4.14.2.1 Recreational Use Values ..... 4-327  
23 4.14.2.2 Recreational Economic Impacts ..... 4-338  
24 4.14.2.3 Customer Utility Electricity Generation Capacity and  
25 Residential Rate Increase Impacts..... 4-340  
26 4.14.2.4 Environmental Justice Impacts..... 4-342  
27 4.14.3 Alternative-Specific Impacts ..... 4-348  
28 4.14.3.1 Alternative A (No Action Alternative)..... 4-348  
29 4.14.3.2 Alternative B ..... 4-349  
30 4.14.3.3 Alternative C ..... 4-350  
31 4.14.3.4 Alternative D (Preferred Alternative)..... 4-352  
32 4.14.3.5 Alternative E..... 4-353  
33 4.14.3.6 Alternative F..... 4-355  
34 4.14.3.7 Alternative G ..... 4-357  
35 4.15 Air Quality..... 4-358  
36 4.15.1 Analysis Methods..... 4-358  
37 4.15.2 Summary of Impacts ..... 4-360  
38 4.15.3 Alternative-Specific Impacts ..... 4-365  
39 4.15.3.1 Alternative A (No Action Alternative)..... 4-366  
40 4.15.3.2 Alternative B ..... 4-366  
41 4.15.3.3 Alternative C ..... 4-366  
42 4.15.3.4 Alternative D (Preferred Alternative)..... 4-366  
43 4.15.3.5 Alternative E..... 4-367  
44 4.15.3.6 Alternative F..... 4-367  
45 4.15.3.7 Alternative G ..... 4-367  
46 4.16 Climate Change ..... 4-368

**CONTENTS (Cont.)**

1  
2  
3  
4 4.16.1 Analysis Methods..... 4-368  
5 4.16.1.1 Effects of LTEMP Alternatives on Climate Change..... 4-368  
6 4.16.1.2 Effects of Climate Change on Hydrology and Downstream  
7 Resources..... 4-369  
8 4.16.2 Summary of Impacts..... 4-370  
9 4.16.2.1 Effects of LTEMP Alternatives on Climate Change..... 4-370  
10 4.16.2.2 Effects of Climate Change on Hydrology and Downstream  
11 Resources..... 4-375  
12 4.16.3 Alternative-Specific Impacts ..... 4-377  
13 4.16.3.1 Alternative A (No Action Alternative)..... 4-377  
14 4.16.3.2 Alternative B ..... 4-377  
15 4.16.3.3 Alternative C ..... 4-380  
16 4.16.3.4 Alternative D (Preferred Alternative)..... 4-380  
17 4.16.3.5 Alternative E..... 4-381  
18 4.16.3.6 Alternative F..... 4-381  
19 4.16.3.7 Alternative G ..... 4-382  
20 4.17 Cumulative Impacts..... 4-382  
21 4.17.1 Past, Present, and Reasonably Foreseeable Future Actions Affecting  
22 Cumulative Impacts ..... 4-382  
23 4.17.1.1 Past and Present (Ongoing) Actions..... 4-391  
24 4.17.1.2 Reasonably Foreseeable Future Actions ..... 4-395  
25 4.17.2 Climate-Related Changes..... 4-398  
26 4.17.3 Cumulative Impacts Summary by Resource..... 4-398  
27 4.17.3.1 Water Resources..... 4-407  
28 4.17.3.2 Sediment Resources ..... 4-408  
29 4.17.3.3 Natural Processes ..... 4-409  
30 4.17.3.4 Aquatic Ecology..... 4-409  
31 4.17.3.5 Vegetation ..... 4-412  
32 4.17.3.6 Wildlife..... 4-413  
33 4.17.3.7 Cultural Resources ..... 4-416  
34 4.17.3.8 Tribal Resources..... 4-417  
35 4.17.3.9 Recreation, Visitor Use, and Experience..... 4-418  
36 4.17.3.10 Wilderness ..... 4-419  
37 4.17.3.11 Visual Resources ..... 4-420  
38 4.17.3.12 Hydropower..... 4-421  
39 4.17.3.13 Socioeconomics and Environmental Justice ..... 4-422  
40 4.17.3.14 Air Quality and Climate Change ..... 4-422  
41 4.18 Unavoidable Adverse Impacts..... 4-423  
42 4.19 Relationship between Short-Term Use and Long-Term Productivity..... 4-424  
43 4.20 Irreversible and Irretrievable Commitments of Resources..... 4-425  
44  
45

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 5 CONSULTATION AND COORDINATION ..... 5-1  
 5  
 6 5.1 Consultation and Coordination with Other Agencies and Programs ..... 5-1  
 7 5.1.1 U.S. Department of the Interior ..... 5-1  
 8 5.1.2 Cooperating Agencies ..... 5-1  
 9 5.1.3 American Indian Tribes ..... 5-2  
 10 5.1.4 Other Consultations ..... 5-6  
 11 5.1.4.1 National Historic Preservation Act ..... 5-6  
 12 5.1.4.2 State and Local Water and Power Agency Coordination ..... 5-7  
 13 5.1.4.3 U.S. Fish and Wildlife Service ..... 5-7  
 14 5.2 Public Involvement ..... 5-8  
 15 5.2.1 Public Scoping Process and Comments Received ..... 5-8  
 16 5.2.2 Public Meetings on Alternatives ..... 5-10  
 17 5.2.3 Glen Canyon Dam Adaptive Management Working Group ..... 5-11  
 18 5.3 Distribution of the LTEMP DEIS ..... 5-11  
 19  
 20 6 REFERENCES ..... 6-1  
 21  
 22 7 LIST OF PREPARERS ..... 7-1  
 23  
 24 8 GLOSSARY ..... 8-1  
 25  
 26 APPENDIX A: Adaptive Management Working Group Desired Future Conditions ..... A-1  
 27  
 28 A.1 Desired Future Conditions: Colorado River Ecosystem ..... A-5  
 29 A.1.1 DFC Description ..... A-5  
 30 A.1.2 DFC Background and Legislation ..... A-6  
 31 A.1.3 Why the Colorado River Ecosystem DFCs Are Important ..... A-6  
 32 A.1.4 Colorado River Ecosystem DFCs ..... A-6  
 33 A.1.4.1 Sediment-Related Resources DFCs ..... A-6  
 34 A.1.4.2 Water Quality DFCs ..... A-7  
 35 A.1.4.3 Colorado River Ecosystem Aquatic Resource DFCs ..... A-7  
 36 A.1.4.4 Colorado River Ecosystem Riparian Resource DFCs ..... A-9  
 37 A.1.5 Colorado River Ecosystem DFCs Additional Information ..... A-9  
 38 A.1.5.1 Colorado River Ecosystem Linkages ..... A-9  
 39 A.1.5.2 Colorado River Ecosystem Metrics ..... A-10  
 40 A.2 Power Desired Future Conditions ..... A-10  
 41 A.2.1 Power DFC Description ..... A-10  
 42 A.2.2 Power DFC Background and Legislation ..... A-10  
 43 A.2.3 Why the Power DFC Is Important ..... A-11  
 44 A.2.4 Power DFCs ..... A-11  
 45 A.2.5 Power DFC Additional Information ..... A-12  
 46 A.2.5.1 Power Linkages ..... A-12



**CONTENTS (Cont.)**

1			
2			
3			
4		A.2.5.2 Power Metrics.....	A-12
5	A.3	Cultural Resources Desired Future Conditions .....	A-13
6		A.3.1 Cultural Resources DFC Description.....	A-13
7		A.3.2 DFC Background and Legislation .....	A-13
8		A.3.3 Why the Cultural Resources DFCs Are Important .....	A-13
9		A.3.4 NRHP Eligible Historic Properties DFCs.....	A-14
10		A.3.4.1 Prehistoric Archaeological Sites and Historic Sites .....	A-14
11		A.3.4.2 Traditional Cultural Properties.....	A-14
12		A.3.5 NRHP Eligible Historic Properties DFC Additional Information .....	A-15
13		A.3.5.1 NRHP Eligible Historic Properties Linkages.....	A-15
14		A.3.5.2 NRHP Eligible Historic Properties Metrics .....	A-16
15		A.3.6 Resources of Traditional Cultural Significance but Not NRHP	
16		Eligible.....	A-16
17		A.3.7 Resources of Traditional Cultural Significance DFCs.....	A-16
18		A.3.8 Resources of Traditional Cultural Significance Linkages .....	A-17
19		A.3.9 Resources of Traditional Cultural Significance Metrics.....	A-17
20	A.4	Recreation Desired Future Conditions .....	A-17
21		A.4.1 Recreation DFC Description.....	A-17
22		A.4.2 DFC Background and Legislation .....	A-17
23		A.4.3 Why the Recreation DFC Is Important .....	A-18
24		A.4.3.1 Grand Canyon National Park .....	A-18
25		A.4.3.2 Glen Canyon National Recreation Area.....	A-18
26		A.4.4 Recreation DFCs.....	A-18
27		A.4.4.1 River Recreation in Grand Canyon National Park .....	A-18
28		A.4.4.2 River Recreation in Glen Canyon National Recreation	
29		Area .....	A-19
30		A.4.4.3 Blue Ribbon Trout Fishery in Glen Canyon National	
31		Recreation Area.....	A-19
32		A.4.4.4 River Corridor Stewardship.....	A-19
33		A.4.5 Recreation DFC Additional Information .....	A-20
34		A.4.6 Recreation Linkages.....	A-20
35		A.4.7 Recreation Metrics .....	A-20
36	A.5	Reference.....	A-21
37			
38	APPENDIX B:	Performance Metrics Used to Evaluate Alternatives .....	B-1
39			
40	B.1	Aquatic Ecology.....	B-3
41		B.1.1 Humpback Chub .....	B-3
42		B.1.2 Other Native Fish.....	B-5
43		B.1.3 Trout Fishery.....	B-5
44		B.1.4 Nonnative Aquatic Species .....	B-6
45	B.2	Archaeological and Cultural Resources .....	B-7
46	B.3	Hydropower and Energy .....	B-9

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 B.4 Natural Processes ..... B-10  
 5 B.5 Recreational Experience..... B-10  
 6 B.5.1 Grand Canyon Metrics..... B-11  
 7 B.5.2 Glen Canyon Metrics ..... B-15  
 8 B.6 Riparian Vegetation..... B-16  
 9 B.7 Sediment..... B-18  
 10 B.8 Tribal Resources..... B-18  
 11 B.9 Water Delivery ..... B-24  
 12 B.10 References ..... B-24  
 13  
 14 APPENDIX C: Decision Analysis to Support Development of the Glen Canyon Dam  
 15 Long-Term Experimental and Management Plan..... C-1  
 16  
 17 APPENDIX D: Hydrology Technical Information and Analysis..... D-1  
 18  
 19 D.1 Analysis Methods..... D-3  
 20 D.1.1 Background..... D-3  
 21 D.1.2 Initial Conditions ..... D-4  
 22 D.1.3 Reservoir Operations ..... D-4  
 23 D.1.3.1 Upper Basin Reservoirs above Lake Powell ..... D-4  
 24 D.1.3.2 Lake Powell and Lake Mead ..... D-5  
 25 D.1.3.3 Lake Mohave and Lake Havasu ..... D-9  
 26 D.1.4 Representation of the Different Alternatives in CRSS ..... D-9  
 27 D.1.4.1 Experimental Components Modeled in CRSS ..... D-22  
 28 D.1.5 Input Hydrology..... D-23  
 29 D.1.6 Input Demands ..... D-26  
 30 D.1.7 Other Key Assumptions..... D-26  
 31 D.2 Supplemental Information on Impact Modeling ..... D-27  
 32 D.2.1 Low Summer Flows..... D-27  
 33 D.2.2 Modeled Annual Releases Extending Beyond the End of the Water  
 34 Year..... D-28  
 35 D.2.3 Lake Elevation ..... D-29  
 36 D.3 References ..... D-36  
 37  
 38 APPENDIX E: Sediment Resources Technical Information and Analysis..... E-1  
 39  
 40 E.1 Introduction ..... E-3  
 41 E.1.1 Analysis Period..... E-3  
 42 E.1.2 General Scope ..... E-3  
 43 E.2 Methods..... E-4  
 44 E.2.1 Sand Budget Model..... E-4  
 45 E.2.1.1 Model Description ..... E-4  
 46 E.2.1.2 Sand Budget Model Modifications..... E-5

**CONTENTS (Cont.)**

1			
2			
3			
4		E.2.1.3	Modified Sand Budget Model Inputs ..... E-6
5	E.2.2		Sediment Metrics ..... E-8
6		E.2.2.1	Sand Load Index..... E-9
7		E.2.2.2	Standard Deviation of High Flows..... E-9
8		E.2.2.3	Sand Mass Balance Index..... E-10
9	E.3		Results ..... E-10
10		E.3.1	HFES Determined by Alternative..... E-10
11		E.3.2	Metrics ..... E-11
12		E.3.2.1	Sand Load Index..... E-12
13		E.3.2.2	Standard Deviation of High Flows..... E-12
14		E.3.3	Sand Mass Balance Index ..... E-12
15		E.3.4	Alternative Performance under Climate Change Scenarios..... E-13
16		E.3.5	Relative Impacts of Dam Operations and Hydrology on
17			Performance ..... E-13
18	E.4		Lake Deltas..... E-15
19	E.5		Limitations and Known Issues ..... E-17
20		E.5.1	Geographic Scope ..... E-17
21		E.5.2	Modeling Improvements..... E-17
22	E.6		References ..... E-18
23			
24	APPENDIX F:		Aquatic Resources Technical Information and Analysis..... F-1
25			
26	F.1		Introduction ..... F-3
27	F.2		Aquatic Food Base Assessment ..... F-4
28		F.2.1	Description of the Aquatic Food Base Downstream from Glen
29			Canyon Dam ..... F-4
30		F.2.1.1	The Aquatic Food Base Prior to Construction of Glen
31			Canyon Dam..... F-5
32		F.2.1.2	The Aquatic Food Base of the Colorado River
33			Downstream from Glen Canyon Dam..... F-5
34		F.2.1.3	Influence of New Zealand Mudsail on the Aquatic Food
35			Base ..... F-13
36		F.2.2	Impacts of LTEMP Alternatives on the Aquatic Food Base ..... F-14
37		F.2.2.1	Flow Effects on the Aquatic Food Base..... F-15
38		F.2.2.2	Temperature Effects on the Aquatic Food Base..... F-23
39		F.2.3	Conclusion ..... F-26
40	F.3		Modeling Effects of LTEMP Alternatives on Rainbow Trout and
41			Humpback Chub..... F-28
42		F.3.1	Model Overview ..... F-28
43		F.3.1.1	Glen Canyon Trout Submodel..... F-29
44		F.3.1.2	Trout Movement Submodel..... F-36
45		F.3.1.3	Humpback Chub Population Submodel ..... F-40
46		F.3.2	Results for LTEMP Alternatives ..... F-52

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 F.3.2.1 Rainbow Trout Performance Measures ..... F-52  
 5 F.3.2.2 Humpback Chub Performance Measures ..... F-60  
 6 F.4 Modeling the Effects of LTEMP Alternatives on Temperature Suitability ..... F-62  
 7 F.4.1 Model Overview ..... F-64  
 8 F.4.2 Humpback Chub Aggregations ..... F-67  
 9 F.4.2.1 Historic Temperature Suitability for Humpback Chub ..... F-69  
 10 F.4.2.2 Results for LTEMP Alternatives ..... F-70  
 11 F.4.3 Other Native Fish ..... F-71  
 12 F.4.3.1 Historic Temperature Suitability for Native Fish ..... F-73  
 13 F.4.3.2 Results for LTEMP Alternatives ..... F-73  
 14 F.4.4 Nonnative Fish ..... F-78  
 15 F.4.4.1 Historic Temperature Suitability for Nonnative Fish ..... F-79  
 16 F.4.4.2 Results for LTEMP Alternatives ..... F-79  
 17 F.4.5 Aquatic Parasites ..... F-81  
 18 F.4.5.1 Historic Temperature Suitability for Aquatic Parasites ..... F-84  
 19 F.4.5.2 Results for LTEMP Alternatives ..... F-86  
 20 F.5 References ..... F-90  
 21  
 22 APPENDIX G: Vegetation Technical Information and Analysis ..... G-1  
 23  
 24 G.1 Analysis Methods ..... G-3  
 25 G.1.1 Old High-Water Zone Analysis ..... G-4  
 26 G.1.2 New High-Water Zone ..... G-5  
 27 G.1.2.1 Native Cover Metric ..... G-6  
 28 G.1.2.2 Native Diversity Metric ..... G-7  
 29 G.1.2.3 Native/Nonnative Ratio Metric ..... G-7  
 30 G.1.2.4 Arrowweed Metric ..... G-8  
 31 G.1.2.5 Overall Score ..... G-8  
 32 G.1.3 Wetlands ..... G-9  
 33 G.2 Alternative-Specific Impacts ..... G-9  
 34 G.2.1 Alternative A (No Action Alternative) ..... G-10  
 35 G.2.2 Alternative B ..... G-10  
 36 G.2.3 Alternative C ..... G-10  
 37 G.2.4 Alternative D (Preferred Alternative) ..... G-11  
 38 G.2.5 Alternative E ..... G-11  
 39 G.2.6 Alternative F ..... G-11  
 40 G.2.7 Alternative G ..... G-12  
 41 G.3 Summary ..... G-12  
 42 G.4 References ..... G-13  
 43  
 44 APPENDIX H: Cultural Resources Technical Information and Analysis ..... H-1  
 45  
 46 H.1 Wind Transport of Sediment ..... H-3

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 H.1.1 Wind Transport of Sediment—Methods..... H-4  
 5 H.1.2 Wind Transport of Sediment—Results..... H-5  
 6 H.2 Flow Effects on Cultural Resources in Glen Canyon..... H-8  
 7 H.2.1 Flow Effects on Cultural Resources in Glen Canyon—Methods..... H-9  
 8 H.2.2 Flow Effects on Cultural Resources in Glen Canyon—Results..... H-9  
 9 H.3 Time Off River..... H-11  
 10 H.3.1 Time Off River—Methods..... H-12  
 11 H.3.2 Time Off River—Results..... H-13  
 12 H.4 References..... H-15  
 13  
 14 APPENDIX I: Tribal Resources Technical Information and Analysis..... I-1  
 15  
 16 I.1 Quantifiable Measures Used to Assess Impacts on Tribal Resources..... I-4  
 17 I.1.1 Riparian Diversity..... I-4  
 18 I.1.2 Wetland Abundance..... I-8  
 19 I.1.3 Trout Management Flows..... I-10  
 20 I.1.4 Mechanical Removal of Trout..... I-12  
 21 I.1.5 Water Levels at Lake Powell..... I-14  
 22 I.1.6 Access to Resources..... I-17  
 23 I.2 References..... I-18  
 24  
 25 APPENDIX J: Recreation, Visitor Use, and Experience Technical Information and  
 26 Analysis..... J-1  
 27  
 28 J.1 Recreational Experience Metrics..... J-3  
 29 J.1.1 Grand Canyon Metrics..... J-4  
 30 J.1.2 Glen Canyon Metrics..... J-4  
 31 J.2 Metric Definitions, Analysis Methods, and Results..... J-5  
 32 J.2.1 Camping Area Index..... J-5  
 33 J.2.1.1 Camping Area Index—Methods..... J-6  
 34 J.2.1.2 Camping Area Index—Results..... J-7  
 35 J.2.2 Navigational Risk Index..... J-8  
 36 J.2.2.1 Navigational Risk Index—Methods..... J-9  
 37 J.2.2.2 Navigational Risk Index—Results..... J-10  
 38 J.2.3 Fluctuation Index..... J-11  
 39 J.2.3.1 Fluctuation Index—Methods..... J-12  
 40 J.2.3.2 Fluctuation Index—Results..... J-13  
 41 J.2.4 Time Off River..... J-14  
 42 J.2.4.1 Time Off River Index—Methods..... J-14  
 43 J.2.4.2 Time Off River Index—Results..... J-15  
 44 J.2.5 Glen Canyon Rafting Use..... J-15  
 45 J.2.5.1 Glen Canyon Rafting Use Metric—Methods..... J-16  
 46 J.2.5.2 Glen Canyon Rafting Use Metric—Results..... J-17

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 J.2.6 Glen Canyon Inundation Metric ..... J-18  
 5 J.2.6.1 Glen Canyon Inundation Metric—Methods ..... J-19  
 6 J.2.6.2 Glen Canyon Inundation Metric—Results ..... J-21  
 7 J.3 Lake Powell and Lake Mead Dock Access ..... J-22  
 8 J.4 Summary ..... J-25  
 9 J.5 References ..... J-25  
 10  
 11 APPENDIX K Hydropower Systems Technical Information and Analysis..... K-1  
 12  
 13 K.1 Economic Value of Glen Canyon Dam Powerplant Capacity and Energy  
 14 Production ..... K-3  
 15 K.1.1 Power Systems Background ..... K-3  
 16 K.1.2 Glen Canyon Dam, Reservoir, and Powerplant Background ..... K-5  
 17 K.1.3 Power Systems Geographic Scope..... K-8  
 18 K.1.3.1 Top Tier: General Western Interconnection Perspective  
 19 Modeling ..... K-9  
 20 K.1.3.2 Middle Tier: LTF Customer Utility Systems ..... K-11  
 21 K.1.3.3 Bottom Tier: Western SLCA/IP Hydropower Resources ..... K-15  
 22 K.1.4 Overview of Power Systems Methods..... K-16  
 23 K.1.5 Description of Individual Power System Models ..... K-20  
 24 K.1.5.1 Colorado River Simulation System Model ..... K-20  
 25 K.1.5.2 Representative Trace Tool..... K-21  
 26 K.1.5.3 Hydropower Outage Model..... K-21  
 27 K.1.5.4 Generation and Transmission Maximization-Lite..... K-21  
 28 K.1.5.5 Sand Budget Model ..... K-29  
 29 K.1.5.6 Large SLCA/IP Powerplant Spreadsheets..... K-29  
 30 K.1.5.7 Small SLCA/IP Powerplant Spreadsheet ..... K-30  
 31 K.1.5.8 Loads Shaping Algorithm ..... K-30  
 32 K.1.5.9 AURORA ..... K-31  
 33 K.1.5.10 LMP Calibration Spreadsheet ..... K-34  
 34 K.1.5.11 Firm Capacity Spreadsheet..... K-35  
 35 K.1.6 SLCA/IP Market System, Data Sources, and Model ..... K-37  
 36 K.1.6.1 Historical Data Sources ..... K-38  
 37 K.1.6.2 AURORA Model Dispatch Results for 2013 ..... K-42  
 38 K.1.6.3 SLCA/IP Market System Projections..... K-42  
 39 K.1.7 Glen Canyon Dam Powerplant Capacity Cost and Benefit  
 40 Methodology ..... K-58  
 41 K.1.7.1 Treatment of Glen Canyon Dam Capital and Fixed O&M  
 42 Costs ..... K-60  
 43 K.1.7.2 Western’s SLCA/IP LTF Obligations and Glen Canyon  
 44 Dam Replacement Capacity ..... K-60  
 45 K.1.7.3 Western SLCA/IP Firm Hydropower Capacity..... K-61

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 K.1.7.4 Firm Capacity Curves for LTEMP Power Systems  
 5 Analyses for the Peak Month of August ..... K-79  
 6 K.1.7.5 AURORA Capacity Expansion Reserve Margin Targets  
 7 and Capacity Additions ..... K-81  
 8 K.1.7.6 Dispatch Performed by AURORA Model Capacity  
 9 Expansion Runs ..... K-85  
 10 K.1.7.7 Rationale for the Selection of Hydrology Conditions Used  
 11 for Capacity Expansion Runs ..... K-89  
 12 K.1.8 Glen Canyon Dam Energy Economic Benefits Methodology ..... K-89  
 13 K.1.9 Net Present Value Calculations and Study Period Adjustments ..... K-93  
 14 K.1.10 Power Systems Results ..... K-95  
 15 K.1.10.1 Main Drivers of Differences among Alternatives ..... K-96  
 16 K.1.10.2 Capacity Expansion Modeling ..... K-100  
 17 K.1.10.3 Economic Impacts ..... K-107  
 18 K.1.10.4 Sensitivity of Results to Exceedance Level ..... K-115  
 19 K.1.10.5 Sensitivity of Results to Discount Rate ..... K-119  
 20 K.1.10.6 Sensitivity of Results to the Base Capacity Expansion Path... K-121  
 21 K.1.10.7 Sensitivity of Results to the Assumed Future Hydrological  
 22 Conditions ..... K-121  
 23 K.1.10.8 Sensitivity of Results to Changes in Ancillary Services ..... K-123  
 24 K.1.10.9 Summary of Economic Ranking ..... K-127  
 25 K.2 Western’s SLCA/IP Firm Electric Service Rate Impacts ..... K-128  
 26 K.2.1 Relationship between the Economic Impacts of LTEMP  
 27 Alternatives and Impacts on SLCA/IP FES Rates ..... K-129  
 28 K.2.2 Temporal Scope of the Analysis and Input Data ..... K-129  
 29 K.2.3 SLCA/IP Rate Setting ..... K-130  
 30 K.2.4 Calculation of Net Electrical Energy Expense ..... K-131  
 31 K.2.4.1 SLCA/IP Electrical Production ..... K-131  
 32 K.2.4.2 Sustainable Hydropower and Available Hydropower  
 33 Capacity and Energy ..... K-131  
 34 K.2.5 Calculation of Capacity Expenses and Total Net Costs ..... K-135  
 35 K.2.6 Western Replacement Resources ..... K-139  
 36 K.2.7 Post-2024 Marketing Period ..... K-140  
 37 K.2.8 Power Repayment Studies to Determine Rate Impacts ..... K-142  
 38 K.2.8.1 PRS Expenses ..... K-142  
 39 K.2.8.2 PRS Revenue Distribution ..... K-144  
 40 K.2.8.3 The SLCA/IP PRS ..... K-145  
 41 K.2.8.4 Standard PRS Rate-Setting Method Versus the Method  
 42 Used in This Analysis ..... K-146  
 43 K.2.9 Results ..... K-146  
 44 K.2.9.1 Pinch-Point Year ..... K-148  
 45 K.2.10 Definitions Used in Section K.2 ..... K-149  
 46 K.3 Impacts on Retail Electricity Rates ..... K-150

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 K.3.1 Analysis Approach..... K-150  
 5 K.3.1.1 Database of Sales, Rates, and SLCA/IP Allocation for  
 6 Retail Utility Systems..... K-152  
 7 K.3.1.2 Incorporation of Power Systems Analysis and Capital  
 8 Recovery Factors..... K-155  
 9 K.3.1.3 Inflation Rates, Sales Growth, and Interest Rates from EIA... K-157  
 10 K.3.1.4 Calculation Process for Computing Rate and Bill Impacts..... K-157  
 11 K.3.2 Results..... K-163  
 12 K.3.2.1 Grid Cost Changes Relative to Western Wholesale  
 13 Revenues..... K-163  
 14 K.3.2.2 Retail Rate Changes for Individual Systems and SLCA/IP  
 15 Power Relative to Total Resources..... K-164  
 16 K.3.2.3 Using Regression Equations to Approximate Retail Rate  
 17 Changes for Systems Not Included in the Database..... K-166  
 18 K.3.3 Summary of Impacts..... K-166  
 19 K.3.3.1 Average Rate Impacts under LTEMP Alternatives over the  
 20 20-Year LTEMP Period..... K-168  
 21 K.3.3.2 Average Year-by-Year Rate Impacts..... K-171  
 22 K.3.3.3 K-Individual System Impacts and Summary  
 23 Descriptions of LTEMP Alternatives..... K-173  
 24 K.3.4 Impacts on Small Systems..... K-178  
 25 K.3.5 Alternative-Specific Impacts..... K-181  
 26 K.3.5.1 Alternative A..... K-181  
 27 K.3.5.2 Alternative B..... K-182  
 28 K.3.5.3 Alternative C..... K-183  
 29 K.3.5.4 Alternative D..... K-184  
 30 K.3.5.5 Alternative E..... K-184  
 31 K.3.5.6 Alternative F..... K-185  
 32 K.3.5.7 Alternative G..... K-185  
 33 K.4 Financial Impacts of LTEMP Alternatives on American Indian Tribes..... K-186  
 34 K.4.1 Contractual Requirements for Calculating and Delivering Benefits  
 35 to Tribes..... K-187  
 36 K.4.2 Calculation of Tribal Benefit Baseline under Alternative A  
 37 (No Action Alternative)..... K-188  
 38 K.4.3 Calculation of Change in Tribal Benefit as a Result of LTEMP EIS  
 39 Alternatives..... K-189  
 40 K.4.4 Impacts on Tribes through a Change in the Retail Rate of the  
 41 Electrical Supplier to Tribal Lands..... K-189  
 42 K.4.5 Calculation of Tribal Impacts for Tribes That Are Direct SLCA/IP  
 43 Recipients..... K-191  
 44 K.4.6 Total Impact of LTEMP DEIS Alternatives: Benefit Change and  
 45 Rate Effect..... K-197



**CONTENTS (Cont.)**

1  
 2  
 3  
 4 K.4.7 Total Impact on Tribes and Tribal Members Versus Retail Rate  
 5 Changes to Households..... K-197  
 6 K.4.8 Conclusions..... K-198  
 7 K.5 Impacts of LTEMP Alternatives on Lake Mead and the Hoover Dam  
 8 Powerplant..... K-202  
 9 K.5.1 Hoover Methods, Model, and Supporting Data..... K-205  
 10 K.5.2 Hoover Monthly Energy Production and Water-to-Power  
 11 Conversion..... K-206  
 12 K.5.3 Hoover Maximum Physical Output and Firm Capacity..... K-212  
 13 K.5.4 Hoover Powerplant Economic Energy Value..... K-214  
 14 K.6 References..... K-218  
 15 Attachment K.1: Geographic Scope of the Analysis..... K-222  
 16 Attachment K.2: AURORA WI Spot Market Energy Prices Adjustments..... K-226  
 17 Attachment K.3: Selection of Representative Trace..... K-229  
 18 Attachment K.4: Discounting Procedures..... K-247  
 19 Attachment K.5: Forced Outage Scenario Generation for Hydroelectric Power  
 20 Facilities..... K-250  
 21 Attachment K.6: Forecast of Monthly Peak Loads and Energy by SLCA/IP  
 22 Long-Term Firm Customer..... K-253  
 23 Attachment K.7: Analysis of the Timing of the Peak Load..... K-255  
 24 Attachment K.8: Analysis of Capacity Determinations— Comparing Results Using  
 25 a Range of Exceedence Levels and Two Summer Peak Months..... K-261  
 26 Attachment K.9: Results of a Survey of Electric Utility Integrated Resource Plans..... K-263  
 27 Attachment K.10: Indices Used for Converting Dollars from One Year to Another..... K-273  
 28 Attachment K.11: Annual SLCA/IP Allocations to American Indian Tribes and  
 29 Benefit Information..... K-278  
 30 Attachment K.12: SLCA/IP American Indian Tribal Allocations Estimated Total  
 31 Electrical Use by Tribe in 1998..... K-284  
 32  
 33 APPENDIX L: Socioeconomic Technical Information and Analysis..... L-1  
 34  
 35 L.1 Recreation Economic Analyses..... L-3  
 36 L.1.1 Recreation Use Values..... L-3  
 37 L.1.1.1 Lake\_Full Utility Model..... L-4  
 38 L.1.1.2 GCRec\_Full Utility Model..... L-5  
 39 L.1.2 Recreation Non-Use Values..... L-6  
 40 L.1.3 Regional Recreation Economic Impacts..... L-8  
 41 L.1.4 Estimates of Recreational Economic Impacts..... L-11  
 42 L.2 Regional Electricity Analyses..... L-12  
 43 L.2.1 Regional Electricity Price Impacts..... L-12  
 44 L.2.2 Regional Electricity Generating Capacity Expansion Impacts..... L-15  
 45 L.3 Additional Socioeconomic Data..... L-15  
 46 L.3.1 Urban Population in the Six-County Region..... L-15

**CONTENTS (Cont.)**

1  
2  
3  
4 L.3.2 Urban Income in the Six-County Region..... L-19  
5 L.4 References ..... L-20  
6  
7 APPENDIX M: Air Quality and Climate Change Technical Information and Analysis ..... M-1  
8  
9 M.1 Analysis Methods..... M-4  
10 M.1.1 System Power Generation..... M-4  
11 M.1.2 Spot Market..... M-5  
12 M.1.3 Generation Type..... M-6  
13 M.2 Results ..... M-6  
14 M.2.1 SO<sub>2</sub> and NO<sub>x</sub>..... M-6  
15 M.2.2 Greenhouse Gas Emissions..... M-8  
16 M.3 References ..... M-9  
17  
18 APPENDIX N: Government-to-Government and National Historic Preservation  
19 Act Consultation ..... N-1  
20  
21 N.1 Government-to-Government Consultation..... N-3  
22 N.2 Consultation with the State Historic Preservation Office ..... N-27  
23 N.3 Reference..... N-30  
24 Attachment N.1 ..... N-31  
25 Attachment N.2 ..... N-73  
26 Attachment N.3 ..... N-135

**FIGURES**

27  
28  
29  
30  
31  
32 1-1 Generalized Locations of Glen Canyon Dam, Lake Powell, the Colorado River  
33 between Lake Powell and Lake Mead, and Adjacent Lands..... 1-5  
34  
35 1-2 Glen Canyon Dam ..... 1-6  
36  
37 1-3 Map of the Colorado River between Lake Powell and Lake Mead ..... 1-20  
38  
39 2-1 Mean, Minimum, and Maximum Daily Flows under Alternative A in an  
40 8.23-maf Year Based on Values Presented in Table 2-3..... 2-17  
41  
42 2-2 Simulated Hourly Flows under Alternative A in an 8.23-maf Year..... 2-17  
43  
44 2-3 Simulated Hourly Flows under Alternative A for a Week in July in an 8.23-maf  
45 Year Showing Typically Lower Weekend Flows ..... 2-18  
46

**FIGURES (Cont.)**

1  
2  
3  
4 2-4 Mean, Minimum, and Maximum Daily Flows under Alternative B in an  
5 8.23-maf Year Based on Values Presented in Table 2-4..... 2-20  
6  
7 2-5 Simulated Hourly Flows under Alternative B in an 8.23-maf Year..... 2-21  
8  
9 2-6 Simulated Hourly Flows under Alternative B for a Week in July in an 8.23-maf  
10 Year Showing Typically Lower Weekend Flows ..... 2-21  
11  
12 2-7 Example Mean, Minimum, and Maximum Daily Flows for a Hydropower  
13 Improvement Experiment under Alternative B in an 8.23-maf Year..... 2-23  
14  
15 2-8 Simulated Hourly Flows for a Hydropower Improvement Experiment under  
16 Alternative B in an 8.23-maf Year ..... 2-23  
17  
18 2-9 Simulated Hourly Flows for a Hydropower Improvement Experiment under  
19 Alternative B for a Week in July in an 8.23-maf Year..... 2-24  
20  
21 2-10 Mean, Minimum, and Maximum Daily Flows under Base Operations of  
22 Alternative C in an 8.23-maf Year Based on the Values Presented in Table 2-5 ..... 2-25  
23  
24 2-11 Simulated Hourly Flows under Alternative C in an 8.23-maf Year..... 2-27  
25  
26 2-12 Simulated Hourly Flows under Alternative C for a Week in July in an 8.23-maf  
27 Year Showing Typically Lower Weekend Flows ..... 2-27  
28  
29 2-13 Decision Tree for Sediment-Related Actions under Alternative C ..... 2-28  
30  
31 2-14 Decision Tree for Humpback Chub-Related Actions under Alternative C..... 2-29  
32  
33 2-15 Example Implementation of a Two-Cycle TMF in June and July with  
34 Resumption of Normal Fluctuations between Cycles and Afterward..... 2-39  
35  
36 2-16 Mean, Minimum, and Maximum Daily Flows under Triggered Low Summer  
37 Flows of Alternative C in an 8.23-maf Year Based on the Values Presented in  
38 Table 2-6..... 2-41  
39  
40 2-17 Mean, Minimum, and Maximum Daily Flows under Alternative D in an  
41 8.23-maf Year Based on Values Presented in Table 2-8..... 2-44  
42  
43 2-18 Simulated Hourly Flows under Alternative D in an 8.23-maf Year..... 2-45  
44  
45 2-19 Simulated Hourly Flows under Alternative D for a Week in July in an 8.23-maf  
46 Year Showing Typically Lower Weekend Flows ..... 2-45

**FIGURES (Cont.)**

1  
2  
3  
4 2-20 Decision Tree for Implementation of Sediment-Related Experimental  
5 Treatments under Alternative D ..... 2-53  
6  
7 2-21 Decision Tree for Implementation of Aquatic Resource-Related Experimental  
8 Treatments under Alternative D ..... 2-54  
9  
10 2-22 Mean, Minimum, and Maximum Daily Flows under Triggered Low Summer  
11 Flows of Alternative C in an 8.23-maf Year Based on the Values Presented in  
12 Table 2-10..... 2-66  
13  
14 2-23 Mean, Minimum, and Maximum Daily Flows under Alternative E in an  
15 8.23-maf Year Based on the Values Presented in Table 2-11 ..... 2-71  
16  
17 2-24 Simulated Hourly Flows under Alternative E in an 8.23-maf Year ..... 2-71  
18  
19 2-25 Simulated Hourly Flows under Alternative E for a Week in July in an 8.23-maf  
20 Year Showing Typically Lower Weekend Flows ..... 2-72  
21  
22 2-26 Decision Tree for Sediment-Related Actions under Alternative E ..... 2-73  
23  
24 2-27 Decision Tree for Trout-Related Actions under Alternative E ..... 2-74  
25  
26 2-28 Mean, Minimum, and Maximum Daily Flows under Base Operations of  
27 Alternative F in an 8.23-maf Year Based on the Values Presented in Table 2-12..... 2-79  
28  
29 2-29 Mean, Minimum, and Maximum Daily Flows under Alternative G in an  
30 8.23-maf Year Based on Values Presented in Table 2-13..... 2-80  
31  
32 3.1-1 LTEMP Project Area and Surrounding Lands ..... 3-2  
33  
34 3.2-1 Map of Lake Powell and Associated Major Tributaries..... 3-7  
35  
36 3.2-2 The Pattern of Annual Historic Flows at Lees Ferry..... 3-10  
37  
38 3.2-3 Map of Lake Mead and Associated Major Tributaries..... 3-11  
39  
40 3.2-4 Profile of Lake Powell from Glen Canyon Dam to the Inflow of the Colorado  
41 River ..... 3-15  
42  
43 3.2-5 Water Temperature at Lees Ferry ..... 3-16  
44  
45 3.2-6 Water Temperatures at Four Stations along the Colorado River from Lees Ferry  
46 to Diamond Creek, 1995–2014..... 3-19

**FIGURES (Cont.)**

1  
2  
3  
4 3.2-7 Mid-June Warming above Release Temperatures Measured at Diamond Creek,  
5 1994–2004, as a Function of Mean Weekly Discharge..... 3-20  
6  
7 3.3-1 Geomorphic Features of the Colorado River..... 3-32  
8  
9 3.3-2 Schematic Diagram of the Fan-Eddy Complex on the Colorado River ..... 3-34  
10  
11 3.3-3 River Cross Section Depicting Sediment Entrapment and Sandbar Building..... 3-35  
12  
13 3.3-4 Aeolian and Fluvial Sand Deposits along the Colorado River..... 3-36  
14  
15 3.3-5 Debris Fans and Variation in Water-Surface Elevation and Channel Width for  
16 Colorado River Flows below Glen Canyon Dam..... 3-38  
17  
18 3.3-6 Comparison of Sandbars Used as Campsites, based on Inventories Conducted  
19 in 1973, 1983, and 1991 ..... 3-39  
20  
21 3.3-7 Repeated Photography Illustrating Sediment Losses and Sandbar Changes  
22 along the Colorado River..... 3-41  
23  
24 3.3-8 Annual Sediment Contributions from the Paria and Little Colorado River ..... 3-45  
25  
26 3.3-9 Matched Photographs of RM 172 Illustrating Positive Depositional Response to  
27 the 2008 HFE..... 3-49  
28  
29 3.3-10 Conceptual Diagram of the Dependency between Net Sandbar Size, Duration  
30 and Frequency of HFEs, and Post-HFE Erosion Rates ..... 3-50  
31  
32 3.3-11 Average Campsite Area above the Reference Stage: before, after, and  
33 6 Months following the 2008 HFE..... 3-51  
34  
35 3.3-12 Longitudinal Profiles of the Mainstem Colorado Riverbed Upstream of the  
36 Hoover Dam in 1935, 1948, 1963, and 2001 ..... 3-53  
37  
38 3.5-1 Temperature Ranges for Spawning, Egg Incubation, and Growth by Native and  
39 Nonnative Fishes of the Colorado River System below Glen Canyon Dam..... 3-67  
40  
41 3.5-2 Humpback Chub Aggregation Areas along the Colorado River between Glen  
42 Canyon Dam and Lake Mead ..... 3-70  
43  
44 3.5-3 Estimated Adult Humpback Chub Abundance from Age-Structured Mark-  
45 Recapture Model Incorporating Uncertainty in Assignment of Age..... 3-71  
46

**FIGURES (Cont.)**

1  
2  
3  
4 3.5-4 Estimated Total Adult Abundance of Humpback Chub in the Lower 8 mi of the  
5 Little Colorado River and a 2-mi Portion of the Colorado River Just Downriver  
6 of the Confluence of the Little Colorado and Colorado Rivers, for September,  
7 2009 through 2012..... 3-71  
8  
9 3.5-5 Water Temperatures at Lees Ferry and the Little Colorado River Confluence,  
10 1995 to Present ..... 3-76  
11  
12 3.5-6 Mean Electrofishing Catch Rates of Rainbow Trout in the Glen Canyon Reach,  
13 1991–2013 ..... 3-91  
14  
15 3.5-7 Mean Electrofishing Catch Rates of Brown Trout in the Colorado River  
16 between Lees Ferry and Lake Mead, 2000–2009..... 3-94  
17  
18 3.6-1 Riparian Vegetation Zones along the Colorado River below Glen Canyon Dam.....3-108  
19  
20 3.7-1 Riparian Zones Used by Nesting Birds .....3-119  
21  
22 3.7-2 Threatened, Endangered, and Sensitive Species Observed along the Colorado  
23 River Corridor .....3-130  
24  
25 3.8-1 Spencer Steamboat .....3-141  
26  
27 3.8-2 A Roaster Site in a Grand Canyon Dune.....3-141  
28  
29 3.8-3 An Archaic Period Site on the Colorado River in GCNP .....3-144  
30  
31 3.8-4 Glen Canyon Linear Style Petroglyph in GCNRA.....3-144  
32  
33 3.8-5 Puebloan Era Architecture along the Colorado River in GCNP .....3-145  
34  
35 3.8-6 Lees Ferry Historic District Located in GCNRA .....3-147  
36  
37 3.10-1 Glen Canyon Reach Rainbow Trout.....3-162  
38  
39 3.10-2 Mean Rainbow Trout Catch Per Unit Effort of Both Boat Anglers and  
40 Shore-Line Anglers from Creel Surveys at Lees Ferry .....3-163  
41  
42 3.10-3 Fishing User Days by Month in the Glen Canyon Reach for 2006 and 2009 .....3-164  
43  
44 3.10-4 Angler Days in the Glen Canyon Reach from 1965 through 2011 .....3-165  
45  
46 3.10-5 Designated Campsite Areas in the Glen Canyon Reach .....3-167

**FIGURES (Cont.)**

1  
2  
3  
4 3.10-6 Shoreline Environment with Steep Erosion Banks at Glen Canyon Reach  
5 Ferry Swale Campsite.....3-168  
6  
7 3.10-7 Pontoon Raft Operated by Colorado River Discovery .....3-168  
8  
9 3.10-8 Boating in Grand Canyon, Anticipated Annual Use by Month.....3-171  
10  
11 3.10-9 Change in Camp Size over Time in the Lees Ferry to Diamond Creek Reach  
12 of GCNP .....3-172  
13  
14 3.10-10 Total High-Elevation Campsite Area for Each Survey between 1998 and 2006 .....3-173  
15  
16 3.10-11 High-Elevation Campsite Area in Critical and Noncritical Reaches between  
17 1998 and 2006 .....3-174  
18  
19 3.12-1 Glen Canyon Viewed from the Colorado River .....3-186  
20  
21 3.12-2 Horseshoe Bend.....3-186  
22  
23 3.12-3 Typical View of the Colorado River and Grand Canyon Afforded  
24 Recreationists on a River Trip.....3-188  
25  
26 3.12-4 Colorado River and Granaries at Nankoweap .....3-188  
27  
28 3.12-5 Entrance to Havasu Canyon .....3-189  
29  
30 3.12-6 Vasey’s Paradise.....3-189  
31  
32 3.14-1 Minority Population Groups in the 11-County Area .....3-210  
33  
34 3.14-2 Low-Income Population Groups in the 11-County Area .....3-211  
35  
36 3.15-1 Nonattainment Areas for SO<sub>2</sub>, 8-Hour O<sub>3</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>, and Pb in the  
37 11-State Area .....3-223  
38  
39 3.15-2 PSD Class I Areas in the 11-State Affected Area .....3-225  
40  
41 3.16-1 Historical Supply and Use and Projected Future Colorado River Basin Water  
42 Supply and.....3-228  
43  
44 4-1 Model Flow Diagram for Analyses Showing Inputs, Intermediate Calculations,  
45 and Output ..... 4-3  
46

**FIGURES (Cont.)**

1  
2  
3  
4 4-2 Example Box-and-Whisker Plot for Alternatives and Their Resource Metric  
5 Values ..... 4-6  
6  
7 4.2-1 Monthly Releases under Each Alternative in Years with Different Annual  
8 Release Volumes ..... 4-20  
9  
10 4.2-2 Mean Monthly Volume under the LTEMP Alternatives Showing the Mean,  
11 Median, 75th Percentile, 25th Percentile, Minimum, and Maximum Values for  
12 21 Hydrology Scenarios and Three Sediment Scenarios ..... 4-22  
13  
14 4.2-3 Mean Daily Flows by Month under the LTEMP Alternatives Showing the  
15 Mean, Median, 75th Percentile, 25th Percentile, Minimum, and Maximum  
16 Values for 21 Hydrology Scenarios and Three Sediment Scenarios..... 4-25  
17  
18 4.2-4 Mean Daily Change in Flows by Month under the LTEMP Alternatives  
19 Showing the Mean, Median, 75th Percentile, 25th Percentile, Minimum, and  
20 Maximum Values for 21 Hydrology Scenarios and Three Sediment Scenarios ..... 4-27  
21  
22 4.2-5 Lake Powell and Lake Mead End of Calendar Year Pool Elevation for 21  
23 Hydrology Traces and Seven Alternatives ..... 4-29  
24  
25 4.2-6 Percentage of Traces below Lake Powell’s Minimum Power Pool and  
26 Percentage of Traces with a Lower Basin Shortage for 21 Hydrology Traces  
27 and Seven Alternatives ..... 4-30  
28  
29 4.2-7 Percentage of Time in Different Operating Tier than Alternative A..... 4-31  
30  
31 4.2-8 Frequency of Lake Powell Operating Tiers from 2014 to 2026 under Each of  
32 the Alternatives for 21 Hydrologic Traces ..... 4-32  
33  
34 4.2-9 Frequency of Lake Powell Operating Tiers from 2027 to 2033 under Each of  
35 the Alternatives for 21 Hydrologic Traces ..... 4-33  
36  
37 4.2-10 Frequency of Occurrence of Annual Releases Extending Beyond the Water  
38 Year per 20-Year Trace for Each of the Alternatives..... 4-34  
39  
40 4.2-11 Comparison of Mean Water Temperatures for Representative Wetter,  
41 Moderate, and Drier Hydrology Traces for Glen Canyon Dam Releases ..... 4-36  
42  
43 4.2-12 Seasonal Glen Canyon Dam Release Temperatures for LTEMP Alternatives ..... 4-37  
44  
45 4.2-13 Seasonal Temperature Trends under the Seven LTEMP Alternatives ..... 4-39  
46



**FIGURES (Cont.)**

1  
2  
3  
4 4.2-14 Projected Mean Salinity Concentrations under the LTEMP Alternatives at  
5 Lees Ferry ..... 4-43  
6  
7 4.3-1 Conceptual Depiction of the Sand Load Index..... 4-64  
8  
9 4.3-2 Conceptual Depiction of the Sand Mass Balance Model ..... 4-65  
10  
11 4.3-3 Variation in Lake Powell Pool Elevation Relative to Full for 21 Hydrology  
12 Traces and Seven Alternatives ..... 4-71  
13  
14 4.3-4 Variation in Lake Mead Pool Elevation Relative to Full for 21 Hydrology  
15 Traces and Seven Alternatives ..... 4-72  
16  
17 4.3-5 Number and Type of HFES Expected to Occur during the 20-Year LTEMP  
18 Period under the Seven Alternatives ..... 4-73  
19  
20 4.3-6 Sand Load Index Values for the 20-Year LTEMP Period under the Seven  
21 Alternatives..... 4-74  
22  
23 4.3-7 Sand Mass Balance Index Values for the 20-Year LTEMP Period under the  
24 Seven Alternatives..... 4-75  
25  
26 4.4-1 Anticipated Relationships among Dam Releases, Physical Conditions, Habitats,  
27 and Ecological Resources in the Colorado River Ecosystem..... 4-85  
28  
29 4.5-1 Modeled Average Population Size of Age-1 and Older Rainbow Trout in the  
30 Glen Canyon Reach during the 20-Year LTEMP Period under the LTEMP  
31 Alternatives Showing the Mean, Median, 75th Percentile, 25th Percentile,  
32 Minimum, and Maximum Values for 21 Hydrology Scenarios .....4-115  
33  
34 4.5-2 Modeled Annual Average Number of Rainbow Trout Emigrating into the  
35 Marble Canyon Reach from the Glen Canyon Reach during the 20-Year  
36 LTEMP Period under the LTEMP Alternatives .....4-117  
37  
38 4.5-3 Modeled Mean Annual Number of Rainbow Trout in the Glen Canyon Reach  
39 Exceeding 16 in. Total Length during 20-Year Simulation Periods under the  
40 LTEMP Alternatives .....4-118  
41  
42 4.5-4 Modeled Mean Annual Temperature Suitability for Rainbow and Brown Trout  
43 under LTEMP Alternatives at Four Locations Downstream of Glen Canyon  
44 Dam .....4-119  
45

**FIGURES (Cont.)**

1  
2  
3  
4 4.5-5 Modeled Mean Annual Temperature Suitability for Warmwater Nonnative Fish  
5 under LTEMP Alternatives at Four Locations Downstream of Glen Canyon  
6 Dam .....4-120  
7  
8 4.5-6 Mean Annual Mainstem Temperature Suitability for Humpback Chub under  
9 LTEMP Alternatives at Reported Aggregation Locations and Combined  
10 Temperature Suitability for RM 157 and RM 213 Locations .....4-122  
11  
12 4.5-7 Mean Modeled Total Length Attained by December 31 for YOY Humpback  
13 Chub Based on Predicted Mainstem Water Temperatures at the Little Colorado  
14 River Confluence and at Pumpkin Spring under Each Alternative .....4-123  
15  
16 4.5-8 Modeled Minimum Population Size for Humpback Chub during the 20-Year  
17 LTEMP Period under LTEMP Alternatives .....4-124  
18  
19 4.5-9 Modeled Mean Annual Temperature Suitability for Native Fish under LTEMP  
20 Alternatives at Four Locations Downstream of Glen Canyon Dam .....4-127  
21  
22 4.5-10 Overall Modeled Mean Annual Temperature Suitability under LTEMP  
23 Alternatives for Aquatic Fish Parasites at Four Locations Downstream of Glen  
24 Canyon Dam .....4-128  
25  
26 4.6-1 Dominant Factors Affecting Riparian Plant Communities below Glen Canyon  
27 Dam .....4-157  
28  
29 4.6-2 Comparison among Alternatives for Four Riparian Vegetation Metrics as  
30 Predicted by a Vegetation Model .....4-163  
31  
32 4.6-3 Comparison among Alternatives for Combined Riparian Vegetation Metrics as  
33 Predicted by a Vegetation Model .....4-164  
34  
35 4.6-4 Comparison among Alternatives for Wetland Cover as Predicted by a  
36 Vegetation Model .....4-173  
37  
38 4.8-1 Number of Days per Year Flows Would Be >23,200 cfs under LTEMP  
39 Alternatives .....4-224  
40  
41 4.8-2 Wind Transport of Sediment Index Values for LTEMP Alternatives .....4-226  
42  
43 4.10-1 Recreation, Visitor Use, and Experience Metric Results for LTEMP  
44 Alternatives .....4-263  
45  
46

**FIGURES (Cont.)**

1  
2  
3  
4 4.13-1 Flow Diagram of the Power Systems Methodology Used in the LTEMP DEIS .....4-298  
5  
6 4.13-2 Average Daily Glen Canyon Dam Generation under Representative  
7 Hydrological Conditions under LTEMP Alternatives.....4-311  
8  
9 4.13-3 Total NPV of Hoover Powerplant Benefits over a 20-Year Period under  
10 LTEMP Alternatives .....4-317  
11  
12 4.15-1 Annual Power Generation by Alternative over the 20-Year LTEMP Period.....4-363  
13  
14 4.16-1 Weights Used To Reflect the Expected Frequency of Hydrologic Conditions  
15 under Climate Change .....4-371  
16  
17 4.16-2 Mean Annual Inflow Showing the Mean, Median, 75th Percentile,  
18 25th Percentile, Minimum, and Maximum Values for 112 Climate-Change  
19 Inflow Traces and 21 Historic Inflow Traces.....4-372  
20  
21 4.16-3 Differences between Historic and Climate-Change-Weighted Values of Mean  
22 Daily Flow and Mean Daily Change in Flow by Month for LTEMP  
23 Alternatives.....4-376  
24  
25 D-1 Operating Tiers as Specified by the 2007 Interim Guidelines for the Operations  
26 of Lake Powell and Lake Mead..... D-7  
27  
28 D-2 Monthly Releases in kaf for Each Alternative in an 8.23-maf Release Year..... D-21  
29  
30 D-3 Locations of CRSS 29 Natural Flow Nodes..... D-24  
31  
32 D-4 Comparison of CRSS Results Generated Using 105 Traces and 21 Traces for  
33 Lake Powell Annual Inflow, Lake Powell Water Year Release Volume and  
34 Lake Powell Monthly Release Volume..... D-25  
35  
36 D-5 Comparison of CRSS Results Generated Using 105 Traces and 21 Traces for  
37 Lake Powell End of December Water Elevations at the 10th, 50th, and  
38 90th Percentiles ..... D-25  
39  
40 D-6 Occurrences of Low Summer Flows in Applicable Alternatives..... D-28  
41  
42 D-7 Frequency of Occurrence of Modeled Annual Releases Extending beyond the  
43 End of the Water Year per 20-Year Trace for Each of the Alternatives ..... D-29  
44  
45 D-8 Median Volume of Modeled Annual Releases Extending beyond the End of the  
46 Water Year Releases by Trace for Each of the Alternatives ..... D-30

**FIGURES (Cont.)**

1  
2  
3  
4 D-9 Lake Powell and Lake Mead End-of-December Pool Elevation for  
5 21 Hydrology Traces under Alternatives A and B ..... D-30  
6  
7 D-10 Lake Powell and Lake Mead End-of-December Pool Elevation for  
8 21 Hydrology Traces under Alternatives A and C ..... D-31  
9  
10 D-11 Lake Powell and Lake Mead End-of-December Pool Elevation for  
11 21 Hydrology Traces under Alternatives A and D ..... D-31  
12  
13 D-12 Lake Powell and Lake Mead End-of-December Year Pool Elevation for  
14 21 Hydrology Traces under Alternatives A and E ..... D-32  
15  
16 D-13 Lake Powell and Lake Mead End-of-December Pool Elevation for  
17 21 Hydrology Traces under Alternatives A and F ..... D-32  
18  
19 D-14 Lake Powell and Lake Mead End-of-December Pool Elevation for  
20 21 Hydrology Traces under Alternatives A and G ..... D-33  
21  
22 D-15 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
23 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
24 Alternatives A and B ..... D-33  
25  
26 D-16 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
27 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
28 Alternatives A and C ..... D-34  
29  
30 D-17 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
31 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
32 Alternatives A and D ..... D-34  
33  
34 D-18 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
35 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
36 Alternatives A and E ..... D-35  
37  
38 D-19 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
39 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
40 Alternatives A and F ..... D-35  
41  
42 D-20 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
43 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
44 Alternatives A and G ..... D-36  
45  
46

**FIGURES (Cont.)**

1  
 2  
 3  
 4 E-1 Comparison of Calendar, Water, and Sediment Years..... E-20  
 5  
 6 E-2 Model Flow Diagram for Analyses Showing Inputs, Intermediate Calculations,  
 7 and Output ..... E-21  
 8  
 9 E-3 Conceptual Schematic of the Sand Budget Model ..... E-22  
 10  
 11 E-4 Historical Paria Sediment Load per Accounting Period and the 20.5-year Load  
 12 for the Trace That Begins in Each Fall Accounting Period..... E-22  
 13  
 14 E-5 Sediment Traces s1, s2, and s3 for the Paria River Used in the Modeling to  
 15 Account for Uncertainty in Future Delivery ..... E-23  
 16  
 17 E-6 Little Colorado River Sediment Traces for s1, s2, and s3 Used in the Modeling  
 18 to Account for Uncertainty in Future Delivery ..... E-23  
 19  
 20 E-7 Conceptual Representation of the Sand Mass Balance Index ..... E-24  
 21  
 22 E-8 Average Sediment and Hydrology Triggered HFE Count by Type for Each  
 23 Long-Term Strategy ..... E-24  
 24  
 25 E-9 Average HFE Count for Sediment Traces s1, s2, s3 for Each Long-Term  
 26 Strategy ..... E-25  
 27  
 28 E-10 Definition of the Statistics Represented by the Box and Whisker Plots Used in  
 29 This Analysis ..... E-25  
 30  
 31 E-11 Sand Load Index Statistics from 63 Simulations for Each Long-Term Strategy ..... E-26  
 32  
 33 E-12 Standard Deviation of High Flows Statistics from 63 Simulations for Each  
 34 Long-Term Strategy ..... E-26  
 35  
 36 E-13 Correlation between SDHF and SLI..... E-27  
 37  
 38 E-14 Sand Mass Balance Index Statistics from 63 Simulations for Each Long-Term  
 39 Strategy ..... E-27  
 40  
 41 E-15 Correlation between SMBI and SLI ..... E-28  
 42  
 43 E-16 Sand Load Index for Long-Term Strategies Using Climate Change Weights ..... E-28  
 44  
 45 E-17 Comparison of the Sand Load Index between Climate Change and Historical  
 46 Weights..... E-29

**FIGURES (Cont.)**

1  
2  
3  
4 E-18 Standard Deviation of High Flows Using Climate Change Weights ..... E-29  
5  
6 E-19 Comparison of the Standard Deviation of High Flows between Climate Change  
7 and Historical Weights ..... E-30  
8  
9 E-20 Sand Mass Balance Index Using Climate Change Weights ..... E-30  
10  
11 E-21 Comparison of the Sand Mass Balance Index between Climate Change and  
12 Historical Weights ..... E-31  
13  
14 E-22 Comparison of Long-Term Strategies C1 and C2 for Hydrology Trace 1,  
15 Sediment Trace 3 ..... E-31  
16  
17 E-23 SMBI for Alternative E Plotted against Alternative C ..... E-32  
18  
19 E-24 SLI for Alternative E Plotted against Alternative C ..... E-32  
20  
21 E-25 Load-Following Curtailment Effects on SLI and SMBI ..... E-33  
22  
23 E-26 Low Summer Flows for WY 2014, Hydrology Trace 1, Sediment Trace 1 ..... E-34  
24  
25 E-27 Hydrology Impacts on the Sand Load Index ..... E-35  
26  
27 E-28 Hydrology Impacts on the Sand Mass Balance Index ..... E-35  
28  
29 E-29 Conceptual Diagram of Water Surface Elevation Affecting Delta Location ..... E-36  
30  
31 E-30 Historical Cumulative Sand Load Leaving Marble Canyon and Reaching the  
32 Gage above Diamond Creek ..... E-36  
33  
34 E-31 Hydrology Impacts of Lake Powell Pool Elevations by Month across  
35 Alternatives ..... E-37  
36  
37 E-32 Hydrology Impacts of Lake Mead Pool Elevations by Month across  
38 Alternatives ..... E-37  
39  
40 F-1 Fit of Regressions Predicting the Log of Recruitment of Rainbow Trout in the  
41 Glen Canyon Reach Estimated by the Korman et al. (2012) Stock Synthesis  
42 Model as a Function of the Annual Release Volume from Glen Canyon Dam,  
43 the Range of Mean Daily Flows during May–August, and the Maximum Flow  
44 Each Year ..... F-31  
45

**FIGURES (Cont.)**

1  
2  
3  
4 F-2 Relationship between Annual Estimates of the Asymptotic Length of Rainbow  
5 Trout in Lees Ferry Predicted by the Stock Synthesis Model as a Function of  
6 the Estimated Abundance for Fish >150 mm Each Year ..... F-32  
7  
8 F-3 The Relationship between Annual Recruitment of Rainbow Trout in Lees Ferry  
9 Estimated by the Korman et al. (2012) Stock Synthesis Model and the Number  
10 of Trout That Emigrate from Lees Ferry into Marble Canyon the Following  
11 Year ..... F-35  
12  
13 F-4 Fit of the Glen Canyon Rainbow Trout Simulation Model to Predictions of  
14 Recruitment, Asymptotic Length, and the Number of Out-migrants Predicted  
15 by the Korman et al. (2012) Stock Synthesis Model..... F-37  
16  
17 F-5 Predicted and Observed Annual Catch of Rainbow Trout by Year and River  
18 Reach..... F-41  
19  
20 F-6 Best-Fitting Distributions Describing Monthly Movement of Rainbow Trout in  
21 Marble Canyon Assuming Either a Normal or Cauchy Distribution ..... F-43  
22  
23 F-7 Visual Summary of Humpback Chub Population Model Structure ..... F-44  
24  
25 F-8 Modeled Effects of Trout Abundance and Temperature on Humpback Chub  
26 Survival and Growth..... F-48  
27  
28 F-9 Simulated Adult Abundances from Backcasted Model Compared to Patterns  
29 Reported in Coggins and Walters (2009) ..... F-51  
30  
31 F-10 Modeled Average Population Size of Age-1 and Older Rainbow Trout in the  
32 Glen Canyon Reach during the 20-year LTEMP Period under LTEMP  
33 Alternatives and Long-Term Strategies..... F-54  
34  
35 F-11 Modeled Mean Annual Number of Rainbow Trout in the Glen Canyon Reach  
36 Exceeding 16 in. Total Length during the 20-year LTEMP Period under the  
37 LTEMP Alternatives and Long-Term Strategies ..... F-55  
38  
39 F-12 Relationship between Modeled Mean Rainbow Trout Abundance in the Glen  
40 Canyon Reach and the Mean Number of Rainbow Trout Exceeding 16 in. Total  
41 Length during the 20-year LTEMP Period under the LTEMP Alternatives and  
42 Long-Term Strategies..... F-56  
43  
44 F-13 Modeled Mean Annual Angler Catch Rate for Rainbow Trout in the Glen  
45 Canyon Reach during the 20-year LTEMP Period under the LTEMP  
46 Alternatives and Long-Term Strategies..... F-57

**FIGURES (Cont.)**

1  
2  
3  
4 F-14 Relationship between Modeled Mean Rainbow Trout Abundance in the Glen  
5 Canyon Reach and Mean Angler Catch Rates during the 20-year LTEMP  
6 Period under the LTEMP Alternatives and Long-Term Strategies ..... F-58  
7  
8 F-15 Modeled Annual Average Number of Rainbow Trout Emigrating into the  
9 Marble Canyon Reach from the Glen Canyon Reach during the 20-year  
10 LTEMP Period under the LTEMP Alternatives and Long-Term Strategies ..... F-59  
11  
12 F-16 Modeled Frequency of Triggered Mechanical Removal for Rainbow Trout in  
13 the Little Colorado River Reach during the 20-year LTEMP Period under the  
14 LTEMP Alternatives and Long-Term Strategies ..... F-61  
15  
16 F-17 Modeled Minimum Population Size for Humpback Chub during the 20-year  
17 LTEMP Period under the LTEMP Alternatives and Long-Term Strategies ..... F-62  
18  
19 F-18 Relationship between Modeled Mean Numbers of Rainbow Trout Out-migrants  
20 from the Glen Canyon Reach and the Modeled Mean Minimum Abundance of  
21 Adult Humpback Chub during the 20-year LTEMP Period under the LTEMP  
22 Alternatives and Long-Term Strategies ..... F-63  
23  
24 F-19 Suitability for Spawning, Egg Incubation, and Growth of Humpback Chub as a  
25 Function of Water Temperature ..... F-68  
26  
27 F-20 Months for Which Annual Temperature Suitability for Specific Life History  
28 Aspects of Humpback Chub Were Calculated ..... F-68  
29  
30 F-21 Modeled Historic Water Temperatures in the Colorado River at Humpback  
31 Chub Aggregation Locations, Water Years 1990–2012 ..... F-70  
32  
33 F-22 Output from the Temperature Suitability Model for Humpback Chub  
34 Aggregation Locations Based on Modeled Water Temperatures for Water  
35 Years 1990–2012 ..... F-71  
36  
37 F-23 Mainstem Temperature Suitability for Humpback Chub Aggregation Locations  
38 under LTEMP Alternatives and Long-Term Strategies ..... F-72  
39  
40 F-24 Suitability of Water Temperatures for Spawning, Egg Incubation, and Growth  
41 of Native Fish Species ..... F-74  
42  
43 F-25 Months for Which Temperature Suitability for Specific Life History Aspects  
44 Were Considered for Native Fish Species ..... F-74  
45



**FIGURES (Cont.)**

1  
2  
3  
4 F-26 Modeled Historic Water Temperatures in the Colorado River Downstream of  
5 Glen Canyon Dam, Water Years 1990–2012 ..... F-75  
6  
7 F-27 Annual Temperature Suitability Scores for Growth, Spawning, and Egg  
8 Incubation of Native Fish Species at RM 225 Based on Modeled Water  
9 Temperatures for Water Years 1990–2012 ..... F-76  
10  
11 F-28 Annual Temperature Suitability Scores for Native Fish by Assessment Location  
12 Based on Modeled Water Temperatures for Water Years 1990–2012..... F-77  
13  
14 F-29 Mean Annual Overall Temperature Suitability for Native Fish by Assessment  
15 Location Based on Modeled Water Temperatures for Water Years 1990–2012 ..... F-77  
16  
17 F-30 Mean Annual Mainstem Temperature Suitability for Native Fish under LTEMP  
18 Alternatives and Long-Term Strategies at RM 61, RM 157, and RM 225, and  
19 Overall Mean for RM 61–225 ..... F-78  
20  
21 F-31 Suitability of Water Temperatures for Spawning, Egg Incubation, and Growth  
22 of Nonnative Fish Species ..... F-80  
23  
24 F-32 Months during Which Temperature Suitability for Specific Life History  
25 Aspects Were Calculated for Nonnative Fish Species ..... F-81  
26  
27 F-33 Annual Temperature Suitability Scores for Spawning, Incubation, and Growth  
28 of Nonnative Fish Species at RM 225 Based on Modeled Temperatures for  
29 Water Years 1990 to 2012 ..... F-82  
30  
31 F-34 Mean Annual Temperature Suitability Scores for Nonnative Fish Species and  
32 for Temperature Groups by River Location Based on Modeled Water  
33 Temperatures for Water Years 1990–2012 ..... F-83  
34  
35 F-35 Mean Annual Overall Temperature Suitability Scores for Coldwater and  
36 Warmwater Nonnative Fish Species Groups Based on Modeled Historic  
37 Temperatures for Water Years 1990–2012 ..... F-83  
38  
39 F-36 Mean Annual Mainstem Temperature Suitability for Coldwater Nonnative Fish  
40 under LTEMP Alternatives and Long-Term Strategies at RM –15 RM 61, RM  
41 157, and RM 225 ..... F-84  
42  
43 F-37 Mean Annual Mainstem Temperature Suitability for Warmwater Nonnative  
44 Fish under LTEMP Alternatives and Long-Term Strategies at RM 0, RM 61,  
45 RM 157, and RM 225 ..... F-85  
46

**FIGURES (Cont.)**

1  
2  
3  
4 F-38 Suitability of Various Water Temperatures for Host Activity and Infestation  
5 Rates of Parasite Species ..... F-86  
6  
7 F-39 Annual Temperature Suitability Scores for Parasite Species at RM 225 ..... F-87  
8  
9 F-40 Mean Annual Temperature Suitability Scores for Parasite Species by River  
10 Location Based on Modeled Water Temperatures for Water Years 1990–2012 ..... F-87  
11  
12 F-41 Overall Means of Annual Suitability Scores for Parasite Species Across All  
13 River Locations during the 1990–2012 Water Years ..... F-88  
14  
15 F-42 Overall Modeled Mean Annual Temperature Suitability under LTEMP  
16 Alternatives and Long-Term Strategies for Aquatic Fish Parasites at Four  
17 Locations Downstream of Glen Canyon Dam..... F-89  
18  
19 G-1 Native Cover Metric for the LTEMP Alternatives and Associated Long-Term  
20 Strategies ..... G-45  
21  
22 G-2 Native Cover Metric under Climate Change for the LTEMP Alternatives and  
23 Associated Long-Term Strategies ..... G-45  
24  
25 G-3 Native Diversity Metric for the LTEMP Alternatives and Associated Long-  
26 Term Strategies..... G-46  
27  
28 G-4 Native Diversity Metric under Climate Change for the LTEMP Alternatives  
29 (Letters) and Associated Long-Term Strategies ..... G-46  
30  
31 G-5 Native/Nonnative Ratio Metric for the LTEMP Alternatives and Associated  
32 Long-Term Strategies..... G-47  
33  
34 G-6 Native/Nonnative Ratio Metric under Climate Change for the LTEMP  
35 Alternatives and Associated Long-Term Strategies ..... G-47  
36  
37 G-7 Arrowweed Metric for the LTEMP Alternatives and Associated Long-Term  
38 Strategies ..... G-48  
39 G-8 Arrowweed Metric under Climate Change for the LTEMP Alternatives and  
40 Associated Long-Term Strategies ..... G-48  
41  
42 G-9 Overall Combined Score for the LTEMP Alternatives and Associated Long-  
43 Term Strategies..... G-49  
44  
45 G-10 Overall Combined Score under Climate Change for the LTEMP Alternatives  
46 and Associated Long-Term Strategies..... G-49

**FIGURES (Cont.)**

1  
2  
3  
4 G-11 Relative Change in Wetland Cover for the LTEMP Alternatives and Associated  
5 Long-Term Strategies..... G-50  
6  
7 G-12 Relative Change in Wetland Cover under Climate Change for the LTEMP  
8 Alternatives and Associated Long-Term Strategies ..... G-50  
9  
10 H-1 Wind Transport of Sediment Index Values for the LTEMP Alternatives and  
11 Associated Long-Term Strategies ..... H-6  
12  
13 H-2 Average Number of HFEs in the 20-Year LTEMP Period ..... H-7  
14  
15 H-3 Daily Maximum Discharge in a Typical 8.23-maf Water Volume Release Year  
16 from the Glen Canyon Dam during the Windy Season of March–June..... H-8  
17  
18 H-4 Number of Days per Year Flows Would Be >23,200 cfs under LTEMP  
19 Alternatives and Long-Term Strategies..... H-10  
20  
21 H-5 Average Number of Days of an HFE Event per Year ..... H-11  
22  
23 H-6 Modeled Glen Canyon Dam Discharge for the Same Year ..... H-12  
24  
25 H-7 Time Off River Index Values for All LTEMP Alternatives and Associated  
26 Long-Term Strategies..... H-14  
27  
28 H-8 Daily Average Discharge for Representative Long-Term LTEMP Strategies..... H-15  
29  
30 I-1 Riparian Diversity for the LTEMP Alternatives and Associated Long-Term  
31 Strategies ..... I-6  
32  
33 I-2 Riparian Diversity under Climate Change Assumptions for the LTEMP  
34 Alternatives and Associated Long-Term Strategies ..... I-7  
35  
36 I-3 Wetland Abundance for the LTEMP Alternatives and Associated Long-Term  
37 Strategies ..... I-9  
38  
39 I-4 Wetland Abundance under Climate Change Assumptions for the LTEMP  
40 Alternatives and Associated Long-Term Strategies ..... I-10  
41  
42 I-5 Frequency of Trout Management Flows for the LTEMP Alternatives and  
43 Associated Long-Term Strategies ..... I-12  
44  
45 I-6 Frequency of Trout Management Flows under Climate Change Assumptions  
46 for the LTEMP Alternatives and Associated Long-Term Strategies ..... I-13

**FIGURES (Cont.)**

1  
2  
3  
4 I-7 Frequency of Mechanical Removal for the LTEMP Alternatives and Associated  
5 Long-Term Strategies..... I-14  
6  
7 I-8 Frequency of Mechanical Removal under Climate Change Assumptions for the  
8 LTEMP Alternatives and Associated Long-Term Strategies..... I-15  
9  
10 I-9 Lake Powell Water Levels for the LTEMP Alternatives and Associated Long-  
11 Term Strategies..... I-16  
12  
13 I-10 Lake Powell Water Levels under Climate Change Assumptions for the LTEMP  
14 Alternatives and Associated Long-Term Strategies..... I-17  
15  
16 J-1 Camping Area Index for LTEMP Long-Term Strategies..... J-8  
17  
18 J-2 Sand Load Index for LTEMP Long-Term Strategies..... J-9  
19  
20 J-3 Navigational Risk Index Values for the LTEMP Long-Term Strategies..... J-11  
21  
22 J-4 Fluctuation Index for LTEMP Long-Term Strategies..... J-13  
23  
24 J-5 Time Off River Index for LTEMP Long-Term Strategies..... J-15  
25  
26 J-6 Average Daily Discharge for All Modeled Traces and Years under LTEMP  
27 Alternatives..... J-16  
28  
29 J-7 Glen Canyon Rafting Metric for All LTEMP Long-Term Strategies..... J-18  
30  
31 J-8 Average Number of HFES in the 20-Year LTEMP Period for LTEMP  
32 Long-Term Strategies..... J-19  
33  
34 J-9 Glen Canyon Inundation Metric for All LTEMP Long-Term Strategies..... J-21  
35  
36 J-10 Percentage of Traces Lake Powell Elevation Equal to or below 3,580 ft AMSL  
37 for the Summer Season..... J-23  
38  
39 J-11 Percentage of Traces Lake Powell Elevation Equal to or below 3,580 ft AMSL  
40 for the Fall and Spring Seasons..... J-23  
41  
42 J-12 Percentage of Traces Lake Mead Elevation Equal to or below 1,050 ft AMSL  
43 for the Summer Season..... J-24  
44  
45 J-13 Percentage of Traces Lake Mead Elevation Equal to or below 1,050 ft AMSL  
46 for the Fall and Spring Seasons..... J-24

**FIGURES (Cont.)**

1  
2  
3  
4 K.1-1 Network Topology Used by the AURORA Western Interconnection Model..... K-10  
5  
6 K.1-2 SLCA/IP LTF Customer Capacity Ownership Percentages..... K-12  
7  
8 K.1-3 Simplified Network Topology of the SLCA/IP Market System ..... K-13  
9  
10 K.1-4 Percent of SLCA/IP Federal Hydropower Nameplate Capacity by Facility..... K-16  
11  
12 K.1-5 Flow Diagram of the Power Systems Methodology Used in the LTEMP DEIS ..... K-18  
13  
14 K.1-6 Illustration of a Typical GTMax-Lite Result for a 24-Hour Period ..... K-24  
15  
16 K.1-7 GTMax-Lite Network Topology for the Large SLCA/IP Hydropower  
17 Resources Other Than Glen Canyon Dam ..... K-26  
18  
19 K.1-8 Illustration of Temporal Modeling Method Used in the GTMax-Lite Five Large  
20 SLCA/IP Plant Configuration..... K-28  
21  
22 K.1-9 Example of the Load Scaling Algorithm LDC..... K-31  
23  
24 K.1-10 Example of the Load Scaling Algorithm Chronological Hourly Loads..... K-32  
25  
26 K.1-11 Projected Annual Average Calibrated AURORA LMPs at the Palo Verde  
27 Market Hub..... K-36  
28  
29 K.1-12 Historical Palo Verde On- and Off-Peak Electricity Prices Compared to Natural  
30 Gas Prices ..... K-36  
31  
32 K.1-13 2014 AEO Projected Delivered Utility Natural Gas Prices..... K-38  
33  
34 K.1-14 Comparison of Modeled and Actual Annual Aggregated Generation Levels for  
35 Natural Gas, Coal, and Nuclear Powerplants under the No Action Alternative ..... K-43  
36  
37 K.1-15 Total Non-coincidental Peak Loads for the SLCA/IP Market System..... K-49  
38  
39 K.1-16 Total Monthly Loads for the SLCA/IP Market System ..... K-49  
40  
41 K.1-17 Projected 2014 AEO Natural Gas Prices at the Henry Hub ..... K-55  
42  
43 K.1-18 2014 AEO Electricity Market Module Regions and the Mapping of States to  
44 Regions ..... K-56  
45  
46 K.1-19 Projected AEO 2014 Coal Prices by Electricity Market Module Region ..... K-58

**FIGURES (Cont.)**

1  
2  
3  
4 K.1-20 Western SLCA/IP Hydropower Powerplants ..... K-62  
5  
6 K.1-21 SLCA/IP Federal Hydropower Capacity Uses and Variability Factors ..... K-63  
7  
8 K.1-22 Reductions in Operating Range when Providing Ancillary Services..... K-65  
9  
10 K.1-23 Illustration of the Trapezoidal Method Used to Compute Capacity at Flaming  
11 Gorge Dam ..... K-71  
12  
13 K.1-24 Illustration of Ramping Time Increase as a Function of Increasing Water  
14 Volumes at Flaming Gorge Dam..... K-72  
15  
16 K.1-25 Capacity Values at Flaming Gorge Dam Calculated over a Wide Range of  
17 Daily Water Releases Using the Trapezoidal Method ..... K-73  
18  
19 K.1-26 Average Historical Non-coincidental Annual Peak Loads for the Eight Large  
20 Customers and Percentages Relative to the Total ..... K-75  
21  
22 K.1-27 Historical Coincidental Annual and Average Peak Loads for the Eight Large  
23 Customers during the CY 2006 through CY 2009 Time Period ..... K-76  
24  
25 K.1-28 Historical Coincidental Annual and Average Peak Loads for Six Large  
26 Customers during the CY 2010 through CY 2012 Time Period ..... K-76  
27  
28 K.1-29 SLCA/IP Models Used for Estimating SHP Capacity ..... K-78  
29  
30 K.1-30 Historical SHP Capacity Obligation and Western Estimated Risk Level in July ..... K-79  
31  
32 K.1-31 Historical SHP Capacity Obligation and Western Estimated Risk Level in  
33 August..... K-80  
34  
35 K.1-32 Comparison of Firm Marketable Capacity Determinations across Alternatives,  
36 Exceedance Levels, and Summer Peak Months ..... K-80  
37  
38 K.1-33 Timing of Capacity Additions in AURORA ..... K-83  
39  
40 K.1-34 Annual Average Hydropower Generation for the Glen Canyon Dam Powerplant  
41 and the Aggregate Generation for all other SLCA/IP Resources..... K-87  
42  
43 K.1-35 Average Daily Glen Canyon Dam Powerplant Hydropower Generations by  
44 Month Based on the Average of All 21 CRSS/SBM Hydrology Traces ..... K-88  
45

**FIGURES (Cont.)**

1  
 2  
 3  
 4 K.1-36 Average Annual Glen Canyon Dam Powerplant Generation for the  
 5 Representative CRSS/SBM Hydrology Trace..... K-91  
 6  
 7 K.1-37 Representative Trace Average Daily Glen Canyon Dam Powerplant  
 8 Generations by Month ..... K-92  
 9  
 10 K.1-38 Average Daily Generation by Month for Each Alternative..... K-96  
 11  
 12 K.1-39 Palo Verde Average Daily Electricity Market Price Statistics by Month during  
 13 the 20-Year LTEMP Period..... K-97  
 14  
 15 K.1-40 Typical Hourly Winter/Summer Price Patterns in the Western United States ..... K-98  
 16  
 17 K.1-41 Average Number of HFEs by Alternative for All 21 Hydrology Traces of  
 18 Sediment Trace 2 ..... K-99  
 19  
 20 K.1-42 Average Amount of Water Spilled by Alternative for All 21 Hydrology Traces  
 21 of Sediment Trace 2..... K-99  
 22  
 23 K.1-43 Average Annual Number of Hours the Lake Powell Elevation Is below the  
 24 Penstock Intake by Alternative for All 21 Hydrology Traces of Sediment  
 25 Trace 2 ..... K-100  
 26  
 27 K.1-44 2014 Annual Energy Outlook Projections of Capacity Additions in the Western  
 28 Interconnection over the LTEMP Period ..... K-103  
 29  
 30 K.1-45 Cumulative Capacity Additions for Alternative A ..... K-105  
 31  
 32 K.1-46 Cost Difference of Alternatives Compared to Alternative A at 50% Exceedance  
 33 Level and 3.375% Discount Rate ..... K-117  
 34  
 35 K.1-47 Cost Difference of Alternatives Compared to Alternative A at 90% Exceedance  
 36 Level and 3.375% Discount Rate ..... K-118  
 37  
 38 K.1-48 Cost Difference of Alternatives Compared to Alternative A at 99% Exceedance  
 39 Level and 3.375% Discount Rate ..... K-118  
 40  
 41 K.1-49 Cost Difference of Alternatives Compared to Alternative A at 90% Exceedance  
 42 Level and 1.4% Discount Rate ..... K-120  
 43  
 44 K.1-50 Cost Difference of Alternatives Compared to Alternative A at 90% Exceedance  
 45 Level and 3.375% Discount Rate, Assuming All Alternative A New Capacity  
 46 Additions Are Advanced Combustion Turbines ..... K-122

**FIGURES (Cont.)**

1  
2  
3  
4 K.1-51 Cost Difference of Alternatives Compared to Alternative A at 90% Exceedance  
5 Level and 3.375% Discount Rate, Assuming All Alternative A New Capacity  
6 Additions Are Advanced Combined Cycle .....K-123  
7  
8 K.1-52 Cost Difference of Alternatives Compared to Alternative A at 90% Exceedance  
9 Level and 3.375% Discount Rate Assuming Average Hydropower Conditions.....K-124  
10  
11 K.2-1 Determination of Energy Hourly Expense or Revenue .....K-136  
12  
13 K.2-2 Determination of Total Net Expense or Revenue by Year for Each Alternative .....K-138  
14  
15 K.3-1 Flowchart Diagram of Rate Impact Analysis Process .....K-152  
16  
17 K.3-2 Projected Carrying Charge Rates Used in Rate Impact Analysis.....K-157  
18  
19 K.3-3 Flowchart Diagram of Allocation Process .....K-158  
20  
21 K.3-4 Load Factors of SLCA/IP Power.....K-161  
22  
23 K.3-5 Scatter Plot of Preference Ratio and Annual Retail Sales.....K-165  
24  
25 K.3-6 Scatter Plots of Percent Retail Rate Change and the Preference Ratio .....K-167  
26  
27 K.3-7 Retail Rate Distribution under Alternative A.....K-168  
28  
29 K.3-8 Monthly Residential Bill Distribution under Alternative A .....K-169  
30  
31 K.3-9 Average Retail Rate Impacts under LTEMP Alternatives Relative to  
32 Alternative A .....K-170  
33  
34 K.3-10 Average Residential Bill Impacts under LTEMP alternatives Relative to  
35 Alternative A .....K-170  
36  
37 K.3-11 Average Retail Percent Revenue Increase Relative to Alternative A .....K-171  
38  
39 K.3-12 Average Monthly Residential Bill Changes Relative to Alternative A.....K-172  
40  
41 K.3-13 Retail Rates under Alternative A.....K-183  
42  
43 K.4-1 Calculation of Change in Tribal Benefit Resulting from LTEMP DEIS  
44 Alternatives.....K-190  
45



**FIGURES (Cont.)**

1  
2  
3  
4 K.4-2 Financial Impacts under Alternative B Relative to Alternative A for Tribal and  
5 Non-Tribal Entities .....K-199  
6  
7 K.4-3 Financial Impacts under Alternative C Relative to Alternative A for Tribal and  
8 Non-Tribal Entities .....K-199  
9  
10 K.4-4 Financial Impacts under Alternative D Relative to Alternative A for Tribal and  
11 Non-Tribal Entities .....K-200  
12  
13 K.4-5 Financial Impacts under Alternative E Relative to Alternative A for Tribal and  
14 Non-Tribal Entities .....K-200  
15  
16 K.4-6 Financial Impacts under Alternative F Relative to Alternative A for Tribal and  
17 Non-Tribal Entities .....K-201  
18  
19 K.4-7 Financial Impacts under Alternative G Relative to Alternative A for Tribal and  
20 Non-Tribal Entities .....K-201  
21  
22 K.5-1 Comparison of Alternative A and Alternative F Lake Powell Average Monthly  
23 Water Releases over the 20-Year Study Period and 21 Hydrology Traces.....K-203  
24  
25 K.5-2 Impact of Changed Lake Powell Month Water Release Volumes on Mead  
26 Average EOM Pool Elevations .....K-203  
27  
28 K.5-3 Lake Mead Storage Elevation Curve and Change in Elevation as a Function of  
29 Lake Mead Water Storage .....K-204  
30  
31 K.5-4 Results of Water-to-Power Conversion Factor Back-casting Exercise.....K-207  
32  
33 K.5-5 Average Monthly Water-to-Power Conversion Factor and Energy Production  
34 per ac-ft of Total Mead Reservoir Release.....K-209  
35  
36 K.5-6 Average Monthly Turbine and Bypass Water Releases .....K-209  
37  
38 K.5-7 Average Monthly Change in Turbine Water Releases .....K-210  
39  
40 K.5-8 Monthly Probability of a Water Bypass Event Due to a Low Mead Pool  
41 Elevation.....K-210  
42  
43 K.5-9 Average Monthly Generation per ac-ft of Total Mead Reservoir Release for All  
44 Power Systems Primary LTEMP DEIS Alternatives .....K-211  
45

**FIGURES (Cont.)**

1  
2  
3  
4 K.5-10 Alternative F Changes in Monthly Hoover Powerplant Turbine Water Releases  
5 under Hydrology Trace 8.....K-212  
6  
7 K.5-11 Average Monthly Hoover Powerplant Generation for All Power Systems  
8 Primary LTEMP DEIS Alternatives.....K-213  
9  
10 K.5-12 Hoover Powerplant Maximum Physical Output as a Function of Lake Mead  
11 Pool Elevation .....K-213  
12  
13 K.5-13 Hoover Powerplant Maximum Output Exceedance Curve for the Month of  
14 August.....K-214  
15  
16 K.5-14 Average Monthly Change in Hoover Powerplant Energy Economic Value  
17 Relative to Alternative A for All Power Systems Primary LTEMP SEIS  
18 Alternatives.....K-215  
19  
20 K.5-15 NPV of Hoover Powerplant Benefits Relative to Alternative A Resulting from  
21 LTEMP Alternatives .....K-216  
22  
23 K.5-16 NPV Comparison of SLCA/IP Costs and Hoover Powerplant Benefits  
24 Resulting from Changed Operating Criteria at Glen Canyon Dam.....K-217  
25  
26 K.5-17 NPV Comparison of SLCA/IP Costs and Hoover Powerplant Benefits  
27 Resulting from LTEMP Alternatives .....K-217  
28  
29 L-1 Elements of the Lake\_Full Utility Model..... L-5  
30  
31 L-2 Elements of the GCRec\_Full Utility Model..... L-6  
32  
33 L-3 Elements of the Regional Recreation Impacts Analysis..... L-9  
34  
35 L-4 Elements of the Regional Electricity Price Impacts Analysis..... L-14  
36  
37 L-5 Elements of the Regional Electricity Generating Capacity Expansion Impacts  
38 Analysis..... L-16  
39  
40

**TABLES**

1  
2  
3  
4 1-1 Glen Canyon Dam Release Constraints under Modified Low Fluctuating Flows ..... 1-21  
5  
6 1-2 Selected Documents Included in the Law of the River ..... 1-32  
7  
8 2-1 Operational Characteristics of LTEMP Alternatives ..... 2-9  
9  
10 2-2 Condition-Dependent and Experimental Elements of LTEMP Alternatives ..... 2-11  
11  
12 2-3 Flow Parameters under Alternative A in an 8.23-maf Year ..... 2-16  
13  
14 2-4 Flow Parameters under Alternative B in an 8.23-maf Year ..... 2-20  
15  
16 2-5 Flow Parameters under Alternative C in an 8.23-maf Year ..... 2-25  
17  
18 2-6 Implementation Criteria for Experimental Treatments of Alternative C ..... 2-30  
19  
20 2-7 Flow Parameters for a Year with Low Summer Flows under Alternative C  
21 in an 8.23-maf Year ..... 2-41  
22  
23 2-8 Flow Parameters under Alternative D in an 8.23-maf Year ..... 2-44  
24  
25 2-9 Implementation Criteria for Experimental Treatments of Alternative D ..... 2-48  
26  
27 2-10 Flow Parameters for a Year with Low Summer Flows under Alternative D  
28 in an 8.23-maf Year ..... 2-65  
29  
30 2-11 Flow Parameters under Alternative E in an 8.23-maf Year ..... 2-70  
31  
32 2-12 Flow Parameters under Alternative F in an 8.23-maf Year ..... 2-79  
33  
34 2-13 Flow Parameters under Alternative G in an 8.23-maf Year ..... 2-80  
35  
36 2-14 Summary of Impacts of LTEMP Alternatives on Resources ..... 2-89  
37  
38 3.5-1 Native Fish of the Colorado River through Glen and Grand Canyons ..... 3-68  
39  
40 3.5-2 Nonnative Fish Found in Colorado River through Glen and Grand Canyons ..... 3-86  
41  
42 3.5-3 Mean Water Temperature and Turbidity for Selected Sites in the Colorado  
43 River Mainstem from 2006 to 2009 ..... 3-89  
44  
45 3.5-4 Nonnative Warmwater Fish Species Reported from the Little Colorado River  
46 Watershed ..... 3-96

**TABLES (Cont.)**

1  
2  
3  
4 3.6-1 Plant Communities Occurring on Reattachment Bars, Separation Bars, and  
5 Channel Margins .....3-107  
6  
7 3.6-2 Special Status Plant Species Known to Occur along the Colorado River from  
8 Glen Canyon Dam to Lake Mead .....3-116  
9  
10 3.7-1 Habitat and Distribution of Threatened, Endangered, and Sensitive Wildlife  
11 Species along the Colorado River Corridor between Glen Canyon Dam and  
12 Lake Mead .....3-127  
13  
14 3.10-1 Colorado River Discovery Commercial Rafting Passengers 2009–2013 .....3-169  
15  
16 3.10-2 Tolerable Daily Flow Fluctuations Reported by Commercial and Private  
17 Trip Leaders .....3-176  
18  
19 3.13-1 Energy and Capacity Characteristics of the Eight Largest Western  
20 Customers, 2013 .....3-199  
21  
22 3.14-1 Population in the Six-County Region .....3-202  
23  
24 3.14-2 Income in the Six-County Region .....3-203  
25  
26 3.14-3 Employment in the Six-County Region .....3-204  
27  
28 3.14-4 Employment by Sector in 2011 .....3-205  
29  
30 3.14-5 Unemployment Rates in the Six-County Region .....3-206  
31  
32 3.14-6 Minority and Low-Income Populations in the 11-County Area .....3-209  
33  
34 3.14-7 Population in the Seven-State Region of Influence .....3-213  
35  
36 3.14-8 Income in the Seven-State Region of Influence .....3-214  
37  
38 3.14-9 Employment in the Seven-State Region of Influence .....3-215  
39  
40 3.14-10 Employment by Sector in 2011 in the Seven-State Region of Influence .....3-216  
41  
42 3.14-11 Unemployment in the Seven-State Region of Influence .....3-217  
43  
44 3.14-12 State Minority and Low-Income Populations, 2010 .....3-218  
45  
46 3.15-1 Clean Air Act Prevention of Significant Deterioration Designations .....3-221

**TABLES (Cont.)**

1  
2  
3  
4 3.15-2 Criteria Pollutant and VOC Emissions in Counties Encompassing Grand  
5 Canyon National Park and for the Navajo Generating Station, 2011.....3-221  
6  
7 3.15-3 Criteria Pollutant and VOC Emissions for 2011, and GHG Emissions for 2010,  
8 over the 11-State Affected Area within the Western Interconnect.....3-226  
9  
10 4.1-1 Experimental Elements Included in Long-Term Strategies Associated with  
11 Each LTEMP Alternative ..... 4-4  
12  
13 4.2-1 Summary of the Impacts of LTEMP Alternatives on Hydrology and Water  
14 Quality ..... 4-13  
15  
16 4.2-2 Summary of Seasonal Temperature Data for LTEMP Alternatives from Lees  
17 Ferry to Diamond Creek..... 4-47  
18  
19 4.3-1 Summary of Impacts of LTEMP Alternatives on Sediment Resources ..... 4-69  
20  
21 4.4-1 Indicators Used To Examine Natural Processes under Each LTEMP Alternative ..... 4-86  
22  
23 4.4-2 Summary of Impacts of LTEMP Alternatives on Natural Processes Associated  
24 with Flow, Water Temperature, Water Quality, and Sediment Resources ..... 4-88  
25  
26 4.5-1 Summary of Impacts of LTEMP Alternatives on Aquatic Ecology.....4-103  
27  
28 4.5-2 Impact of High-Flow Experiments from Glen Canyon Dam on the Aquatic  
29 Food Base .....4-110  
30  
31 4.6-1 Vegetation States, Plant Associations, and Corresponding Submodels .....4-153  
32  
33 4.6-2 Vegetation States and Corresponding Mapped Vegetation Types .....4-156  
34  
35 4.6-3 Summary of Impacts on Old High-Water Zone, New High-Water Zone, and  
36 Wetland Plant Community Types .....4-158  
37  
38 4.6-4 Transitions between Riparian Community Types and the Flows That Initiate  
39 Transitions .....4-166  
40  
41 4.6-5 Priority Nonnative Species Identified for Control within the Colorado River  
42 Corridor .....4-171  
43  
44 4.6-6 Summary of Impacts on Special Status Plant Species under LTEMP  
45 Alternatives.....4-174  
46

**TABLES (Cont.)**

1  
2  
3  
4 4.7-1 Summary of Impacts of LTEMP Alternatives on Wildlife .....4-189  
5  
6 4.7-2 Summary of Impacts of LTEMP Alternatives on Special Status Wildlife  
7 Species .....4-199  
8  
9 4.8-1 Summary of Impacts of LTEMP Alternatives on Cultural Resources in Glen  
10 and Grand Canyons .....4-221  
11  
12 4.9-1 Vegetation Community Diversity and Change in Tamarisk Cover.....4-233  
13  
14 4.9-2 Summary of Impacts on Tribal Resources .....4-243  
15  
16 4.10-1 Summary of Impacts of LTEMP Alternatives on Visitor Use and Experience .....4-259  
17  
18 4.11-1 Summary of Impacts of LTEMP Alternatives on Wilderness Experience.....4-283  
19  
20 4.13-1 Summary of the Impacts of LTEMP Alternatives on Hydropower Resources .....4-307  
21  
22 4.14-1 Summary of Impacts of LTEMP Alternative on Socioeconomics and  
23 Environmental Justice .....4-328  
24  
25 4.14-2 Mean Annual Net Economic Value of Recreation Associated with LTEMP  
26 Alternatives.....4-336  
27  
28 4.14-3 Recreational Visitation by Activity in Lake Powell, Upper and Lower Grand  
29 Canyon, and Lake Mead, 2012.....4-339  
30  
31 4.14-4 Mean Annual Employment Associated with Recreational Expenditures  
32 under LTEMP Alternatives .....4-339  
33  
34 4.14-5 Mean Annual Income Associated with Recreational Expenditures  
35 under LTEMP Alternatives .....4-340  
36  
37 4.14-6 Seven-State Economic Impacts under LTEMP Alternatives of Additional  
38 Generating Capacity for the Eight Largest Customer Utilities, 2015–2033 .....4-341  
39  
40 4.14-7 Average Annual Impacts on Economic Activity from Changes to Residential  
41 Electricity Bills of Largest Eight Customer Utilities, 2015–2033, Relative to  
42 Alternative A .....4-342  
43  
44 4.14-8 Financial Impacts on Tribal and Non-Tribal Electricity Customers .....4-347  
45  
46

**TABLES (Cont.)**

1  
2  
3  
4 4.15-1 Summary of Impacts of LTEMP Alternatives on Visibility and Regional Air  
5 Quality .....4-361  
6  
7 4.15-2 Distributions of SO<sub>2</sub> and NO<sub>x</sub> Emissions Averaged over the 20-Year LTEMP  
8 Period by Alternative.....4-364  
9  
10 4.16-1 Summary of Impacts of LTEMP Alternatives on GHG Emissions .....4-373  
11  
12 4.16-2 Expected Impact of LTEMP Alternatives on Downstream Resources under  
13 Climate Change Compared to Those under Historic Conditions .....4-378  
14  
15 4.17-1 Impacting Factors Associated with Past, Present, and Reasonably Foreseeable  
16 Future Actions and Basin-Wide Trends in the LTEMP Project Area .....4-383  
17  
18 4.17-2 Summary of Cumulative Impacts and Incremental Contributions from LTEMP  
19 Alternatives.....4-399  
20  
21 5.1-1 Summary of Cooperating Agency Involvement..... 5-3  
22  
23 B-1 Tolerable Flow Fluctuations for Recreational River Use..... B-13  
24  
25 D-1 Initial Reservoir Conditions ..... D-5  
26  
27 D-2 Monthly Release Volumes by Water Year Release for Alternative A ..... D-11  
28  
29 D-3 Monthly Release Volumes by Water Year Release for Alternative B ..... D-12  
30  
31 D-4 Monthly Release Volumes by Water Year Release for Alternative C ..... D-13  
32  
33 D-5 Monthly Release Volumes by Water Year Release for Alternative C with Low  
34 Summer Flows..... D-14  
35  
36 D-6 Monthly Release Volumes by Water Year Release for Alternative D ..... D-15  
37  
38 D-7 Monthly Release Volumes by Water Year Release for Alternative D with Low  
39 Summer Flows..... D-16  
40  
41 D-8 Monthly Release Volumes by Water Year Release for Alternative E ..... D-17  
42  
43 D-9 Monthly Release Volumes by Water Year Release for Alternative E with Low  
44 Summer Flows..... D-18  
45  
46 D-10 Monthly Release Volumes by Water Year Release for Alternative F..... D-19

**TABLES (Cont.)**

1  
2  
3  
4 D-11 Monthly Release Volumes by Water Year Release for Alternative G..... D-20  
5  
6 D-12 Minimum Release Constraints Used for Each Alternative..... D-21  
7  
8 D-13 Input Demands, by State..... D-27  
9  
10 E-1 Sources for Historical Tributary Sediment Load Data ..... E-38  
11  
12 E-2 Historical Periods Used for Paria Sediment Traces s1, s2, and s3 ..... E-38  
13  
14 E-3 Historical Periods Used for Little Colorado River Sediment Traces s1,  
15 s2, and s3 ..... E-38  
16  
17 E-4 List of HFEs Available for Sediment-Triggered Events ..... E-39  
18  
19 F-1 Average Mean Habitat-Weighted Invertebrate Biomass at Select Sites in the  
20 Colorado River, July 2006–June 2009 ..... F-8  
21  
22 F-2 Average Mean Habitat-Weighted Invertebrate Production at Select Sites in the  
23 Colorado River, July 2006–June 2009 ..... F-9  
24  
25 F-3 Average Mean Habitat-Weighted Invertebrate Abundance at Select Sites in the  
26 Colorado River, July 2006–June 2009 ..... F-10  
27  
28 F-4 Distribution, Ecological Importance, and Favorable Temperature Range for  
29 Select Primary Producers ..... F-11  
30  
31 F-5 Temperature Requirements for Common Zooplankton ..... F-24  
32  
33 F-6 Distribution, Importance to Higher Trophic Levels, and Temperature Range for  
34 Common Benthic Macroinvertebrates Downstream of Glen Canyon Dam..... F-25  
35  
36 F-7 Temperature Requirements for the Asian Tapeworm, Anchor Worm, and Trout  
37 Nematode..... F-26  
38  
39 F-8 Summary of Metrics Values from the Rainbow Trout-Humpback Chub Model..... F-53  
40  
41 F-9 Description of Input Parameters for the LTEMP Temperature Suitability Model..... F-66  
42  
43 F-10 Humpback Chub Aggregation Locations ..... F-67  
44  
45 F-11 Locations Used for Temperature Suitability Modeling of Native Fish,  
46 Nonnative Fish, and Parasites..... F-73



**TABLES (Cont.)**

1  
2  
3  
4 G-1 Vegetation States, Plant Associations, and Corresponding Submodels ..... G-15  
5  
6 G-2 Hydrologic Events Considered in the Riparian Vegetation Model ..... G-16  
7  
8 G-3 Riparian Vegetation Model Transition Rules ..... G-17  
9  
10 G-4 New High-Water Zone and Old High-Water Zone Vegetation Classes Mapped  
11 from Lees Ferry to Diamond Creek ..... G-22  
12  
13 G-5 Vegetation States and Corresponding Mapped Vegetation Types ..... G-24  
14  
15 G-6 Example Results for the Native Cover Metric ..... G-25  
16  
17 G-7 Example Results for the Arrowweed Metric ..... G-25  
18  
19 G-8 Results for Alternative A ..... G-26  
20  
21 G-9 Results for Alternative B, Long-Term Strategy B1 ..... G-27  
22  
23 G-10 Results for Alternative B, Long-Term Strategy B2 ..... G-28  
24  
25 G-11 Results for Alternative C, Long-Term Strategy C1 ..... G-29  
26  
27 G-12 Results for Alternative C, Long-Term Strategy C2 ..... G-30  
28  
29 G-13 Results for Alternative C, Long-Term Strategy C3 ..... G-31  
30  
31 G-14 Results for Alternative C, Long-Term Strategy C4 ..... G-32  
32  
33 G-15 Results for Alternative D, Long-Term Strategy D1 ..... G-33  
34  
35 G-16 Results for Alternative D, Long-Term Strategy D2 ..... G-34  
36  
37 G-17 Results for Alternative D, Long-Term Strategy D3 ..... G-35  
38  
39 G-18 Results for Alternative D, Long-Term Strategy D4 ..... G-36  
40  
41 G-19 Results for Alternative E, Long-Term Strategy E1 ..... G-37  
42  
43 G-20 Results for Alternative E, Long-Term Strategy E2 ..... G-38  
44  
45 G-21 Results for Alternative E, Long-Term Strategy E3 ..... G-39  
46

**TABLES (Cont.)**

1  
2  
3  
4 G-22 Results for Alternative E, Long-Term Strategy E4..... G-40  
5  
6 G-23 Results for Alternative E, Long-Term Strategy E5..... G-41  
7  
8 G-24 Results for Alternative E, Long-Term Strategy E6..... G-42  
9  
10 G-25 Results for Alternative F..... G-43  
11  
12 G-26 Results for Alternative G..... G-44  
13  
14 I-1 Federal Regulations and Executive Orders Pertaining to Consultation with  
15 Tribes..... I-3  
16  
17 I-2 Vegetation States..... I-5  
18  
19 J-1 Reported Mean Tolerable Daily Changes in Flow Levels for Commercial  
20 Motor Guides, Commercial Oar Guides, and Private Trip Leaders..... J-12  
21  
22 J-2 Recreation Response to Daily Maximum Flow..... J-20  
23  
24 J-3 Summary of Recreation, Visitor Use, and Experience Metrics..... J-25  
25  
26 K.1-1 Cost and Performance Characteristics of Capacity Expansion Candidates..... K-51  
27  
28 K.1-2 Cumulative Annual Percent Increase in Natural Gas Prices at the Henry Hub..... K-54  
29  
30 K.1-3 Cumulative Annual Percent Increase in Regional Coal Prices..... K-57  
31  
32 K.1-4 Cumulative Annual Percent Increase in Regional Distillate Fuel Prices..... K-59  
33  
34 K.1-5 Assumed Ancillary Services Provided by SLCA/IP Hydropower Facilities from  
35 2013 to 2030..... K-64  
36  
37 K.1-6 Summary of Utility IRPS for Four Large SLCA/IP Customers and Other Large  
38 Utilities in Areas Neighboring the SLCA/IP System..... K-86  
39  
40 K.1-7 SLCA/IP Marketable Capacity at the 90% Exceedance Level..... K-101  
41  
42 K.1-8 Difference in Cumulative Capacity Additions of Each Alternative Relative to  
43 Alternative A..... K-104  
44  
45 K.1-9 Comparison of the Amount and Timing of New Capacity Additions for  
46 Alternatives A and F..... K-106

**TABLES (Cont.)**

1  
2  
3  
4 K.1-10 Total Economic Impacts by Alternative at the 90% Exceedance Level .....K-108  
5  
6 K.1-11 Estimated Cost of LTEMP Experiments .....K-115  
7  
8 K.1-12 Comparison of Marketable Capacity, Replacement Capacity, and Capacity  
9 Additions by Exceedance Level .....K-116  
10  
11 K.1-13 Firm SLCA/IP Federal Hydropower Capacity at Various Exceedance Levels at  
12 Glen Canyon Dam by Alternative and Ancillary Service Scenarios.....K-125  
13  
14 K.1-14 Comparison of Capacity and Energy Values at Glen Canyon Dam by  
15 Alternative and Ancillary Services Scenarios at the 90% Exceedance Level.....K-126  
16  
17 K.1-15 Difference Relative to Alternative A.....K-127  
18  
19 K.1-16 Summary of Economic Rankings for Baseline and All Sensitivity Scenarios .....K-128  
20  
21 K.2-1 SHP Contractual Obligations and Project Use Required Deliveries by Month .....K-132  
22  
23 K.2-2 SHP Hourly Load Shapes by Month and Type of Day .....K-133  
24  
25 K.2-3 Total Levelized Capital and Fixed O&M Cost for System Capacity Expansion  
26 by Alternative and Year.....K-137  
27  
28 K.2-4 Total Levelized Capital and Fixed O&M Cost for System Capacity Expansion  
29 by Alternative and Year Expressed as the Difference from Alternative A .....K-139  
30  
31 K.2-5 Total Net Purchase Power Expenses by Year and Alternative for the  
32 Continuous Current Obligations Scenario .....K-143  
33  
34 K.2-6 Total Net Purchase Power Expenses by Year and Alternative for the Reduced  
35 Obligations to Match Resource Scenario .....K-144  
36  
37 K.2-7 SLCA/IP Rate Impact by Alternative.....K-147  
38  
39 K.3-1 Energy Allocations for Systems Receiving Indirect SLCA/IP Allocations .....K-153  
40  
41 K.3-2 Coverage of Retail Information from EIA Database Relative to SLCA/IP  
42 Preference Power Allocation.....K-154  
43  
44 K.3-3 Average Annual Grid Cost Relative to SLCA/IP Wholesale Revenues Relative  
45 to Alternative A .....K-164  
46

**TABLES (Cont.)**

1  
2  
3  
4 K.3-4 Summary Table of Comparative Values .....K-174  
5  
6 K.3-5 Individual Systems with the Largest Percent Retail Rate Impacts Relative to  
7 Alternative A .....K-175  
8  
9 K.3-6 Individual Systems with the Smallest Percent Retail Rate Impacts Relative to  
10 Alternative A .....K-177  
11  
12 K.3-7 Individual Systems with the Largest Monthly Residential Bill Impacts Relative  
13 to Alternative A .....K-179  
14  
15 K.3-8 Individual Systems with the Smallest Monthly Residential Bill Impacts  
16 Relative to Alternative A.....K-180  
17  
18 K.3-9 Size and Preference Ratio for Utility Systems with Large Rate Impacts.....K-181  
19  
20 K.3-10 Rate Impacts for Selected Groups in Maximum Impact Year .....K-182  
21  
22 K.4-1 Monthly Change in Residential Electric Utility Bill for Tribes by Alternative .....K-192  
23  
24 K.4-2 Total Dollar Annual Impact on Tribes under LTEMP Alternatives Relative to  
25 Alternative A .....K-194  
26  
27 L-1 Total Regional Economic Impacts of Non-Local Recreation Expenditures, 2013 ..... L-12  
28  
29 L-2 Urban Population, Income, and Poverty in the Six-County Region..... L-17  
30  
31 M-1 Emission Factors by Plant for System Power Generation and Spot Market .....M-10  
32  
33 M-2 Power Generation Averaged over the 20-Year LTEMP Period by Alternative .....M-12  
34  
35 M-3 Summary of Potential Impacts of LTEMP Alternatives on Visibility and  
36 Regional Air Quality .....M-15  
37  
38 M-4 Annual SO<sub>2</sub> Emissions Averaged over the 20-Year LTEMP Period by  
39 Alternative .....M-16  
40  
41 M-5 Annual NO<sub>x</sub> Emissions Averaged over the 20-Year LTEMP Period by  
42 Alternative .....M-19  
43  
44 M-6 Distributions of SO<sub>2</sub> and NO<sub>x</sub> Emissions Averaged over the 20-Year LTEMP  
45 Period by Alternative.....M-22  
46

**TABLES (Cont.)**

1  
2  
3  
4 M-7 Annual Greenhouse Gas Emissions Averaged over the 20-Year LTEMP Period  
5 by Alternative .....M-23  
6  
7 M-8 Summary of Potential Impacts of LTEMP Alternatives on CO<sub>2</sub>e Emissions .....M-26  
8  
9 N-1 Summary of Tribal Participation Status ..... N-5  
10  
11 N-2 Summary of Tribal Correspondence ..... N-6  
12  
13 N-3 Summary of Major Face-to-Face Meetings, Webinars, and Conference Calls  
14 Involving Tribes ..... N-25  
15  
16 N-4 Summary of Individual Tribal Consultation Meetings to Date ..... N-26  
17  
18 N-5 Index of Project Tribal Government Consultation and Coordination  
19 Correspondence ..... N-28  
20

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2  
3  
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## ACRONYMS AND ABBREVIATIONS

1		
2		
3		
4	ac	acre(s)
5	ac-ft	acre-foot (feet)
6	ACHP	Advisory Council on Historic Preservation
7	AML	abandoned mine land
8	AMSL	above mean sea level
9	AMWG	Adaptive Management Work Group
10	AOP	Annual Operation Plan for Colorado River Reservoirs
11	APE	Area of Potential Effect
12	Argonne	Argonne National Laboratory
13	ASMR	Age-Structured Mark Recapture Model
14	AZGFD	Arizona Game and Fish Department
15	AZ-SGCN	Arizona Species of Greatest Conservation Need
16		
17	BA	Balancing Authority (in Chapter 3 only)
18		Biological Assessment (in all other sections)
19	BGEPA	Bald and Golden Eagle Protection Act of 1940
20	BIA	Bureau of Indian Affairs
21	BO	Biological Opinion
22		
23	C	Celsius
24	CAA	Clean Air Act
25	CAAA	Clean Air Act Amendments
26	CAEDYM	Computational Aquatic Ecosystem Dynamics Model
27	CCC	Civilian Conservation Corps
28	CEQ	Council on Environmental Quality
29	CFMP	<i>Comprehensive Fisheries Management Plan</i>
30	CFR	<i>Code of Federal Regulations</i>
31	cfs	cubic feet per second
32	CH <sub>4</sub>	methane
33	CO	carbon monoxide
34	CO <sub>2</sub>	carbon dioxide
35	CO <sub>2</sub> e	carbon dioxide equivalent
36	CPUE	catch per unit effort
37	CRBC	Colorado River Board of California
38	CRCN	Colorado River Commission of Nevada
39	CRD	Colorado River Discovery
40	CREDA	Colorado River Energy Distributors Association
41	CRMP	Colorado River Management Plan
42	CRSP	Colorado River Storage Project
43	CRSPA	Colorado River Storage Project Act of 1956
44	CRSS	Colorado River Simulation System
45	CSU	Colorado Springs Utilities
46		

1	DEIS	Draft Environmental Impact Statement
2	Deseret	Deseret Generation and Transmission Cooperative
3	DFC	desired future condition
4	DO	dissolved oxygen
5	DOE	U.S. Department of Energy
6	DOI	U.S. Department of the Interior
7	DPS	Distinct Population Segment
8		
9	EA	Environmental Assessment
10	eGRID	Emissions & Generation Resource Integrated Database
11	EIA	Energy Information Administration
12	EIR	Environmental Impact Report
13	EIS	Environmental Impact Statement
14	ELCOM	Estuary, Lake and Coastal Ocean Model
15	EMS	emergency medical services
16	E.O.	Executive Order
17	EPA	U.S. Environmental Protection Agency
18	EPT	Ephemeroptera, Plecoptera, and Trichoptera
19	ESA	Endangered Species Act of 1973, as amended
20		
21	F	Fahrenheit
22	FCPP	Four Corners Power Plant
23	FES	Firm Electric Service
24	FONSI	Finding of No Significant Impact
25	FR	<i>Federal Register</i>
26	ft	foot (feet)
27	FWS	U.S. Fish and Wildlife Service
28	FY	fiscal year
29		
30	GCDAMP	Glen Canyon Dam Adaptive Management Program
31	GCM	general circulation model
32	GCMRC	Grand Canyon Monitoring and Research Center
33	GCNP	Grand Canyon National Park
34	GCNRA	Glen Canyon National Recreation Area
35	GCPA	Grand Canyon Protection Act of 1992
36	GHG	greenhouse gas
37	GMP	General Management Plan
38	GW	gigawatt(s)
39	GWh	gigawatt-hour(s)
40	GWP	global warming potential
41		
42	H <sub>2</sub> S	hydrogen sulfide
43	HBC	humpback chub
44	HFC	hydrofluorocarbon
45	HFE	high-flow experiment
46	hr	hour(s)



1	HRR	Hualapai River Runners
2		
3	in.	inch(es)
4	IPM	Integrated Pest Management
5	IRP	integrated resource plan
6	ISM	Indexed Sequential Method
7		
8	kaf	thousand acre-feet
9	kWh	kilowatt-hour(s)
10		
11	lb	pound(s)
12	LCRMSCP	Lower Colorado River Multi-Species Conservation Program
13	LMM	Lake Mead Model
14	LMNRA	Lake Mead National Recreation Area
15	LROC	Long-Range Operating Criteria
16	LTEMP	Long-Term Experimental and Management Plan
17	LTEP	Long Term Experimental Plan
18	LTF	long-term firm
19		
20	maf	million acre-feet
21	MAMB	miscellaneous algae, macrophytes, and bryophytes
22	MBTA	Migratory Bird Treaty Act
23	MCL	maximum contaminant level
24	mi	mile(s)
25	MLFF	Modified Low Fluctuating Flow
26	MMt	million metric tons
27	MOA	Memorandum of Agreement
28	MT	metric ton(s)
29	MW	megawatt(s)
30	MWh	megawatt-hour(s)
31		
32	N <sub>2</sub> O	nitrous oxide
33	NAAQS	National Ambient Air Quality Standards
34	NAU	Northern Arizona University
35	NC	no change
36	NEPA	National Environmental Policy Act of 1969, as amended
37	NERC	North American Electric Reliability Corporation
38	NEV	net economic use value
39	NGO	nongovernmental organization
40	NHPA	National Historic Preservation Act
41	NM	national monument
42	NO <sub>2</sub>	nitrogen dioxide
43	NO <sub>3</sub>	nitrate-nitrogen
44	NOI	Notice of Intent
45	NO <sub>x</sub>	nitrogen oxides
46	NPS	National Park Service

1	NPV	net present value
2	NRHP	<i>National Register of Historic Places</i>
3	NTUA	Navajo Tribal Unit Authority
4		
5	O&M	operation and maintenance
6	O <sub>3</sub>	ozone
7	OPAC	Office of Planning and Compliance
8	OSMRE	Office of Surface Mining Reclamation and Enforcement
9		
10	PA	Programmatic Agreement
11	Pb	lead
12	PEPC	Planning, Environment, and Public Comment
13	PFC	perfluorocarbon
14	P.L.	Public Law
15	PM	particulate matter
16	PM <sub>2.5</sub>	particulate matter ≤2.5 μm in aerodynamic diameter
17	PM <sub>10</sub>	particulate matter ≤10 μm in aerodynamic diameter
18	POM	particulate organic matter
19	PSAR	preventative search and rescue
20	PSD	Prevention of Significant Deterioration
21		
22	RA	resource available
23	Reclamation	Bureau of Reclamation
24	RM	river mile
25	RMP	Resource Management Plan
26	ROD	Record of Decision
27	RSG	Reserve Sharing Group
28		
29	SAAQS	State Ambient Air Quality Standards
30	SBM	Sand Budget Model
31	SCP	Salinity Control Project
32	SD	standard deviation
33	SDA	Structured Design Analysis
34	SE	standard error
35	Secretary, the	Secretary of the Interior
36	SF <sub>6</sub>	sulfur hexafluoride
37	SHPO	State Historic Preservation Officer
38	SLCA/IP	Salt Lake City Area Integrated Projects
39	SO	Secretarial Order
40	SO <sub>2</sub>	sulfur dioxide
41	SPC	Southern Paiute Consortium
42	SRP	Salt River Project
43	SRSG	Southwest Reserve Sharing Group
44		
45	TCD	temperature control device
46	TCP	traditional cultural property

1	TDS	total dissolved solids
2	THPO	Tribal Historic Preservation Officer
3	TL	total length
4	TMF	trout management flow
5	Tri-State	Tri-State Generation and Transmission Association
6	TWG	Technical Working Group
7		
8	UAMPS	Utah Associated Municipal Power Systems
9	UBWR	Utah Board of Water Resources
10	UCRC	Upper Colorado River Commission
11	UMPA	Utah Municipal Power Agency
12	USC	<i>United States Code</i>
13	USFS	U.S. Forest Service
14	USGS	U.S. Geological Survey
15		
16	VOC	volatile organic compound
17		
18	WACM	Western Area Colorado-Missouri Region
19	WALC	Western Area Lower Colorado Region
20	WAUW	Western Area Upper Great Plains West Region
21	WECC	Western Electricity Coordinating Council
22	Western	Western Area Power Administration
23		
24	YOY	young-of-year
25	yr	year(s)
26		
27	ZHHPO	Zuni Heritage and Historic Preservation Office
28		

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# Glen Canyon Dam

Long-Term Experimental and Management Plan  
Environmental Impact Statement



## PUBLIC DRAFT

### Volume 2—Appendices

U.S. Department of the Interior  
Bureau of Reclamation,  
Upper Colorado Region  
National Park Service,  
Intermountain Region

December 2015



**Cover photo credits:**

Title bar: Grand Canyon National Park

Grand Canyon: Grand Canyon National Park

Glen Canyon Dam: T.R. Reeve

High-flow experimental release: T.R. Reeve

Fisherman: T. Gunn

Humpback chub: Arizona Game and Fish Department

Rafters: Grand Canyon National Park

1     **GLEN CANYON DAM LONG-TERM EXPERIMENTAL AND MANAGEMENT PLAN**  
2                     **DRAFT ENVIRONMENTAL IMPACT STATEMENT**

3  
4  
5     **Joint-Lead Agencies**

6     Bureau of Reclamation  
7     National Park Service

8  
9     **Cooperating Agencies**

Department of the Interior	Havasupai Tribe
Bureau of Indian Affairs	Hopi Tribe
U.S. Fish and Wildlife Service	Hualapai Tribe
U.S. Department of Energy	Kaibab Band of Paiute Indians
Western Area Power Administration	Navajo Nation
Arizona Game and Fish Department	Pueblo of Zuni
Colorado River Board of California	Salt River Project
Colorado River Commission of Nevada	Utah Associated Municipal Power Systems
Upper Colorado River Commission	

10  
11  
12                     **ABSTRACT**

13  
14  
15             The U.S. Department of the Interior (DOI), through the Bureau of Reclamation and  
16 National Park Service (NPS), proposes to develop and implement a Long-Term Experimental  
17 and Management Plan (LTEMP) for operations of Glen Canyon Dam. The LTEMP would  
18 provide a framework for adaptively managing Glen Canyon Dam operations over the next  
19 20 years, consistent with the Grand Canyon Protection Act of 1992 (GCPA) and other provisions  
20 of applicable federal law. The LTEMP would determine specific options for dam operations,  
21 non-flow actions, and appropriate experimental and management actions that will meet the  
22 GCPA's requirements and minimize impacts on resources within the area impacted by dam  
23 operations, including those of importance to American Indian Tribes.

24  
25             The Draft Environmental Impact Statement (DEIS) draws on the scientific information  
26 that has been collected under the Glen Canyon Dam Adaptive Management Program over the  
27 last 20 years to identify the potential environmental effects associated with taking no action, as  
28 well as a reasonable range of alternatives to no action for implementing the proposed federal  
29 action. The alternatives addressed in this DEIS include a broad range of operations and actions  
30 that would meet the purpose, need, and objectives of the proposed federal action. The primary  
31 resources that could be affected by the proposed action include sediment resources, aquatic and  
32 terrestrial ecological resources, recreational resources, socioeconomic resources, hydropower  
33 resources, resources of importance to American Indian Tribes, and historic and cultural resources  
34 in the vicinity of the Glen and Grand Canyons. The DEIS has been developed in accordance with  
35 the National Environmental Policy Act of 1969, as amended (NEPA), and follows the  
36 implementing regulations developed by the President's Council on Environmental Quality in  
37 Title 40 *Code of Federal Regulations* (CFR) Parts 1500 to 1508 and DOI regulations

1 implementing NEPA in 43 CFR Part 46. Based on the impact analyses conducted, DOI has  
2 chosen Alternative D as the preferred alternative.

3  
4 The review period for this DEIS will end 90 days after publication of the  
5 U.S. Environmental Protection Agency Notice of Availability in the *Federal Register*. During  
6 the 90-day comment period, comments will be accepted electronically through the NPS  
7 Planning, Environment, and Public Comment website (<http://parkplanning.nps.gov/LTEMPEIS>)  
8 and in hard copy delivered by the U.S. Postal Service or other mail delivery service. Written  
9 comments will also be accepted during public meetings on the DEIS. Comments will not be  
10 accepted by fax, by e-mail, or in any format other than those specified above. Bulk comments in  
11 any format (hard copy or electronic) submitted on behalf of others will also not be accepted.

12  
13 For additional information, visit <http://ltempeis.anl.gov> or contact:

14  
15 Glen Canyon Dam LTEMP Draft EIS  
16 Argonne National Laboratory  
17 9700 S. Cass Avenue—EVS/240  
18 Argonne, IL 60439  
19 Phone: 630-252-3169  
20  
22



**CONTENTS**

1  
2  
3  
4 ABSTRACT ..... iii  
5  
6 ACRONYMS AND ABBREVIATIONS ..... lxiii  
7  
8 1 INTRODUCTION ..... 1-1  
9  
10 1.1 Description of the Proposed Action ..... 1-4  
11 1.2 Purpose of and Need for Action ..... 1-5  
12 1.3 Lead and Cooperating Agencies and Consulting Tribes ..... 1-9  
13 1.3.1 Lead Agencies ..... 1-9  
14 1.3.2 Cooperating Agencies and Consulting Tribes ..... 1-9  
15 1.4 Objectives and Resource Goals of the LTEMP ..... 1-10  
16 1.5 Scope of the DEIS ..... 1-12  
17 1.5.1 Affected Region and Resources ..... 1-13  
18 1.5.2 Impact Topics Selected for Detailed Analysis ..... 1-14  
19 1.5.3 Impact Topics Dismissed from Detailed Analysis ..... 1-15  
20 1.6 Role of Adaptive Management ..... 1-16  
21 1.6.1 History of the Existing Adaptive Management Program ..... 1-16  
22 1.6.2 Relationship of Adaptive Management to NEPA and Changes  
23 to Operations ..... 1-17  
24 1.7 Role of Decision Analysis in the DEIS Process ..... 1-17  
25 1.8 History, Location, and Setting ..... 1-18  
26 1.8.1 History and Purpose of Glen Canyon Dam ..... 1-18  
27 1.8.2 Location of Glen Canyon Dam and LTEMP Affected Area ..... 1-19  
28 1.8.3 Operation of the Glen Canyon Dam ..... 1-20  
29 1.8.4 History, Purpose, and Significance of the National Park System  
30 Units ..... 1-22  
31 1.8.4.1 Grand Canyon National Park ..... 1-22  
32 1.8.4.2 Glen Canyon National Recreation Area ..... 1-24  
33 1.8.4.3 Lake Mead National Recreation Area ..... 1-24  
34 1.8.5 Tribal Lands ..... 1-25  
35 1.8.5.1 Navajo Nation ..... 1-26  
36 1.8.5.2 Hualapai ..... 1-26  
37 1.8.5.3 Havasupai ..... 1-26  
38 1.8.5.4 Southern Paiute Tribes ..... 1-27  
39 1.8.5.5 Hopi ..... 1-28  
40 1.8.5.6 Pueblo of Zuni ..... 1-28  
41 1.8.5.7 Fort Mojave ..... 1-29  
42 1.9 Laws and Regulations Related to Operations of Glen Canyon Dam and  
43 Park Management ..... 1-29  
44 1.9.1 Environmental Laws and Executive Orders ..... 1-29  
45 1.9.2 Cultural/Historical Laws and Executive Orders ..... 1-30  
46

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 1.9.3 American Indian and Tribal Consultation Laws and Executive  
 5 Orders..... 1-30  
 6 1.9.4 Law of the River ..... 1-31  
 7 1.10 Related Actions ..... 1-31  
 8 1.10.1 Biological Opinions ..... 1-31  
 9 1.10.2 Environmental Impact Statements and Related Documents..... 1-31  
 10 1.10.3 Environmental Assessments and Related Documents ..... 1-35  
 11 1.10.4 Other Actions, Programs, Plans, and Projects ..... 1-35  
 12  
 13 2 DESCRIPTION OF ALTERNATIVES ..... 2-1  
 14  
 15 2.1 Development of Alternatives..... 2-2  
 16 2.2 Descriptions of Alternatives Considered in Detail..... 2-4  
 17 2.2.1 Alternative A (No Action Alternative) ..... 2-8  
 18 2.2.2 Alternative B..... 2-19  
 19 2.2.3 Alternative C..... 2-22  
 20 2.2.3.1 Base Operations under Alternative C ..... 2-24  
 21 2.2.3.2 Experimental Framework for Alternative C..... 2-26  
 22 2.2.4 Alternative D (Preferred Alternative) ..... 2-42  
 23 2.2.4.1 Base Operations under Alternative D..... 2-42  
 24 2.2.4.2 Operational Flexibility under Alternative D ..... 2-43  
 25 2.2.4.3 Experimental Framework for Alternative D ..... 2-46  
 26 2.2.5 Alternative E..... 2-69  
 27 2.2.5.1 Base Operations under Alternative E ..... 2-69  
 28 2.2.5.2 Experimental Framework for Alternative E..... 2-72  
 29 2.2.6 Alternative F ..... 2-77  
 30 2.2.7 Alternative G..... 2-78  
 31 2.3 Alternatives Considered and Eliminated from Detailed Study ..... 2-81  
 32 2.3.1 Modified Low Fluctuating Flows with Extended Protocols ..... 2-81  
 33 2.3.2 Naturally Patterned Flow Alternative ..... 2-82  
 34 2.3.3 Seasonal Fluctuations with Low Summer Flow Alternative ..... 2-82  
 35 2.3.4 Grand Canyon First! Alternative ..... 2-83  
 36 2.3.5 Species Community and Habitat-Based Alternative..... 2-83  
 37 2.3.6 Stewardship Alternative..... 2-83  
 38 2.3.7 Twelve-Year Experiment of Two Steady-Flow Alternatives ..... 2-84  
 39 2.3.8 Decommission Glen Canyon Dam Alternative..... 2-84  
 40 2.3.9 Fill Lake Mead First Alternative..... 2-85  
 41 2.3.10 Full-Powerplant Capacity Operations Alternative..... 2-85  
 42 2.3.11 Run-of-the-River Alternative..... 2-85  
 43 2.4 Alternative Elements Eliminated from Detailed Study ..... 2-86  
 44 2.4.1 New Infrastructure ..... 2-86  
 45 2.4.2 Flow and Non-Flow Actions..... 2-87  
 46 2.5 Summary Comparison of Alternatives ..... 2-88

**CONTENTS (Cont.)**

1			
2			
3			
4	3	AFFECTED ENVIRONMENT .....	3-1
5			
6	3.1	Project Area .....	3-1
7	3.1.1	Geologic Setting.....	3-1
8	3.1.2	Climatic Setting .....	3-3
9	3.1.3	Colorado River Ecosystem Resource Linkages.....	3-3
10	3.1.3.1	Water Release Characteristics .....	3-4
11	3.2	Water Resources.....	3-5
12	3.2.1	Hydrology .....	3-5
13	3.2.1.1	Lake Powell Hydrology.....	3-6
14	3.2.1.2	Hydrology of the Colorado River Downstream of Glen	
15		Canyon Dam.....	3-9
16	3.2.1.3	Lake Mead Hydrology.....	3-11
17	3.2.1.4	Seeps and Springs.....	3-12
18	3.2.2	Water Quality.....	3-14
19	3.2.2.1	Lake Powell Water Quality .....	3-14
20	3.2.2.2	Colorado River Water Quality .....	3-16
21	3.2.2.3	Lake Mead Water Quality .....	3-24
22	3.2.3	Tribal Perspectives on Water Resources.....	3-27
23	3.2.4	Hydrology and Climate Change.....	3-28
24	3.2.4.1	Basis for Runoff Estimates.....	3-29
25	3.2.4.2	Water Variability and Availability .....	3-29
26	3.2.4.3	Seasonal Timing Shifts.....	3-31
27	3.2.4.4	Water Quality .....	3-31
28	3.3	Sediment Resources .....	3-32
29	3.3.1	Background: Geomorphology of the Colorado River.....	3-32
30	3.3.1.1	Geomorphic Features of the Colorado River .....	3-33
31	3.3.1.2	Glen Canyon Geomorphology.....	3-36
32	3.3.1.3	Marble and Grand Canyon Geomorphology .....	3-37
33	3.3.2	Sediment Characteristics and Transport Mechanisms .....	3-39
34	3.3.2.1	Sediment Sources .....	3-43
35	3.3.2.2	Sediment Transport and Storage .....	3-46
36	3.3.2.3	Lake Deltas.....	3-52
37	3.4	Natural Processes .....	3-54
38	3.5	Aquatic Ecology.....	3-55
39	3.5.1	Aquatic Food Base.....	3-56
40	3.5.1.1	Periphyton and Rooted Aquatic Plants.....	3-57
41	3.5.1.2	Plankton.....	3-59
42	3.5.1.3	Macroinvertebrates.....	3-59
43	3.5.1.4	Nonnative Invasive Species.....	3-61
44	3.5.1.5	Food Web Dynamics .....	3-65
45	3.5.2	Native Fish.....	3-65
46	3.5.2.1	Special Status Fish Species .....	3-67

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 3.5.2.2 Other Native Species ..... 3-81  
 5 3.5.3 Nonnative Fish ..... 3-85  
 6 3.5.3.1 Coldwater Nonnative Species ..... 3-89  
 7 3.5.3.2 Warmwater Nonnative Species ..... 3-95  
 8 3.5.3.3 Interactions with Native Species ..... 3-97  
 9 3.5.3.4 Nonnative Fish Control Activities and Effects of Flow  
 10 Conditions ..... 3-99  
 11 3.6 Vegetation ..... 3-104  
 12 3.6.1 Historic and Remnant Riparian Plant Communities ..... 3-104  
 13 3.6.2 Existing Riparian Vegetation Downstream from Glen Canyon Dam ..... 3-106  
 14 3.6.2.1 Tribal Perspectives on Vegetation ..... 3-114  
 15 3.6.3 Special Status Plant Species ..... 3-115  
 16 3.7 Wildlife ..... 3-115  
 17 3.7.1 Invertebrates ..... 3-118  
 18 3.7.2 Amphibians and Reptiles ..... 3-120  
 19 3.7.3 Birds ..... 3-121  
 20 3.7.4 Mammals ..... 3-122  
 21 3.7.4.1 Tribal Perspectives on Wildlife Species ..... 3-125  
 22 3.7.5 Special Status Wildlife Species ..... 3-126  
 23 3.7.5.1 Invertebrates ..... 3-126  
 24 3.7.5.2 Amphibians and Reptiles ..... 3-129  
 25 3.7.5.3 Birds ..... 3-131  
 26 3.7.5.4 Mammals ..... 3-137  
 27 3.8 Cultural Resources ..... 3-137  
 28 3.8.1 Area of Potential Effect ..... 3-139  
 29 3.8.2 Description of Cultural Resources and Site Types ..... 3-140  
 30 3.8.2.1 Archaeological Resources ..... 3-142  
 31 3.8.2.2 Historic Resources ..... 3-146  
 32 3.8.2.3 Cultural Landscapes ..... 3-147  
 33 3.8.2.4 Traditional Cultural Properties and Ethnographic  
 34 Resources ..... 3-148  
 35 3.9 Tribal Cultural Resources ..... 3-149  
 36 3.9.1 Havasupai ..... 3-149  
 37 3.9.2 Hualapai ..... 3-150  
 38 3.9.3 Southern Paiute Tribes ..... 3-153  
 39 3.9.4 Hopi ..... 3-153  
 40 3.9.5 Navajo Nation ..... 3-154  
 41 3.9.6 Zuni ..... 3-156  
 42 3.9.7 Fort Mojave Indian Tribe ..... 3-159  
 43 3.9.8 Indian Trust Assets and Trust Responsibility ..... 3-160  
 44 3.10 Recreation, Visitor Use, and Experience ..... 3-160  
 45 3.10.1 Glen Canyon Reach of the Colorado River in Glen Canyon National  
 46 Recreation Area ..... 3-160

**CONTENTS (Cont.)**

1  
2  
3  
4 3.10.1.1 Recreational Fishery..... 3-161  
5 3.10.1.2 Day-Rafting, Boating, and Camping in the Glen Canyon  
6 Reach..... 3-166  
7 3.10.2 The Colorado River in Grand Canyon National Park..... 3-169  
8 3.10.3 Recreation Use on Lakes Mead and Powell ..... 3-178  
9 3.10.3.1 Lake Mead National Recreation Area..... 3-178  
10 3.10.3.2 Lake Powell, Glen Canyon National Recreation Area..... 3-179  
11 3.11 Wilderness..... 3-180  
12 3.11.1 Law and Policy ..... 3-180  
13 3.11.2 Defining Wilderness Character..... 3-181  
14 3.12 Visual Resources..... 3-184  
15 3.12.1 Glen Canyon National Recreation Area ..... 3-185  
16 3.12.2 Grand Canyon and the Colorado River..... 3-185  
17 3.12.3 Lake Mead National Recreation Area..... 3-190  
18 3.13 Hydropower..... 3-190  
19 3.13.1 Power Operations..... 3-191  
20 3.13.1.1 Hydropower Generation..... 3-191  
21 3.13.1.2 Basin Fund..... 3-192  
22 3.13.1.3 Operational Flexibility ..... 3-192  
23 3.13.1.4 Scheduling..... 3-194  
24 3.13.1.5 Load/Generation Following and Regulation ..... 3-194  
25 3.13.1.6 Capacity Reserves ..... 3-196  
26 3.13.1.7 Disturbances and Emergencies and Outage Assistance..... 3-196  
27 3.13.1.8 Transmission System..... 3-197  
28 3.13.2 Power Marketing..... 3-197  
29 3.13.2.1 Wholesale Rates ..... 3-200  
30 3.13.2.2 Retail Rates..... 3-201  
31 3.14 Socioeconomics and Environmental Justice ..... 3-201  
32 3.14.1 The Six-County Region of Influence..... 3-201  
33 3.14.1.1 Population..... 3-202  
34 3.14.1.2 Income..... 3-202  
35 3.14.1.3 Employment ..... 3-204  
36 3.14.1.4 Unemployment..... 3-206  
37 3.14.1.5 Environmental Justice ..... 3-206  
38 3.14.2 The Seven-State Region of Influence ..... 3-213  
39 3.14.2.1 Population..... 3-213  
40 3.14.2.2 Income..... 3-214  
41 3.14.2.3 Employment ..... 3-215  
42 3.14.2.4 Unemployment..... 3-217  
43 3.14.2.5 Environmental Justice ..... 3-217  
44 3.15 Air Quality..... 3-219  
45 3.15.1 Local Air Quality ..... 3-220  
46 3.15.2 Regional Air Quality..... 3-221

**CONTENTS (Cont.)**

1  
2  
3  
4 3.15.3 Regional Air Emissions ..... 3-224  
5 3.16 Climate Change ..... 3-226  
6  
7 4 ENVIRONMENTAL CONSEQUENCES ..... 4-1  
8  
9 4.1 Overall Analysis and Assessment Approach..... 4-1  
10 4.2 Water Resources..... 4-7  
11 4.2.1 Analysis Methods..... 4-8  
12 4.2.1.1 Hydrology..... 4-8  
13 4.2.1.2 Water Quality ..... 4-11  
14 4.2.2 Summary of Impacts ..... 4-12  
15 4.2.2.1 Hydrology..... 4-12  
16 4.2.2.2 Water Quality ..... 4-34  
17 4.2.3 Alternative-Specific Impacts ..... 4-44  
18 4.2.3.1 Alternative A (No Action Alternative)..... 4-44  
19 4.2.3.2 Alternative B ..... 4-46  
20 4.2.3.3 Alternative C ..... 4-49  
21 4.2.3.4 Alternative D (Preferred Alternative)..... 4-52  
22 4.2.3.5 Alternative E..... 4-54  
23 4.2.3.6 Alternative F..... 4-56  
24 4.2.3.7 Alternative G ..... 4-59  
25 4.3 Sediment Resources ..... 4-61  
26 4.3.1 Analysis Methods..... 4-62  
27 4.3.2 Summary of Impacts ..... 4-66  
28 4.3.3 Alternative-Specific Impacts ..... 4-68  
29 4.3.3.1 Alternative A (No Action Alternative)..... 4-71  
30 4.3.3.2 Alternative B ..... 4-73  
31 4.3.3.3 Alternative C ..... 4-76  
32 4.3.3.4 Alternative D (Preferred Alternative)..... 4-77  
33 4.3.3.5 Alternative E..... 4-80  
34 4.3.3.6 Alternative F..... 4-81  
35 4.3.3.7 Alternative G ..... 4-82  
36 4.4 Natural Processes ..... 4-83  
37 4.4.1 Analysis Methods..... 4-84  
38 4.4.2 Summary of Impacts ..... 4-84  
39 4.4.3 Alternative-Specific Impacts ..... 4-92  
40 4.4.3.1 Alternative A (No Action Alternative)..... 4-92  
41 4.4.3.2 Alternative B ..... 4-92  
42 4.4.3.3 Alternative C ..... 4-93  
43 4.4.3.4 Alternative D (Preferred Alternative)..... 4-94  
44 4.4.3.5 Alternative E..... 4-94  
45 4.4.3.6 Alternative F..... 4-95  
46 4.4.3.7 Alternative G ..... 4-96

**CONTENTS (Cont.)**

1			
2			
3			
4	4.5	Aquatic Ecology.....	4-97
5		4.5.1 Analysis Methods.....	4-97
6		4.5.1.1 Aquatic Food Base.....	4-97
7		4.5.1.2 Nonnative Fish.....	4-98
8		4.5.1.3 Native Fish.....	4-100
9		4.5.1.4 Aquatic Parasites.....	4-101
10		4.5.2 Summary of Impacts.....	4-102
11		4.5.2.1 Aquatic Food Base.....	4-102
12		4.5.2.2 Nonnative Fish.....	4-112
13		4.5.2.3 Native Fish.....	4-120
14		4.5.2.4 Aquatic Parasites.....	4-128
15		4.5.3 Alternative-Specific Impacts on Aquatic Resources.....	4-129
16		4.5.3.1 Alternative A (No Action Alternative).....	4-129
17		4.5.3.2 Alternative B.....	4-132
18		4.5.3.3 Alternative C.....	4-135
19		4.5.3.4 Alternative D (Preferred Alternative).....	4-138
20		4.5.3.5 Alternative E.....	4-142
21		4.5.3.6 Alternative F.....	4-145
22		4.5.3.7 Alternative G.....	4-148
23	4.6	Vegetation.....	4-151
24		4.6.1 Analysis Methods.....	4-151
25		4.6.2 Summary of Impacts.....	4-157
26		4.6.2.1 Impacts on Old High Water Zone Vegetation.....	4-157
27		4.6.2.2 Impacts on New High Water Zone.....	4-165
28		4.6.2.3 Wetlands.....	4-170
29		4.6.2.4 Special Status Plant Species.....	4-172
30		4.6.3 Alternative-Specific Impacts.....	4-175
31		4.6.3.1 Alternative A (No Action Alternative).....	4-175
32		4.6.3.2 Alternative B.....	4-176
33		4.6.3.3 Alternative C.....	4-178
34		4.6.3.4 Alternative D (Preferred Alternative).....	4-179
35		4.6.3.5 Alternative E.....	4-181
36		4.6.3.6 Alternative F.....	4-183
37		4.6.3.7 Alternative G.....	4-184
38	4.7	Wildlife.....	4-186
39		4.7.1 Analysis Methods.....	4-186
40		4.7.2 Summary of Impacts.....	4-187
41		4.7.2.1 Terrestrial Invertebrates.....	4-188
42		4.7.2.2 Amphibians and Reptiles.....	4-193
43		4.7.2.3 Birds.....	4-195
44		4.7.2.4 Mammals.....	4-197
45		4.7.2.5 Special Status Species.....	4-198
46		4.7.3 Alternative-Specific Impacts on Wildlife.....	4-210

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 4.7.3.1 Alternative A (No Action Alternative)..... 4-210  
 5 4.7.3.2 Alternative B ..... 4-211  
 6 4.7.3.3 Alternative C ..... 4-212  
 7 4.7.3.4 Alternative D (Preferred Alternative)..... 4-213  
 8 4.7.3.5 Alternative E..... 4-214  
 9 4.7.3.6 Alternative F..... 4-215  
 10 4.7.3.7 Alternative G ..... 4-216  
 11 4.8 Cultural Resources ..... 4-217  
 12 4.8.1 Compliance with Federal Regulations ..... 4-217  
 13 4.8.2 Analysis Methods..... 4-217  
 14 4.8.3 Summary of Impacts ..... 4-220  
 15 4.8.4 Alternative-Specific Impacts ..... 4-226  
 16 4.8.4.1 Alternative A (No Action Alternative)..... 4-226  
 17 4.8.4.2 Alternative B ..... 4-227  
 18 4.8.4.3 Alternative C ..... 4-228  
 19 4.8.4.4 Alternative D (Preferred Alternative)..... 4-228  
 20 4.8.4.5 Alternative E..... 4-229  
 21 4.8.4.6 Alternative F..... 4-230  
 22 4.8.4.7 Alternative G ..... 4-230  
 23 4.9 Tribal Resources..... 4-231  
 24 4.9.1 Tribal Resource Goals..... 4-231  
 25 4.9.1.1 Increase the Health of the Ecosystem in Glen, Marble, and  
 26 Grand Canyons ..... 4-232  
 27 4.9.1.2 Protect and Preserve Sites of Cultural Importance..... 4-235  
 28 4.9.1.3 Preserve and Enhance Respect for Canyon Life ..... 4-236  
 29 4.9.1.4 Preserve and Enhance the Sacred Integrity of Glen,  
 30 Marble, and Grand Canyons..... 4-238  
 31 4.9.1.5 Maintain and Enhance Healthy Stewardship Opportunities  
 32 and Maintain and Enhance Tribal Connections to the  
 33 Canyons ..... 4-239  
 34 4.9.1.6 Economic Opportunity ..... 4-240  
 35 4.9.1.7 Maintain Tribal Water Rights and Supply ..... 4-240  
 36 4.9.1.8 LTEMP Process..... 4-241  
 37 4.9.2 Analysis Methods..... 4-241  
 38 4.9.3 Summary of Impacts ..... 4-242  
 39 4.9.4 Alternative-Specific Impacts ..... 4-247  
 40 4.9.4.1 Alternative A (No Action Alternative)..... 4-247  
 41 4.9.4.2 Alternative B ..... 4-249  
 42 4.9.4.3 Alternative C ..... 4-250  
 43 4.9.4.4 Alternative D (Preferred Alternative)..... 4-251  
 44 4.9.4.5 Alternative E..... 4-253  
 45 4.9.4.6 Alternative F..... 4-254  
 46 4.9.4.7 Alternative G ..... 4-255



**CONTENTS (Cont.)**

1  
2  
3  
4 4.10 Recreation, Visitor Use, and Experience..... 4-257  
5 4.10.1 Analysis Methods..... 4-257  
6 4.10.2 Summary of Impacts..... 4-258  
7 4.10.2.1 Glen Canyon Fishing..... 4-264  
8 4.10.2.2 Glen Canyon Day Rafting..... 4-266  
9 4.10.2.3 Glen Canyon Recreational Facilities..... 4-266  
10 4.10.2.4 Whitewater Boating..... 4-267  
11 4.10.2.5 Lake Activities and Facilities..... 4-268  
12 4.10.2.6 Tribal Recreation Operations..... 4-268  
13 4.10.2.7 Pearce Ferry..... 4-269  
14 4.10.2.8 Park Operations and Management..... 4-270  
15 4.10.3 Alternative-Specific Impacts..... 4-270  
16 4.10.3.1 Alternative A (No Action Alternative)..... 4-270  
17 4.10.3.2 Alternative B..... 4-272  
18 4.10.3.3 Alternative C..... 4-273  
19 4.10.3.4 Alternative D (Preferred Alternative)..... 4-275  
20 4.10.3.5 Alternative E..... 4-276  
21 4.10.3.6 Alternative F..... 4-277  
22 4.10.3.7 Alternative G..... 4-278  
23 4.11 Wilderness..... 4-280  
24 4.11.1 Analysis Methods..... 4-280  
25 4.11.2 Summary of Impacts..... 4-281  
26 4.11.3 Alternative-Specific Impacts..... 4-286  
27 4.11.3.1 Alternative A (No Action Alternative)..... 4-286  
28 4.11.3.2 Alternative B..... 4-287  
29 4.11.3.3 Alternative C..... 4-288  
30 4.11.3.4 Alternative D (Preferred Alternative)..... 4-288  
31 4.11.3.5 Alternative E..... 4-289  
32 4.11.3.6 Alternative F..... 4-290  
33 4.11.3.7 Alternative G..... 4-291  
34 4.12 Visual Resources..... 4-292  
35 4.13 Hydropower..... 4-294  
36 4.13.1 Analysis Methods..... 4-294  
37 4.13.1.1 Hydropower Resource and Capacity Expansion Impacts..... 4-295  
38 4.13.1.2 Wholesale Rate Impacts..... 4-301  
39 4.13.1.3 Retail Rate Impacts..... 4-303  
40 4.13.1.4 Hoover Dam Impacts..... 4-305  
41 4.13.2 Summary of Hydropower Impacts..... 4-306  
42 4.13.2.1 Monthly Water Release Impacts..... 4-306  
43 4.13.2.2 Hydropower Power Generation and Capacity Impacts..... 4-310  
44 4.13.2.3 Economic Impacts..... 4-312  
45 4.13.2.4 Change in FES Wholesale Rates..... 4-315  
46 4.13.2.5 Retail Rate and Bills Impacts..... 4-315

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 4.13.2.6 Impacts of LTEMP Alternatives on Hoover Dam Power  
 5 Economics ..... 4-316  
 6 4.13.3 Alternative-Specific Impacts ..... 4-317  
 7 4.13.3.1 Alternative A (No Action Alternative)..... 4-317  
 8 4.13.3.2 Alternative B ..... 4-318  
 9 4.13.3.3 Alternative C ..... 4-319  
 10 4.13.3.4 Alternative D (Preferred Alternative)..... 4-320  
 11 4.13.3.5 Alternative E..... 4-321  
 12 4.13.3.6 Alternative F..... 4-322  
 13 4.13.3.7 Alternative G ..... 4-323  
 14 4.14 Socioeconomics and Environmental Justice ..... 4-324  
 15 4.14.1 Analysis Methods..... 4-324  
 16 4.14.1.1 Recreational Use Values ..... 4-325  
 17 4.14.1.2 Recreational Economic Impacts ..... 4-326  
 18 4.14.1.3 Electricity Bill Increase and Generation Capacity  
 19 Expansion Impacts ..... 4-326  
 20 4.14.1.4 Environmental Justice ..... 4-327  
 21 4.14.2 Summary of Impacts on Socioeconomics and Environmental Justice ... 4-327  
 22 4.14.2.1 Recreational Use Values ..... 4-327  
 23 4.14.2.2 Recreational Economic Impacts ..... 4-338  
 24 4.14.2.3 Customer Utility Electricity Generation Capacity and  
 25 Residential Rate Increase Impacts..... 4-340  
 26 4.14.2.4 Environmental Justice Impacts..... 4-342  
 27 4.14.3 Alternative-Specific Impacts ..... 4-348  
 28 4.14.3.1 Alternative A (No Action Alternative)..... 4-348  
 29 4.14.3.2 Alternative B ..... 4-349  
 30 4.14.3.3 Alternative C ..... 4-350  
 31 4.14.3.4 Alternative D (Preferred Alternative)..... 4-352  
 32 4.14.3.5 Alternative E..... 4-353  
 33 4.14.3.6 Alternative F..... 4-355  
 34 4.14.3.7 Alternative G ..... 4-357  
 35 4.15 Air Quality..... 4-358  
 36 4.15.1 Analysis Methods..... 4-358  
 37 4.15.2 Summary of Impacts ..... 4-360  
 38 4.15.3 Alternative-Specific Impacts ..... 4-365  
 39 4.15.3.1 Alternative A (No Action Alternative)..... 4-366  
 40 4.15.3.2 Alternative B ..... 4-366  
 41 4.15.3.3 Alternative C ..... 4-366  
 42 4.15.3.4 Alternative D (Preferred Alternative)..... 4-366  
 43 4.15.3.5 Alternative E..... 4-367  
 44 4.15.3.6 Alternative F..... 4-367  
 45 4.15.3.7 Alternative G ..... 4-367  
 46 4.16 Climate Change ..... 4-368

**CONTENTS (Cont.)**

1  
2  
3  
4 4.16.1 Analysis Methods..... 4-368  
5 4.16.1.1 Effects of LTEMP Alternatives on Climate Change..... 4-368  
6 4.16.1.2 Effects of Climate Change on Hydrology and Downstream  
7 Resources..... 4-369  
8 4.16.2 Summary of Impacts..... 4-370  
9 4.16.2.1 Effects of LTEMP Alternatives on Climate Change..... 4-370  
10 4.16.2.2 Effects of Climate Change on Hydrology and Downstream  
11 Resources..... 4-375  
12 4.16.3 Alternative-Specific Impacts ..... 4-377  
13 4.16.3.1 Alternative A (No Action Alternative)..... 4-377  
14 4.16.3.2 Alternative B ..... 4-377  
15 4.16.3.3 Alternative C ..... 4-380  
16 4.16.3.4 Alternative D (Preferred Alternative)..... 4-380  
17 4.16.3.5 Alternative E..... 4-381  
18 4.16.3.6 Alternative F..... 4-381  
19 4.16.3.7 Alternative G ..... 4-382  
20 4.17 Cumulative Impacts..... 4-382  
21 4.17.1 Past, Present, and Reasonably Foreseeable Future Actions Affecting  
22 Cumulative Impacts ..... 4-382  
23 4.17.1.1 Past and Present (Ongoing) Actions..... 4-391  
24 4.17.1.2 Reasonably Foreseeable Future Actions ..... 4-395  
25 4.17.2 Climate-Related Changes..... 4-398  
26 4.17.3 Cumulative Impacts Summary by Resource..... 4-398  
27 4.17.3.1 Water Resources..... 4-407  
28 4.17.3.2 Sediment Resources ..... 4-408  
29 4.17.3.3 Natural Processes ..... 4-409  
30 4.17.3.4 Aquatic Ecology..... 4-409  
31 4.17.3.5 Vegetation ..... 4-412  
32 4.17.3.6 Wildlife..... 4-413  
33 4.17.3.7 Cultural Resources ..... 4-416  
34 4.17.3.8 Tribal Resources..... 4-417  
35 4.17.3.9 Recreation, Visitor Use, and Experience..... 4-418  
36 4.17.3.10 Wilderness..... 4-419  
37 4.17.3.11 Visual Resources ..... 4-420  
38 4.17.3.12 Hydropower..... 4-421  
39 4.17.3.13 Socioeconomics and Environmental Justice ..... 4-422  
40 4.17.3.14 Air Quality and Climate Change ..... 4-422  
41 4.18 Unavoidable Adverse Impacts..... 4-423  
42 4.19 Relationship between Short-Term Use and Long-Term Productivity..... 4-424  
43 4.20 Irreversible and Irretrievable Commitments of Resources..... 4-425  
44  
45

**CONTENTS (Cont.)**

1  
2  
3  
4 5 CONSULTATION AND COORDINATION ..... 5-1  
5  
6 5.1 Consultation and Coordination with Other Agencies and Programs ..... 5-1  
7 5.1.1 U.S. Department of the Interior ..... 5-1  
8 5.1.2 Cooperating Agencies ..... 5-1  
9 5.1.3 American Indian Tribes ..... 5-2  
10 5.1.4 Other Consultations ..... 5-6  
11 5.1.4.1 National Historic Preservation Act ..... 5-6  
12 5.1.4.2 State and Local Water and Power Agency Coordination ..... 5-7  
13 5.1.4.3 U.S. Fish and Wildlife Service ..... 5-7  
14 5.2 Public Involvement ..... 5-8  
15 5.2.1 Public Scoping Process and Comments Received ..... 5-8  
16 5.2.2 Public Meetings on Alternatives ..... 5-10  
17 5.2.3 Glen Canyon Dam Adaptive Management Working Group ..... 5-11  
18 5.3 Distribution of the LTEMP DEIS ..... 5-11  
19  
20 6 REFERENCES ..... 6-1  
21  
22 7 LIST OF PREPARERS ..... 7-1  
23  
24 8 GLOSSARY ..... 8-1  
25  
26 APPENDIX A: Adaptive Management Working Group Desired Future Conditions ..... A-1  
27  
28 A.1 Desired Future Conditions: Colorado River Ecosystem ..... A-5  
29 A.1.1 DFC Description ..... A-5  
30 A.1.2 DFC Background and Legislation ..... A-6  
31 A.1.3 Why the Colorado River Ecosystem DFCs Are Important ..... A-6  
32 A.1.4 Colorado River Ecosystem DFCs ..... A-6  
33 A.1.4.1 Sediment-Related Resources DFCs ..... A-6  
34 A.1.4.2 Water Quality DFCs ..... A-7  
35 A.1.4.3 Colorado River Ecosystem Aquatic Resource DFCs ..... A-7  
36 A.1.4.4 Colorado River Ecosystem Riparian Resource DFCs ..... A-9  
37 A.1.5 Colorado River Ecosystem DFCs Additional Information ..... A-9  
38 A.1.5.1 Colorado River Ecosystem Linkages ..... A-9  
39 A.1.5.2 Colorado River Ecosystem Metrics ..... A-10  
40 A.2 Power Desired Future Conditions ..... A-10  
41 A.2.1 Power DFC Description ..... A-10  
42 A.2.2 Power DFC Background and Legislation ..... A-10  
43 A.2.3 Why the Power DFC Is Important ..... A-11  
44 A.2.4 Power DFCs ..... A-11  
45 A.2.5 Power DFC Additional Information ..... A-12  
46 A.2.5.1 Power Linkages ..... A-12

**CONTENTS (Cont.)**

1  
 2  
 3  
 4  
 5  
 6  
 7  
 8  
 9  
 10  
 11  
 12  
 13  
 14  
 15  
 16  
 17  
 18  
 19  
 20  
 21  
 22  
 23  
 24  
 25  
 26  
 27  
 28  
 29  
 30  
 31  
 32  
 33  
 34  
 35  
 36  
 37  
 38  
 39  
 40  
 41  
 42  
 43  
 44  
 45  
 46

	A.2.5.2	Power Metrics.....	A-12
A.3		Cultural Resources Desired Future Conditions.....	A-13
	A.3.1	Cultural Resources DFC Description.....	A-13
	A.3.2	DFC Background and Legislation.....	A-13
	A.3.3	Why the Cultural Resources DFCs Are Important.....	A-13
	A.3.4	NRHP Eligible Historic Properties DFCs.....	A-14
		A.3.4.1 Prehistoric Archaeological Sites and Historic Sites.....	A-14
		A.3.4.2 Traditional Cultural Properties.....	A-14
	A.3.5	NRHP Eligible Historic Properties DFC Additional Information.....	A-15
		A.3.5.1 NRHP Eligible Historic Properties Linkages.....	A-15
		A.3.5.2 NRHP Eligible Historic Properties Metrics.....	A-16
	A.3.6	Resources of Traditional Cultural Significance but Not NRHP Eligible.....	A-16
	A.3.7	Resources of Traditional Cultural Significance DFCs.....	A-16
	A.3.8	Resources of Traditional Cultural Significance Linkages.....	A-17
	A.3.9	Resources of Traditional Cultural Significance Metrics.....	A-17
A.4		Recreation Desired Future Conditions.....	A-17
	A.4.1	Recreation DFC Description.....	A-17
	A.4.2	DFC Background and Legislation.....	A-17
	A.4.3	Why the Recreation DFC Is Important.....	A-18
		A.4.3.1 Grand Canyon National Park.....	A-18
		A.4.3.2 Glen Canyon National Recreation Area.....	A-18
	A.4.4	Recreation DFCs.....	A-18
		A.4.4.1 River Recreation in Grand Canyon National Park.....	A-18
		A.4.4.2 River Recreation in Glen Canyon National Recreation Area.....	A-19
		A.4.4.3 Blue Ribbon Trout Fishery in Glen Canyon National Recreation Area.....	A-19
		A.4.4.4 River Corridor Stewardship.....	A-19
	A.4.5	Recreation DFC Additional Information.....	A-20
	A.4.6	Recreation Linkages.....	A-20
	A.4.7	Recreation Metrics.....	A-20
A.5		Reference.....	A-21
APPENDIX B:		Performance Metrics Used to Evaluate Alternatives.....	B-1
B.1		Aquatic Ecology.....	B-3
	B.1.1	Humpback Chub.....	B-3
	B.1.2	Other Native Fish.....	B-5
	B.1.3	Trout Fishery.....	B-5
	B.1.4	Nonnative Aquatic Species.....	B-6
B.2		Archaeological and Cultural Resources.....	B-7
B.3		Hydropower and Energy.....	B-9

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 B.4 Natural Processes ..... B-10  
 5 B.5 Recreational Experience..... B-10  
 6 B.5.1 Grand Canyon Metrics..... B-11  
 7 B.5.2 Glen Canyon Metrics ..... B-15  
 8 B.6 Riparian Vegetation..... B-16  
 9 B.7 Sediment..... B-18  
 10 B.8 Tribal Resources..... B-18  
 11 B.9 Water Delivery ..... B-24  
 12 B.10 References ..... B-24  
 13  
 14 APPENDIX C: Decision Analysis to Support Development of the Glen Canyon Dam  
 15 Long-Term Experimental and Management Plan..... C-1  
 16  
 17 APPENDIX D: Hydrology Technical Information and Analysis..... D-1  
 18  
 19 D.1 Analysis Methods..... D-3  
 20 D.1.1 Background..... D-3  
 21 D.1.2 Initial Conditions ..... D-4  
 22 D.1.3 Reservoir Operations ..... D-4  
 23 D.1.3.1 Upper Basin Reservoirs above Lake Powell ..... D-4  
 24 D.1.3.2 Lake Powell and Lake Mead ..... D-5  
 25 D.1.3.3 Lake Mohave and Lake Havasu ..... D-9  
 26 D.1.4 Representation of the Different Alternatives in CRSS ..... D-9  
 27 D.1.4.1 Experimental Components Modeled in CRSS ..... D-22  
 28 D.1.5 Input Hydrology..... D-23  
 29 D.1.6 Input Demands ..... D-26  
 30 D.1.7 Other Key Assumptions..... D-26  
 31 D.2 Supplemental Information on Impact Modeling ..... D-27  
 32 D.2.1 Low Summer Flows..... D-27  
 33 D.2.2 Modeled Annual Releases Extending Beyond the End of the Water  
 34 Year..... D-28  
 35 D.2.3 Lake Elevation ..... D-29  
 36 D.3 References ..... D-36  
 37  
 38 APPENDIX E: Sediment Resources Technical Information and Analysis..... E-1  
 39  
 40 E.1 Introduction ..... E-3  
 41 E.1.1 Analysis Period..... E-3  
 42 E.1.2 General Scope ..... E-3  
 43 E.2 Methods..... E-4  
 44 E.2.1 Sand Budget Model..... E-4  
 45 E.2.1.1 Model Description ..... E-4  
 46 E.2.1.2 Sand Budget Model Modifications..... E-5

**CONTENTS (Cont.)**

1			
2			
3			
4		E.2.1.3	Modified Sand Budget Model Inputs ..... E-6
5	E.2.2		Sediment Metrics ..... E-8
6		E.2.2.1	Sand Load Index..... E-9
7		E.2.2.2	Standard Deviation of High Flows..... E-9
8		E.2.2.3	Sand Mass Balance Index..... E-10
9	E.3		Results ..... E-10
10		E.3.1	HFES Determined by Alternative..... E-10
11		E.3.2	Metrics ..... E-11
12		E.3.2.1	Sand Load Index..... E-12
13		E.3.2.2	Standard Deviation of High Flows..... E-12
14		E.3.3	Sand Mass Balance Index ..... E-12
15		E.3.4	Alternative Performance under Climate Change Scenarios..... E-13
16		E.3.5	Relative Impacts of Dam Operations and Hydrology on
17			Performance ..... E-13
18	E.4		Lake Deltas..... E-15
19	E.5		Limitations and Known Issues ..... E-17
20		E.5.1	Geographic Scope ..... E-17
21		E.5.2	Modeling Improvements..... E-17
22	E.6		References ..... E-18
23			
24	APPENDIX F:		Aquatic Resources Technical Information and Analysis..... F-1
25			
26	F.1		Introduction ..... F-3
27	F.2		Aquatic Food Base Assessment ..... F-4
28		F.2.1	Description of the Aquatic Food Base Downstream from Glen
29			Canyon Dam ..... F-4
30		F.2.1.1	The Aquatic Food Base Prior to Construction of Glen
31			Canyon Dam..... F-5
32		F.2.1.2	The Aquatic Food Base of the Colorado River
33			Downstream from Glen Canyon Dam..... F-5
34		F.2.1.3	Influence of New Zealand Mudsail on the Aquatic Food
35			Base ..... F-13
36		F.2.2	Impacts of LTEMP Alternatives on the Aquatic Food Base ..... F-14
37		F.2.2.1	Flow Effects on the Aquatic Food Base..... F-15
38		F.2.2.2	Temperature Effects on the Aquatic Food Base..... F-23
39		F.2.3	Conclusion ..... F-26
40	F.3		Modeling Effects of LTEMP Alternatives on Rainbow Trout and
41			Humpback Chub..... F-28
42		F.3.1	Model Overview ..... F-28
43		F.3.1.1	Glen Canyon Trout Submodel..... F-29
44		F.3.1.2	Trout Movement Submodel..... F-36
45		F.3.1.3	Humpback Chub Population Submodel ..... F-40
46		F.3.2	Results for LTEMP Alternatives ..... F-52

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 F.3.2.1 Rainbow Trout Performance Measures ..... F-52  
 5 F.3.2.2 Humpback Chub Performance Measures ..... F-60  
 6 F.4 Modeling the Effects of LTEMP Alternatives on Temperature Suitability ..... F-62  
 7 F.4.1 Model Overview ..... F-64  
 8 F.4.2 Humpback Chub Aggregations ..... F-67  
 9 F.4.2.1 Historic Temperature Suitability for Humpback Chub ..... F-69  
 10 F.4.2.2 Results for LTEMP Alternatives ..... F-70  
 11 F.4.3 Other Native Fish ..... F-71  
 12 F.4.3.1 Historic Temperature Suitability for Native Fish ..... F-73  
 13 F.4.3.2 Results for LTEMP Alternatives ..... F-73  
 14 F.4.4 Nonnative Fish ..... F-78  
 15 F.4.4.1 Historic Temperature Suitability for Nonnative Fish ..... F-79  
 16 F.4.4.2 Results for LTEMP Alternatives ..... F-79  
 17 F.4.5 Aquatic Parasites ..... F-81  
 18 F.4.5.1 Historic Temperature Suitability for Aquatic Parasites ..... F-84  
 19 F.4.5.2 Results for LTEMP Alternatives ..... F-86  
 20 F.5 References ..... F-90  
 21  
 22 APPENDIX G: Vegetation Technical Information and Analysis ..... G-1  
 23  
 24 G.1 Analysis Methods ..... G-3  
 25 G.1.1 Old High-Water Zone Analysis ..... G-4  
 26 G.1.2 New High-Water Zone ..... G-5  
 27 G.1.2.1 Native Cover Metric ..... G-6  
 28 G.1.2.2 Native Diversity Metric ..... G-7  
 29 G.1.2.3 Native/Nonnative Ratio Metric ..... G-7  
 30 G.1.2.4 Arrowweed Metric ..... G-8  
 31 G.1.2.5 Overall Score ..... G-8  
 32 G.1.3 Wetlands ..... G-9  
 33 G.2 Alternative-Specific Impacts ..... G-9  
 34 G.2.1 Alternative A (No Action Alternative) ..... G-10  
 35 G.2.2 Alternative B ..... G-10  
 36 G.2.3 Alternative C ..... G-10  
 37 G.2.4 Alternative D (Preferred Alternative) ..... G-11  
 38 G.2.5 Alternative E ..... G-11  
 39 G.2.6 Alternative F ..... G-11  
 40 G.2.7 Alternative G ..... G-12  
 41 G.3 Summary ..... G-12  
 42 G.4 References ..... G-13  
 43  
 44 APPENDIX H: Cultural Resources Technical Information and Analysis ..... H-1  
 45  
 46 H.1 Wind Transport of Sediment ..... H-3



**CONTENTS (Cont.)**

1		
2		
3		
4	H.1.1	Wind Transport of Sediment—Methods..... H-4
5	H.1.2	Wind Transport of Sediment—Results..... H-5
6	H.2	Flow Effects on Cultural Resources in Glen Canyon..... H-8
7	H.2.1	Flow Effects on Cultural Resources in Glen Canyon—Methods..... H-9
8	H.2.2	Flow Effects on Cultural Resources in Glen Canyon—Results..... H-9
9	H.3	Time Off River..... H-11
10	H.3.1	Time Off River—Methods..... H-12
11	H.3.2	Time Off River—Results..... H-13
12	H.4	References..... H-15
13		
14	APPENDIX I:	Tribal Resources Technical Information and Analysis..... I-1
15		
16	I.1	Quantifiable Measures Used to Assess Impacts on Tribal Resources..... I-4
17	I.1.1	Riparian Diversity..... I-4
18	I.1.2	Wetland Abundance..... I-8
19	I.1.3	Trout Management Flows..... I-10
20	I.1.4	Mechanical Removal of Trout..... I-12
21	I.1.5	Water Levels at Lake Powell..... I-14
22	I.1.6	Access to Resources..... I-17
23	I.2	References..... I-18
24		
25	APPENDIX J:	Recreation, Visitor Use, and Experience Technical Information and
26		Analysis..... J-1
27		
28	J.1	Recreational Experience Metrics..... J-3
29	J.1.1	Grand Canyon Metrics..... J-4
30	J.1.2	Glen Canyon Metrics..... J-4
31	J.2	Metric Definitions, Analysis Methods, and Results..... J-5
32	J.2.1	Camping Area Index..... J-5
33	J.2.1.1	Camping Area Index—Methods..... J-6
34	J.2.1.2	Camping Area Index—Results..... J-7
35	J.2.2	Navigational Risk Index..... J-8
36	J.2.2.1	Navigational Risk Index—Methods..... J-9
37	J.2.2.2	Navigational Risk Index—Results..... J-10
38	J.2.3	Fluctuation Index..... J-11
39	J.2.3.1	Fluctuation Index—Methods..... J-12
40	J.2.3.2	Fluctuation Index—Results..... J-13
41	J.2.4	Time Off River..... J-14
42	J.2.4.1	Time Off River Index—Methods..... J-14
43	J.2.4.2	Time Off River Index—Results..... J-15
44	J.2.5	Glen Canyon Rafting Use..... J-15
45	J.2.5.1	Glen Canyon Rafting Use Metric—Methods..... J-16
46	J.2.5.2	Glen Canyon Rafting Use Metric—Results..... J-17

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 J.2.6 Glen Canyon Inundation Metric ..... J-18  
 5 J.2.6.1 Glen Canyon Inundation Metric—Methods ..... J-19  
 6 J.2.6.2 Glen Canyon Inundation Metric—Results ..... J-21  
 7 J.3 Lake Powell and Lake Mead Dock Access ..... J-22  
 8 J.4 Summary ..... J-25  
 9 J.5 References ..... J-25  
 10  
 11 APPENDIX K Hydropower Systems Technical Information and Analysis..... K-1  
 12  
 13 K.1 Economic Value of Glen Canyon Dam Powerplant Capacity and Energy  
 14 Production ..... K-3  
 15 K.1.1 Power Systems Background ..... K-3  
 16 K.1.2 Glen Canyon Dam, Reservoir, and Powerplant Background ..... K-5  
 17 K.1.3 Power Systems Geographic Scope..... K-8  
 18 K.1.3.1 Top Tier: General Western Interconnection Perspective  
 19 Modeling ..... K-9  
 20 K.1.3.2 Middle Tier: LTF Customer Utility Systems ..... K-11  
 21 K.1.3.3 Bottom Tier: Western SLCA/IP Hydropower Resources ..... K-15  
 22 K.1.4 Overview of Power Systems Methods..... K-16  
 23 K.1.5 Description of Individual Power System Models ..... K-20  
 24 K.1.5.1 Colorado River Simulation System Model ..... K-20  
 25 K.1.5.2 Representative Trace Tool..... K-21  
 26 K.1.5.3 Hydropower Outage Model..... K-21  
 27 K.1.5.4 Generation and Transmission Maximization-Lite..... K-21  
 28 K.1.5.5 Sand Budget Model ..... K-29  
 29 K.1.5.6 Large SLCA/IP Powerplant Spreadsheets..... K-29  
 30 K.1.5.7 Small SLCA/IP Powerplant Spreadsheet ..... K-30  
 31 K.1.5.8 Loads Shaping Algorithm ..... K-30  
 32 K.1.5.9 AURORA ..... K-31  
 33 K.1.5.10 LMP Calibration Spreadsheet ..... K-34  
 34 K.1.5.11 Firm Capacity Spreadsheet..... K-35  
 35 K.1.6 SLCA/IP Market System, Data Sources, and Model ..... K-37  
 36 K.1.6.1 Historical Data Sources ..... K-38  
 37 K.1.6.2 AURORA Model Dispatch Results for 2013 ..... K-42  
 38 K.1.6.3 SLCA/IP Market System Projections..... K-42  
 39 K.1.7 Glen Canyon Dam Powerplant Capacity Cost and Benefit  
 40 Methodology ..... K-58  
 41 K.1.7.1 Treatment of Glen Canyon Dam Capital and Fixed O&M  
 42 Costs ..... K-60  
 43 K.1.7.2 Western’s SLCA/IP LTF Obligations and Glen Canyon  
 44 Dam Replacement Capacity ..... K-60  
 45 K.1.7.3 Western SLCA/IP Firm Hydropower Capacity..... K-61

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 K.1.7.4 Firm Capacity Curves for LTEMP Power Systems  
 5 Analyses for the Peak Month of August ..... K-79  
 6 K.1.7.5 AURORA Capacity Expansion Reserve Margin Targets  
 7 and Capacity Additions ..... K-81  
 8 K.1.7.6 Dispatch Performed by AURORA Model Capacity  
 9 Expansion Runs ..... K-85  
 10 K.1.7.7 Rationale for the Selection of Hydrology Conditions Used  
 11 for Capacity Expansion Runs ..... K-89  
 12 K.1.8 Glen Canyon Dam Energy Economic Benefits Methodology ..... K-89  
 13 K.1.9 Net Present Value Calculations and Study Period Adjustments ..... K-93  
 14 K.1.10 Power Systems Results ..... K-95  
 15 K.1.10.1 Main Drivers of Differences among Alternatives ..... K-96  
 16 K.1.10.2 Capacity Expansion Modeling ..... K-100  
 17 K.1.10.3 Economic Impacts ..... K-107  
 18 K.1.10.4 Sensitivity of Results to Exceedance Level ..... K-115  
 19 K.1.10.5 Sensitivity of Results to Discount Rate ..... K-119  
 20 K.1.10.6 Sensitivity of Results to the Base Capacity Expansion Path... K-121  
 21 K.1.10.7 Sensitivity of Results to the Assumed Future Hydrological  
 22 Conditions ..... K-121  
 23 K.1.10.8 Sensitivity of Results to Changes in Ancillary Services ..... K-123  
 24 K.1.10.9 Summary of Economic Ranking ..... K-127  
 25 K.2 Western’s SLCA/IP Firm Electric Service Rate Impacts ..... K-128  
 26 K.2.1 Relationship between the Economic Impacts of LTEMP  
 27 Alternatives and Impacts on SLCA/IP FES Rates ..... K-129  
 28 K.2.2 Temporal Scope of the Analysis and Input Data ..... K-129  
 29 K.2.3 SLCA/IP Rate Setting ..... K-130  
 30 K.2.4 Calculation of Net Electrical Energy Expense ..... K-131  
 31 K.2.4.1 SLCA/IP Electrical Production ..... K-131  
 32 K.2.4.2 Sustainable Hydropower and Available Hydropower  
 33 Capacity and Energy ..... K-131  
 34 K.2.5 Calculation of Capacity Expenses and Total Net Costs ..... K-135  
 35 K.2.6 Western Replacement Resources ..... K-139  
 36 K.2.7 Post-2024 Marketing Period ..... K-140  
 37 K.2.8 Power Repayment Studies to Determine Rate Impacts ..... K-142  
 38 K.2.8.1 PRS Expenses ..... K-142  
 39 K.2.8.2 PRS Revenue Distribution ..... K-144  
 40 K.2.8.3 The SLCA/IP PRS ..... K-145  
 41 K.2.8.4 Standard PRS Rate-Setting Method Versus the Method  
 42 Used in This Analysis ..... K-146  
 43 K.2.9 Results ..... K-146  
 44 K.2.9.1 Pinch-Point Year ..... K-148  
 45 K.2.10 Definitions Used in Section K.2 ..... K-149  
 46 K.3 Impacts on Retail Electricity Rates ..... K-150

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 K.3.1 Analysis Approach..... K-150  
 5 K.3.1.1 Database of Sales, Rates, and SLCA/IP Allocation for  
 6 Retail Utility Systems..... K-152  
 7 K.3.1.2 Incorporation of Power Systems Analysis and Capital  
 8 Recovery Factors..... K-155  
 9 K.3.1.3 Inflation Rates, Sales Growth, and Interest Rates from EIA... K-157  
 10 K.3.1.4 Calculation Process for Computing Rate and Bill Impacts..... K-157  
 11 K.3.2 Results..... K-163  
 12 K.3.2.1 Grid Cost Changes Relative to Western Wholesale  
 13 Revenues ..... K-163  
 14 K.3.2.2 Retail Rate Changes for Individual Systems and SLCA/IP  
 15 Power Relative to Total Resources ..... K-164  
 16 K.3.2.3 Using Regression Equations to Approximate Retail Rate  
 17 Changes for Systems Not Included in the Database..... K-166  
 18 K.3.3 Summary of Impacts..... K-166  
 19 K.3.3.1 Average Rate Impacts under LTEMP Alternatives over the  
 20 20-Year LTEMP Period ..... K-168  
 21 K.3.3.2 Average Year-by-Year Rate Impacts ..... K-171  
 22 K.3.3.3 K-Individual System Impacts and Summary  
 23 Descriptions of LTEMP Alternatives..... K-173  
 24 K.3.4 Impacts on Small Systems ..... K-178  
 25 K.3.5 Alternative-Specific Impacts ..... K-181  
 26 K.3.5.1 Alternative A ..... K-181  
 27 K.3.5.2 Alternative B ..... K-182  
 28 K.3.5.3 Alternative C ..... K-183  
 29 K.3.5.4 Alternative D ..... K-184  
 30 K.3.5.5 Alternative E..... K-184  
 31 K.3.5.6 Alternative F..... K-185  
 32 K.3.5.7 Alternative G ..... K-185  
 33 K.4 Financial Impacts of LTEMP Alternatives on American Indian Tribes ..... K-186  
 34 K.4.1 Contractual Requirements for Calculating and Delivering Benefits  
 35 to Tribes ..... K-187  
 36 K.4.2 Calculation of Tribal Benefit Baseline under Alternative A  
 37 (No Action Alternative)..... K-188  
 38 K.4.3 Calculation of Change in Tribal Benefit as a Result of LTEMP EIS  
 39 Alternatives..... K-189  
 40 K.4.4 Impacts on Tribes through a Change in the Retail Rate of the  
 41 Electrical Supplier to Tribal Lands..... K-189  
 42 K.4.5 Calculation of Tribal Impacts for Tribes That Are Direct SLCA/IP  
 43 Recipients..... K-191  
 44 K.4.6 Total Impact of LTEMP DEIS Alternatives: Benefit Change and  
 45 Rate Effect ..... K-197

**CONTENTS (Cont.)**

1  
 2  
 3  
 4 K.4.7 Total Impact on Tribes and Tribal Members Versus Retail Rate  
 5 Changes to Households..... K-197  
 6 K.4.8 Conclusions..... K-198  
 7 K.5 Impacts of LTEMP Alternatives on Lake Mead and the Hoover Dam  
 8 Powerplant..... K-202  
 9 K.5.1 Hoover Methods, Model, and Supporting Data..... K-205  
 10 K.5.2 Hoover Monthly Energy Production and Water-to-Power  
 11 Conversion..... K-206  
 12 K.5.3 Hoover Maximum Physical Output and Firm Capacity..... K-212  
 13 K.5.4 Hoover Powerplant Economic Energy Value..... K-214  
 14 K.6 References..... K-218  
 15 Attachment K.1: Geographic Scope of the Analysis..... K-222  
 16 Attachment K.2: AURORA WI Spot Market Energy Prices Adjustments..... K-226  
 17 Attachment K.3: Selection of Representative Trace..... K-229  
 18 Attachment K.4: Discounting Procedures..... K-247  
 19 Attachment K.5: Forced Outage Scenario Generation for Hydroelectric Power  
 20 Facilities..... K-250  
 21 Attachment K.6: Forecast of Monthly Peak Loads and Energy by SLCA/IP  
 22 Long-Term Firm Customer..... K-253  
 23 Attachment K.7: Analysis of the Timing of the Peak Load..... K-255  
 24 Attachment K.8: Analysis of Capacity Determinations— Comparing Results Using  
 25 a Range of Exceedence Levels and Two Summer Peak Months..... K-261  
 26 Attachment K.9: Results of a Survey of Electric Utility Integrated Resource Plans..... K-263  
 27 Attachment K.10: Indices Used for Converting Dollars from One Year to Another..... K-273  
 28 Attachment K.11: Annual SLCA/IP Allocations to American Indian Tribes and  
 29 Benefit Information..... K-278  
 30 Attachment K.12: SLCA/IP American Indian Tribal Allocations Estimated Total  
 31 Electrical Use by Tribe in 1998..... K-284  
 32  
 33 APPENDIX L: Socioeconomic Technical Information and Analysis..... L-1  
 34  
 35 L.1 Recreation Economic Analyses..... L-3  
 36 L.1.1 Recreation Use Values..... L-3  
 37 L.1.1.1 Lake\_Full Utility Model..... L-4  
 38 L.1.1.2 GCRec\_Full Utility Model..... L-5  
 39 L.1.2 Recreation Non-Use Values..... L-6  
 40 L.1.3 Regional Recreation Economic Impacts..... L-8  
 41 L.1.4 Estimates of Recreational Economic Impacts..... L-11  
 42 L.2 Regional Electricity Analyses..... L-12  
 43 L.2.1 Regional Electricity Price Impacts..... L-12  
 44 L.2.2 Regional Electricity Generating Capacity Expansion Impacts..... L-15  
 45 L.3 Additional Socioeconomic Data..... L-15  
 46 L.3.1 Urban Population in the Six-County Region..... L-15

**CONTENTS (Cont.)**

1  
2  
3  
4 L.3.2 Urban Income in the Six-County Region..... L-19  
5 L.4 References ..... L-20  
6  
7 APPENDIX M: Air Quality and Climate Change Technical Information and Analysis ..... M-1  
8  
9 M.1 Analysis Methods..... M-4  
10 M.1.1 System Power Generation..... M-4  
11 M.1.2 Spot Market..... M-5  
12 M.1.3 Generation Type..... M-6  
13 M.2 Results ..... M-6  
14 M.2.1 SO<sub>2</sub> and NO<sub>x</sub>..... M-6  
15 M.2.2 Greenhouse Gas Emissions..... M-8  
16 M.3 References ..... M-9  
17  
18 APPENDIX N: Government-to-Government and National Historic Preservation  
19 Act Consultation ..... N-1  
20  
21 N.1 Government-to-Government Consultation..... N-3  
22 N.2 Consultation with the State Historic Preservation Office ..... N-27  
23 N.3 Reference..... N-30  
24 Attachment N.1 ..... N-31  
25 Attachment N.2 ..... N-73  
26 Attachment N.3 ..... N-135

**FIGURES**

27  
28  
29  
30  
31  
32 1-1 Generalized Locations of Glen Canyon Dam, Lake Powell, the Colorado River  
33 between Lake Powell and Lake Mead, and Adjacent Lands..... 1-5  
34  
35 1-2 Glen Canyon Dam ..... 1-6  
36  
37 1-3 Map of the Colorado River between Lake Powell and Lake Mead ..... 1-20  
38  
39 2-1 Mean, Minimum, and Maximum Daily Flows under Alternative A in an  
40 8.23-maf Year Based on Values Presented in Table 2-3..... 2-17  
41  
42 2-2 Simulated Hourly Flows under Alternative A in an 8.23-maf Year..... 2-17  
43  
44 2-3 Simulated Hourly Flows under Alternative A for a Week in July in an 8.23-maf  
45 Year Showing Typically Lower Weekend Flows ..... 2-18  
46

**FIGURES (Cont.)**

1  
2  
3  
4 2-4 Mean, Minimum, and Maximum Daily Flows under Alternative B in an  
5 8.23-maf Year Based on Values Presented in Table 2-4..... 2-20  
6  
7 2-5 Simulated Hourly Flows under Alternative B in an 8.23-maf Year..... 2-21  
8  
9 2-6 Simulated Hourly Flows under Alternative B for a Week in July in an 8.23-maf  
10 Year Showing Typically Lower Weekend Flows ..... 2-21  
11  
12 2-7 Example Mean, Minimum, and Maximum Daily Flows for a Hydropower  
13 Improvement Experiment under Alternative B in an 8.23-maf Year..... 2-23  
14  
15 2-8 Simulated Hourly Flows for a Hydropower Improvement Experiment under  
16 Alternative B in an 8.23-maf Year ..... 2-23  
17  
18 2-9 Simulated Hourly Flows for a Hydropower Improvement Experiment under  
19 Alternative B for a Week in July in an 8.23-maf Year..... 2-24  
20  
21 2-10 Mean, Minimum, and Maximum Daily Flows under Base Operations of  
22 Alternative C in an 8.23-maf Year Based on the Values Presented in Table 2-5 ..... 2-25  
23  
24 2-11 Simulated Hourly Flows under Alternative C in an 8.23-maf Year..... 2-27  
25  
26 2-12 Simulated Hourly Flows under Alternative C for a Week in July in an 8.23-maf  
27 Year Showing Typically Lower Weekend Flows ..... 2-27  
28  
29 2-13 Decision Tree for Sediment-Related Actions under Alternative C ..... 2-28  
30  
31 2-14 Decision Tree for Humpback Chub-Related Actions under Alternative C..... 2-29  
32  
33 2-15 Example Implementation of a Two-Cycle TMF in June and July with  
34 Resumption of Normal Fluctuations between Cycles and Afterward..... 2-39  
35  
36 2-16 Mean, Minimum, and Maximum Daily Flows under Triggered Low Summer  
37 Flows of Alternative C in an 8.23-maf Year Based on the Values Presented in  
38 Table 2-6..... 2-41  
39  
40 2-17 Mean, Minimum, and Maximum Daily Flows under Alternative D in an  
41 8.23-maf Year Based on Values Presented in Table 2-8..... 2-44  
42  
43 2-18 Simulated Hourly Flows under Alternative D in an 8.23-maf Year..... 2-45  
44  
45 2-19 Simulated Hourly Flows under Alternative D for a Week in July in an 8.23-maf  
46 Year Showing Typically Lower Weekend Flows ..... 2-45

**FIGURES (Cont.)**

1  
2  
3  
4 2-20 Decision Tree for Implementation of Sediment-Related Experimental  
5 Treatments under Alternative D ..... 2-53  
6  
7 2-21 Decision Tree for Implementation of Aquatic Resource-Related Experimental  
8 Treatments under Alternative D ..... 2-54  
9  
10 2-22 Mean, Minimum, and Maximum Daily Flows under Triggered Low Summer  
11 Flows of Alternative C in an 8.23-maf Year Based on the Values Presented in  
12 Table 2-10..... 2-66  
13  
14 2-23 Mean, Minimum, and Maximum Daily Flows under Alternative E in an  
15 8.23-maf Year Based on the Values Presented in Table 2-11 ..... 2-71  
16  
17 2-24 Simulated Hourly Flows under Alternative E in an 8.23-maf Year ..... 2-71  
18  
19 2-25 Simulated Hourly Flows under Alternative E for a Week in July in an 8.23-maf  
20 Year Showing Typically Lower Weekend Flows ..... 2-72  
21  
22 2-26 Decision Tree for Sediment-Related Actions under Alternative E ..... 2-73  
23  
24 2-27 Decision Tree for Trout-Related Actions under Alternative E ..... 2-74  
25  
26 2-28 Mean, Minimum, and Maximum Daily Flows under Base Operations of  
27 Alternative F in an 8.23-maf Year Based on the Values Presented in Table 2-12..... 2-79  
28  
29 2-29 Mean, Minimum, and Maximum Daily Flows under Alternative G in an  
30 8.23-maf Year Based on Values Presented in Table 2-13..... 2-80  
31  
32 3.1-1 LTEMP Project Area and Surrounding Lands ..... 3-2  
33  
34 3.2-1 Map of Lake Powell and Associated Major Tributaries..... 3-7  
35  
36 3.2-2 The Pattern of Annual Historic Flows at Lees Ferry..... 3-10  
37  
38 3.2-3 Map of Lake Mead and Associated Major Tributaries..... 3-11  
39  
40 3.2-4 Profile of Lake Powell from Glen Canyon Dam to the Inflow of the Colorado  
41 River ..... 3-15  
42  
43 3.2-5 Water Temperature at Lees Ferry ..... 3-16  
44  
45 3.2-6 Water Temperatures at Four Stations along the Colorado River from Lees Ferry  
46 to Diamond Creek, 1995–2014..... 3-19



**FIGURES (Cont.)**

1  
2  
3  
4 3.2-7 Mid-June Warming above Release Temperatures Measured at Diamond Creek,  
5 1994–2004, as a Function of Mean Weekly Discharge..... 3-20  
6  
7 3.3-1 Geomorphic Features of the Colorado River..... 3-32  
8  
9 3.3-2 Schematic Diagram of the Fan-Eddy Complex on the Colorado River ..... 3-34  
10  
11 3.3-3 River Cross Section Depicting Sediment Entrapment and Sandbar Building..... 3-35  
12  
13 3.3-4 Aeolian and Fluvial Sand Deposits along the Colorado River..... 3-36  
14  
15 3.3-5 Debris Fans and Variation in Water-Surface Elevation and Channel Width for  
16 Colorado River Flows below Glen Canyon Dam..... 3-38  
17  
18 3.3-6 Comparison of Sandbars Used as Campsites, based on Inventories Conducted  
19 in 1973, 1983, and 1991 ..... 3-39  
20  
21 3.3-7 Repeated Photography Illustrating Sediment Losses and Sandbar Changes  
22 along the Colorado River..... 3-41  
23  
24 3.3-8 Annual Sediment Contributions from the Paria and Little Colorado River ..... 3-45  
25  
26 3.3-9 Matched Photographs of RM 172 Illustrating Positive Depositional Response to  
27 the 2008 HFE..... 3-49  
28  
29 3.3-10 Conceptual Diagram of the Dependency between Net Sandbar Size, Duration  
30 and Frequency of HFEs, and Post-HFE Erosion Rates ..... 3-50  
31  
32 3.3-11 Average Campsite Area above the Reference Stage: before, after, and  
33 6 Months following the 2008 HFE..... 3-51  
34  
35 3.3-12 Longitudinal Profiles of the Mainstem Colorado Riverbed Upstream of the  
36 Hoover Dam in 1935, 1948, 1963, and 2001 ..... 3-53  
37  
38 3.5-1 Temperature Ranges for Spawning, Egg Incubation, and Growth by Native and  
39 Nonnative Fishes of the Colorado River System below Glen Canyon Dam..... 3-67  
40  
41 3.5-2 Humpback Chub Aggregation Areas along the Colorado River between Glen  
42 Canyon Dam and Lake Mead ..... 3-70  
43  
44 3.5-3 Estimated Adult Humpback Chub Abundance from Age-Structured Mark-  
45 Recapture Model Incorporating Uncertainty in Assignment of Age..... 3-71  
46

**FIGURES (Cont.)**

1  
2  
3  
4 3.5-4 Estimated Total Adult Abundance of Humpback Chub in the Lower 8 mi of the  
5 Little Colorado River and a 2-mi Portion of the Colorado River Just Downriver  
6 of the Confluence of the Little Colorado and Colorado Rivers, for September,  
7 2009 through 2012..... 3-71  
8  
9 3.5-5 Water Temperatures at Lees Ferry and the Little Colorado River Confluence,  
10 1995 to Present ..... 3-76  
11  
12 3.5-6 Mean Electrofishing Catch Rates of Rainbow Trout in the Glen Canyon Reach,  
13 1991–2013 ..... 3-91  
14  
15 3.5-7 Mean Electrofishing Catch Rates of Brown Trout in the Colorado River  
16 between Lees Ferry and Lake Mead, 2000–2009..... 3-94  
17  
18 3.6-1 Riparian Vegetation Zones along the Colorado River below Glen Canyon Dam.....3-108  
19  
20 3.7-1 Riparian Zones Used by Nesting Birds .....3-119  
21  
22 3.7-2 Threatened, Endangered, and Sensitive Species Observed along the Colorado  
23 River Corridor .....3-130  
24  
25 3.8-1 Spencer Steamboat .....3-141  
26  
27 3.8-2 A Roaster Site in a Grand Canyon Dune.....3-141  
28  
29 3.8-3 An Archaic Period Site on the Colorado River in GCNP .....3-144  
30  
31 3.8-4 Glen Canyon Linear Style Petroglyph in GCNRA.....3-144  
32  
33 3.8-5 Puebloan Era Architecture along the Colorado River in GCNP .....3-145  
34  
35 3.8-6 Lees Ferry Historic District Located in GCNRA .....3-147  
36  
37 3.10-1 Glen Canyon Reach Rainbow Trout.....3-162  
38  
39 3.10-2 Mean Rainbow Trout Catch Per Unit Effort of Both Boat Anglers and  
40 Shore-Line Anglers from Creel Surveys at Lees Ferry .....3-163  
41  
42 3.10-3 Fishing User Days by Month in the Glen Canyon Reach for 2006 and 2009 .....3-164  
43  
44 3.10-4 Angler Days in the Glen Canyon Reach from 1965 through 2011 .....3-165  
45  
46 3.10-5 Designated Campsite Areas in the Glen Canyon Reach .....3-167

**FIGURES (Cont.)**

1  
2  
3  
4 3.10-6 Shoreline Environment with Steep Erosion Banks at Glen Canyon Reach  
5 Ferry Swale Campsite.....3-168  
6  
7 3.10-7 Pontoon Raft Operated by Colorado River Discovery .....3-168  
8  
9 3.10-8 Boating in Grand Canyon, Anticipated Annual Use by Month.....3-171  
10  
11 3.10-9 Change in Camp Size over Time in the Lees Ferry to Diamond Creek Reach  
12 of GCNP .....3-172  
13  
14 3.10-10 Total High-Elevation Campsite Area for Each Survey between 1998 and 2006 .....3-173  
15  
16 3.10-11 High-Elevation Campsite Area in Critical and Noncritical Reaches between  
17 1998 and 2006 .....3-174  
18  
19 3.12-1 Glen Canyon Viewed from the Colorado River .....3-186  
20  
21 3.12-2 Horseshoe Bend.....3-186  
22  
23 3.12-3 Typical View of the Colorado River and Grand Canyon Afforded  
24 Recreationists on a River Trip.....3-188  
25  
26 3.12-4 Colorado River and Granaries at Nankoweap .....3-188  
27  
28 3.12-5 Entrance to Havasu Canyon .....3-189  
29  
30 3.12-6 Vasey’s Paradise.....3-189  
31  
32 3.14-1 Minority Population Groups in the 11-County Area .....3-210  
33  
34 3.14-2 Low-Income Population Groups in the 11-County Area .....3-211  
35  
36 3.15-1 Nonattainment Areas for SO<sub>2</sub>, 8-Hour O<sub>3</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>, and Pb in the  
37 11-State Area .....3-223  
38  
39 3.15-2 PSD Class I Areas in the 11-State Affected Area .....3-225  
40  
41 3.16-1 Historical Supply and Use and Projected Future Colorado River Basin Water  
42 Supply and.....3-228  
43  
44 4-1 Model Flow Diagram for Analyses Showing Inputs, Intermediate Calculations,  
45 and Output ..... 4-3  
46

**FIGURES (Cont.)**

1  
2  
3  
4 4-2 Example Box-and-Whisker Plot for Alternatives and Their Resource Metric  
5 Values ..... 4-6  
6  
7 4.2-1 Monthly Releases under Each Alternative in Years with Different Annual  
8 Release Volumes ..... 4-20  
9  
10 4.2-2 Mean Monthly Volume under the LTEMP Alternatives Showing the Mean,  
11 Median, 75th Percentile, 25th Percentile, Minimum, and Maximum Values for  
12 21 Hydrology Scenarios and Three Sediment Scenarios ..... 4-22  
13  
14 4.2-3 Mean Daily Flows by Month under the LTEMP Alternatives Showing the  
15 Mean, Median, 75th Percentile, 25th Percentile, Minimum, and Maximum  
16 Values for 21 Hydrology Scenarios and Three Sediment Scenarios..... 4-25  
17  
18 4.2-4 Mean Daily Change in Flows by Month under the LTEMP Alternatives  
19 Showing the Mean, Median, 75th Percentile, 25th Percentile, Minimum, and  
20 Maximum Values for 21 Hydrology Scenarios and Three Sediment Scenarios ..... 4-27  
21  
22 4.2-5 Lake Powell and Lake Mead End of Calendar Year Pool Elevation for 21  
23 Hydrology Traces and Seven Alternatives ..... 4-29  
24  
25 4.2-6 Percentage of Traces below Lake Powell’s Minimum Power Pool and  
26 Percentage of Traces with a Lower Basin Shortage for 21 Hydrology Traces  
27 and Seven Alternatives ..... 4-30  
28  
29 4.2-7 Percentage of Time in Different Operating Tier than Alternative A..... 4-31  
30  
31 4.2-8 Frequency of Lake Powell Operating Tiers from 2014 to 2026 under Each of  
32 the Alternatives for 21 Hydrologic Traces ..... 4-32  
33  
34 4.2-9 Frequency of Lake Powell Operating Tiers from 2027 to 2033 under Each of  
35 the Alternatives for 21 Hydrologic Traces ..... 4-33  
36  
37 4.2-10 Frequency of Occurrence of Annual Releases Extending Beyond the Water  
38 Year per 20-Year Trace for Each of the Alternatives..... 4-34  
39  
40 4.2-11 Comparison of Mean Water Temperatures for Representative Wetter,  
41 Moderate, and Drier Hydrology Traces for Glen Canyon Dam Releases ..... 4-36  
42  
43 4.2-12 Seasonal Glen Canyon Dam Release Temperatures for LTEMP Alternatives ..... 4-37  
44  
45 4.2-13 Seasonal Temperature Trends under the Seven LTEMP Alternatives ..... 4-39  
46

**FIGURES (Cont.)**

1  
 2  
 3  
 4 4.2-14 Projected Mean Salinity Concentrations under the LTEMP Alternatives at  
 5 Lees Ferry ..... 4-43  
 6  
 7 4.3-1 Conceptual Depiction of the Sand Load Index..... 4-64  
 8  
 9 4.3-2 Conceptual Depiction of the Sand Mass Balance Model ..... 4-65  
 10  
 11 4.3-3 Variation in Lake Powell Pool Elevation Relative to Full for 21 Hydrology  
 12 Traces and Seven Alternatives ..... 4-71  
 13  
 14 4.3-4 Variation in Lake Mead Pool Elevation Relative to Full for 21 Hydrology  
 15 Traces and Seven Alternatives ..... 4-72  
 16  
 17 4.3-5 Number and Type of HFES Expected to Occur during the 20-Year LTEMP  
 18 Period under the Seven Alternatives ..... 4-73  
 19  
 20 4.3-6 Sand Load Index Values for the 20-Year LTEMP Period under the Seven  
 21 Alternatives..... 4-74  
 22  
 23 4.3-7 Sand Mass Balance Index Values for the 20-Year LTEMP Period under the  
 24 Seven Alternatives..... 4-75  
 25  
 26 4.4-1 Anticipated Relationships among Dam Releases, Physical Conditions, Habitats,  
 27 and Ecological Resources in the Colorado River Ecosystem..... 4-85  
 28  
 29 4.5-1 Modeled Average Population Size of Age-1 and Older Rainbow Trout in the  
 30 Glen Canyon Reach during the 20-Year LTEMP Period under the LTEMP  
 31 Alternatives Showing the Mean, Median, 75th Percentile, 25th Percentile,  
 32 Minimum, and Maximum Values for 21 Hydrology Scenarios .....4-115  
 33  
 34 4.5-2 Modeled Annual Average Number of Rainbow Trout Emigrating into the  
 35 Marble Canyon Reach from the Glen Canyon Reach during the 20-Year  
 36 LTEMP Period under the LTEMP Alternatives .....4-117  
 37  
 38 4.5-3 Modeled Mean Annual Number of Rainbow Trout in the Glen Canyon Reach  
 39 Exceeding 16 in. Total Length during 20-Year Simulation Periods under the  
 40 LTEMP Alternatives .....4-118  
 41  
 42 4.5-4 Modeled Mean Annual Temperature Suitability for Rainbow and Brown Trout  
 43 under LTEMP Alternatives at Four Locations Downstream of Glen Canyon  
 44 Dam .....4-119  
 45

**FIGURES (Cont.)**

1  
2  
3  
4 4.5-5 Modeled Mean Annual Temperature Suitability for Warmwater Nonnative Fish  
5 under LTEMP Alternatives at Four Locations Downstream of Glen Canyon  
6 Dam .....4-120  
7  
8 4.5-6 Mean Annual Mainstem Temperature Suitability for Humpback Chub under  
9 LTEMP Alternatives at Reported Aggregation Locations and Combined  
10 Temperature Suitability for RM 157 and RM 213 Locations .....4-122  
11  
12 4.5-7 Mean Modeled Total Length Attained by December 31 for YOY Humpback  
13 Chub Based on Predicted Mainstem Water Temperatures at the Little Colorado  
14 River Confluence and at Pumpkin Spring under Each Alternative .....4-123  
15  
16 4.5-8 Modeled Minimum Population Size for Humpback Chub during the 20-Year  
17 LTEMP Period under LTEMP Alternatives .....4-124  
18  
19 4.5-9 Modeled Mean Annual Temperature Suitability for Native Fish under LTEMP  
20 Alternatives at Four Locations Downstream of Glen Canyon Dam .....4-127  
21  
22 4.5-10 Overall Modeled Mean Annual Temperature Suitability under LTEMP  
23 Alternatives for Aquatic Fish Parasites at Four Locations Downstream of Glen  
24 Canyon Dam .....4-128  
25  
26 4.6-1 Dominant Factors Affecting Riparian Plant Communities below Glen Canyon  
27 Dam .....4-157  
28  
29 4.6-2 Comparison among Alternatives for Four Riparian Vegetation Metrics as  
30 Predicted by a Vegetation Model .....4-163  
31  
32 4.6-3 Comparison among Alternatives for Combined Riparian Vegetation Metrics as  
33 Predicted by a Vegetation Model .....4-164  
34  
35 4.6-4 Comparison among Alternatives for Wetland Cover as Predicted by a  
36 Vegetation Model .....4-173  
37  
38 4.8-1 Number of Days per Year Flows Would Be >23,200 cfs under LTEMP  
39 Alternatives .....4-224  
40  
41 4.8-2 Wind Transport of Sediment Index Values for LTEMP Alternatives .....4-226  
42  
43 4.10-1 Recreation, Visitor Use, and Experience Metric Results for LTEMP  
44 Alternatives .....4-263  
45  
46

**FIGURES (Cont.)**

1  
2  
3  
4 4.13-1 Flow Diagram of the Power Systems Methodology Used in the LTEMP DEIS .....4-298  
5  
6 4.13-2 Average Daily Glen Canyon Dam Generation under Representative  
7 Hydrological Conditions under LTEMP Alternatives.....4-311  
8  
9 4.13-3 Total NPV of Hoover Powerplant Benefits over a 20-Year Period under  
10 LTEMP Alternatives .....4-317  
11  
12 4.15-1 Annual Power Generation by Alternative over the 20-Year LTEMP Period.....4-363  
13  
14 4.16-1 Weights Used To Reflect the Expected Frequency of Hydrologic Conditions  
15 under Climate Change .....4-371  
16  
17 4.16-2 Mean Annual Inflow Showing the Mean, Median, 75th Percentile,  
18 25th Percentile, Minimum, and Maximum Values for 112 Climate-Change  
19 Inflow Traces and 21 Historic Inflow Traces.....4-372  
20  
21 4.16-3 Differences between Historic and Climate-Change-Weighted Values of Mean  
22 Daily Flow and Mean Daily Change in Flow by Month for LTEMP  
23 Alternatives.....4-376  
24  
25 D-1 Operating Tiers as Specified by the 2007 Interim Guidelines for the Operations  
26 of Lake Powell and Lake Mead..... D-7  
27  
28 D-2 Monthly Releases in kaf for Each Alternative in an 8.23-maf Release Year..... D-21  
29  
30 D-3 Locations of CRSS 29 Natural Flow Nodes..... D-24  
31  
32 D-4 Comparison of CRSS Results Generated Using 105 Traces and 21 Traces for  
33 Lake Powell Annual Inflow, Lake Powell Water Year Release Volume and  
34 Lake Powell Monthly Release Volume..... D-25  
35  
36 D-5 Comparison of CRSS Results Generated Using 105 Traces and 21 Traces for  
37 Lake Powell End of December Water Elevations at the 10th, 50th, and  
38 90th Percentiles ..... D-25  
39  
40 D-6 Occurrences of Low Summer Flows in Applicable Alternatives..... D-28  
41  
42 D-7 Frequency of Occurrence of Modeled Annual Releases Extending beyond the  
43 End of the Water Year per 20-Year Trace for Each of the Alternatives ..... D-29  
44  
45 D-8 Median Volume of Modeled Annual Releases Extending beyond the End of the  
46 Water Year Releases by Trace for Each of the Alternatives ..... D-30

**FIGURES (Cont.)**

1  
2  
3  
4 D-9 Lake Powell and Lake Mead End-of-December Pool Elevation for  
5 21 Hydrology Traces under Alternatives A and B ..... D-30  
6  
7 D-10 Lake Powell and Lake Mead End-of-December Pool Elevation for  
8 21 Hydrology Traces under Alternatives A and C ..... D-31  
9  
10 D-11 Lake Powell and Lake Mead End-of-December Pool Elevation for  
11 21 Hydrology Traces under Alternatives A and D ..... D-31  
12  
13 D-12 Lake Powell and Lake Mead End-of-December Year Pool Elevation for  
14 21 Hydrology Traces under Alternatives A and E ..... D-32  
15  
16 D-13 Lake Powell and Lake Mead End-of-December Pool Elevation for  
17 21 Hydrology Traces under Alternatives A and F ..... D-32  
18  
19 D-14 Lake Powell and Lake Mead End-of-December Pool Elevation for  
20 21 Hydrology Traces under Alternatives A and G ..... D-33  
21  
22 D-15 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
23 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
24 Alternatives A and B ..... D-33  
25  
26 D-16 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
27 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
28 Alternatives A and C ..... D-34  
29  
30 D-17 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
31 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
32 Alternatives A and D ..... D-34  
33  
34 D-18 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
35 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
36 Alternatives A and E ..... D-35  
37  
38 D-19 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
39 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
40 Alternatives A and F ..... D-35  
41  
42 D-20 Percent of Traces below Lake Powell’s Minimum Power Pool and Percent of  
43 Traces with a Lower Basin Shortage for 21 Hydrology Traces under  
44 Alternatives A and G ..... D-36  
45  
46



**FIGURES (Cont.)**

1  
2  
3  
4 E-1 Comparison of Calendar, Water, and Sediment Years..... E-20  
5  
6 E-2 Model Flow Diagram for Analyses Showing Inputs, Intermediate Calculations,  
7 and Output ..... E-21  
8  
9 E-3 Conceptual Schematic of the Sand Budget Model ..... E-22  
10  
11 E-4 Historical Paria Sediment Load per Accounting Period and the 20.5-year Load  
12 for the Trace That Begins in Each Fall Accounting Period..... E-22  
13  
14 E-5 Sediment Traces s1, s2, and s3 for the Paria River Used in the Modeling to  
15 Account for Uncertainty in Future Delivery ..... E-23  
16  
17 E-6 Little Colorado River Sediment Traces for s1, s2, and s3 Used in the Modeling  
18 to Account for Uncertainty in Future Delivery ..... E-23  
19  
20 E-7 Conceptual Representation of the Sand Mass Balance Index ..... E-24  
21  
22 E-8 Average Sediment and Hydrology Triggered HFE Count by Type for Each  
23 Long-Term Strategy ..... E-24  
24  
25 E-9 Average HFE Count for Sediment Traces s1, s2, s3 for Each Long-Term  
26 Strategy ..... E-25  
27  
28 E-10 Definition of the Statistics Represented by the Box and Whisker Plots Used in  
29 This Analysis ..... E-25  
30  
31 E-11 Sand Load Index Statistics from 63 Simulations for Each Long-Term Strategy ..... E-26  
32  
33 E-12 Standard Deviation of High Flows Statistics from 63 Simulations for Each  
34 Long-Term Strategy ..... E-26  
35  
36 E-13 Correlation between SDHF and SLI..... E-27  
37  
38 E-14 Sand Mass Balance Index Statistics from 63 Simulations for Each Long-Term  
39 Strategy ..... E-27  
40  
41 E-15 Correlation between SMBI and SLI ..... E-28  
42  
43 E-16 Sand Load Index for Long-Term Strategies Using Climate Change Weights ..... E-28  
44  
45 E-17 Comparison of the Sand Load Index between Climate Change and Historical  
46 Weights..... E-29

**FIGURES (Cont.)**

1  
2  
3  
4 E-18 Standard Deviation of High Flows Using Climate Change Weights ..... E-29  
5  
6 E-19 Comparison of the Standard Deviation of High Flows between Climate Change  
7 and Historical Weights ..... E-30  
8  
9 E-20 Sand Mass Balance Index Using Climate Change Weights ..... E-30  
10  
11 E-21 Comparison of the Sand Mass Balance Index between Climate Change and  
12 Historical Weights ..... E-31  
13  
14 E-22 Comparison of Long-Term Strategies C1 and C2 for Hydrology Trace 1,  
15 Sediment Trace 3 ..... E-31  
16  
17 E-23 SMBI for Alternative E Plotted against Alternative C ..... E-32  
18  
19 E-24 SLI for Alternative E Plotted against Alternative C ..... E-32  
20  
21 E-25 Load-Following Curtailment Effects on SLI and SMBI ..... E-33  
22  
23 E-26 Low Summer Flows for WY 2014, Hydrology Trace 1, Sediment Trace 1 ..... E-34  
24  
25 E-27 Hydrology Impacts on the Sand Load Index ..... E-35  
26  
27 E-28 Hydrology Impacts on the Sand Mass Balance Index ..... E-35  
28  
29 E-29 Conceptual Diagram of Water Surface Elevation Affecting Delta Location ..... E-36  
30  
31 E-30 Historical Cumulative Sand Load Leaving Marble Canyon and Reaching the  
32 Gage above Diamond Creek ..... E-36  
33  
34 E-31 Hydrology Impacts of Lake Powell Pool Elevations by Month across  
35 Alternatives ..... E-37  
36  
37 E-32 Hydrology Impacts of Lake Mead Pool Elevations by Month across  
38 Alternatives ..... E-37  
39  
40 F-1 Fit of Regressions Predicting the Log of Recruitment of Rainbow Trout in the  
41 Glen Canyon Reach Estimated by the Korman et al. (2012) Stock Synthesis  
42 Model as a Function of the Annual Release Volume from Glen Canyon Dam,  
43 the Range of Mean Daily Flows during May–August, and the Maximum Flow  
44 Each Year ..... F-31  
45

**FIGURES (Cont.)**

1  
2  
3  
4 F-2 Relationship between Annual Estimates of the Asymptotic Length of Rainbow  
5 Trout in Lees Ferry Predicted by the Stock Synthesis Model as a Function of  
6 the Estimated Abundance for Fish >150 mm Each Year ..... F-32  
7  
8 F-3 The Relationship between Annual Recruitment of Rainbow Trout in Lees Ferry  
9 Estimated by the Korman et al. (2012) Stock Synthesis Model and the Number  
10 of Trout That Emigrate from Lees Ferry into Marble Canyon the Following  
11 Year ..... F-35  
12  
13 F-4 Fit of the Glen Canyon Rainbow Trout Simulation Model to Predictions of  
14 Recruitment, Asymptotic Length, and the Number of Out-migrants Predicted  
15 by the Korman et al. (2012) Stock Synthesis Model..... F-37  
16  
17 F-5 Predicted and Observed Annual Catch of Rainbow Trout by Year and River  
18 Reach ..... F-41  
19  
20 F-6 Best-Fitting Distributions Describing Monthly Movement of Rainbow Trout in  
21 Marble Canyon Assuming Either a Normal or Cauchy Distribution ..... F-43  
22  
23 F-7 Visual Summary of Humpback Chub Population Model Structure ..... F-44  
24  
25 F-8 Modeled Effects of Trout Abundance and Temperature on Humpback Chub  
26 Survival and Growth..... F-48  
27  
28 F-9 Simulated Adult Abundances from Backcasted Model Compared to Patterns  
29 Reported in Coggins and Walters (2009) ..... F-51  
30  
31 F-10 Modeled Average Population Size of Age-1 and Older Rainbow Trout in the  
32 Glen Canyon Reach during the 20-year LTEMP Period under LTEMP  
33 Alternatives and Long-Term Strategies..... F-54  
34  
35 F-11 Modeled Mean Annual Number of Rainbow Trout in the Glen Canyon Reach  
36 Exceeding 16 in. Total Length during the 20-year LTEMP Period under the  
37 LTEMP Alternatives and Long-Term Strategies ..... F-55  
38  
39 F-12 Relationship between Modeled Mean Rainbow Trout Abundance in the Glen  
40 Canyon Reach and the Mean Number of Rainbow Trout Exceeding 16 in. Total  
41 Length during the 20-year LTEMP Period under the LTEMP Alternatives and  
42 Long-Term Strategies..... F-56  
43  
44 F-13 Modeled Mean Annual Angler Catch Rate for Rainbow Trout in the Glen  
45 Canyon Reach during the 20-year LTEMP Period under the LTEMP  
46 Alternatives and Long-Term Strategies..... F-57

**FIGURES (Cont.)**

1  
2  
3  
4 F-14 Relationship between Modeled Mean Rainbow Trout Abundance in the Glen  
5 Canyon Reach and Mean Angler Catch Rates during the 20-year LTEMP  
6 Period under the LTEMP Alternatives and Long-Term Strategies ..... F-58  
7  
8 F-15 Modeled Annual Average Number of Rainbow Trout Emigrating into the  
9 Marble Canyon Reach from the Glen Canyon Reach during the 20-year  
10 LTEMP Period under the LTEMP Alternatives and Long-Term Strategies ..... F-59  
11  
12 F-16 Modeled Frequency of Triggered Mechanical Removal for Rainbow Trout in  
13 the Little Colorado River Reach during the 20-year LTEMP Period under the  
14 LTEMP Alternatives and Long-Term Strategies ..... F-61  
15  
16 F-17 Modeled Minimum Population Size for Humpback Chub during the 20-year  
17 LTEMP Period under the LTEMP Alternatives and Long-Term Strategies ..... F-62  
18  
19 F-18 Relationship between Modeled Mean Numbers of Rainbow Trout Out-migrants  
20 from the Glen Canyon Reach and the Modeled Mean Minimum Abundance of  
21 Adult Humpback Chub during the 20-year LTEMP Period under the LTEMP  
22 Alternatives and Long-Term Strategies ..... F-63  
23  
24 F-19 Suitability for Spawning, Egg Incubation, and Growth of Humpback Chub as a  
25 Function of Water Temperature ..... F-68  
26  
27 F-20 Months for Which Annual Temperature Suitability for Specific Life History  
28 Aspects of Humpback Chub Were Calculated ..... F-68  
29  
30 F-21 Modeled Historic Water Temperatures in the Colorado River at Humpback  
31 Chub Aggregation Locations, Water Years 1990–2012 ..... F-70  
32  
33 F-22 Output from the Temperature Suitability Model for Humpback Chub  
34 Aggregation Locations Based on Modeled Water Temperatures for Water  
35 Years 1990–2012 ..... F-71  
36  
37 F-23 Mainstem Temperature Suitability for Humpback Chub Aggregation Locations  
38 under LTEMP Alternatives and Long-Term Strategies ..... F-72  
39  
40 F-24 Suitability of Water Temperatures for Spawning, Egg Incubation, and Growth  
41 of Native Fish Species ..... F-74  
42  
43 F-25 Months for Which Temperature Suitability for Specific Life History Aspects  
44 Were Considered for Native Fish Species ..... F-74  
45

**FIGURES (Cont.)**

1  
2  
3  
4 F-26 Modeled Historic Water Temperatures in the Colorado River Downstream of  
5 Glen Canyon Dam, Water Years 1990–2012 ..... F-75  
6  
7 F-27 Annual Temperature Suitability Scores for Growth, Spawning, and Egg  
8 Incubation of Native Fish Species at RM 225 Based on Modeled Water  
9 Temperatures for Water Years 1990–2012 ..... F-76  
10  
11 F-28 Annual Temperature Suitability Scores for Native Fish by Assessment Location  
12 Based on Modeled Water Temperatures for Water Years 1990–2012..... F-77  
13  
14 F-29 Mean Annual Overall Temperature Suitability for Native Fish by Assessment  
15 Location Based on Modeled Water Temperatures for Water Years 1990–2012 ..... F-77  
16  
17 F-30 Mean Annual Mainstem Temperature Suitability for Native Fish under LTEMP  
18 Alternatives and Long-Term Strategies at RM 61, RM 157, and RM 225, and  
19 Overall Mean for RM 61–225 ..... F-78  
20  
21 F-31 Suitability of Water Temperatures for Spawning, Egg Incubation, and Growth  
22 of Nonnative Fish Species ..... F-80  
23  
24 F-32 Months during Which Temperature Suitability for Specific Life History  
25 Aspects Were Calculated for Nonnative Fish Species ..... F-81  
26  
27 F-33 Annual Temperature Suitability Scores for Spawning, Incubation, and Growth  
28 of Nonnative Fish Species at RM 225 Based on Modeled Temperatures for  
29 Water Years 1990 to 2012 ..... F-82  
30  
31 F-34 Mean Annual Temperature Suitability Scores for Nonnative Fish Species and  
32 for Temperature Groups by River Location Based on Modeled Water  
33 Temperatures for Water Years 1990–2012 ..... F-83  
34  
35 F-35 Mean Annual Overall Temperature Suitability Scores for Coldwater and  
36 Warmwater Nonnative Fish Species Groups Based on Modeled Historic  
37 Temperatures for Water Years 1990–2012 ..... F-83  
38  
39 F-36 Mean Annual Mainstem Temperature Suitability for Coldwater Nonnative Fish  
40 under LTEMP Alternatives and Long-Term Strategies at RM –15 RM 61, RM  
41 157, and RM 225 ..... F-84  
42  
43 F-37 Mean Annual Mainstem Temperature Suitability for Warmwater Nonnative  
44 Fish under LTEMP Alternatives and Long-Term Strategies at RM 0, RM 61,  
45 RM 157, and RM 225 ..... F-85  
46

**FIGURES (Cont.)**

1  
2  
3  
4 F-38 Suitability of Various Water Temperatures for Host Activity and Infestation  
5 Rates of Parasite Species ..... F-86  
6  
7 F-39 Annual Temperature Suitability Scores for Parasite Species at RM 225 ..... F-87  
8  
9 F-40 Mean Annual Temperature Suitability Scores for Parasite Species by River  
10 Location Based on Modeled Water Temperatures for Water Years 1990–2012 ..... F-87  
11  
12 F-41 Overall Means of Annual Suitability Scores for Parasite Species Across All  
13 River Locations during the 1990–2012 Water Years ..... F-88  
14  
15 F-42 Overall Modeled Mean Annual Temperature Suitability under LTEMP  
16 Alternatives and Long-Term Strategies for Aquatic Fish Parasites at Four  
17 Locations Downstream of Glen Canyon Dam..... F-89  
18  
19 G-1 Native Cover Metric for the LTEMP Alternatives and Associated Long-Term  
20 Strategies ..... G-45  
21  
22 G-2 Native Cover Metric under Climate Change for the LTEMP Alternatives and  
23 Associated Long-Term Strategies ..... G-45  
24  
25 G-3 Native Diversity Metric for the LTEMP Alternatives and Associated Long-  
26 Term Strategies..... G-46  
27  
28 G-4 Native Diversity Metric under Climate Change for the LTEMP Alternatives  
29 (Letters) and Associated Long-Term Strategies..... G-46  
30  
31 G-5 Native/Nonnative Ratio Metric for the LTEMP Alternatives and Associated  
32 Long-Term Strategies..... G-47  
33  
34 G-6 Native/Nonnative Ratio Metric under Climate Change for the LTEMP  
35 Alternatives and Associated Long-Term Strategies ..... G-47  
36  
37 G-7 Arrowweed Metric for the LTEMP Alternatives and Associated Long-Term  
38 Strategies ..... G-48  
39 G-8 Arrowweed Metric under Climate Change for the LTEMP Alternatives and  
40 Associated Long-Term Strategies ..... G-48  
41  
42 G-9 Overall Combined Score for the LTEMP Alternatives and Associated Long-  
43 Term Strategies..... G-49  
44  
45 G-10 Overall Combined Score under Climate Change for the LTEMP Alternatives  
46 and Associated Long-Term Strategies..... G-49

**FIGURES (Cont.)**

1  
2  
3  
4 G-11 Relative Change in Wetland Cover for the LTEMP Alternatives and Associated  
5 Long-Term Strategies..... G-50  
6  
7 G-12 Relative Change in Wetland Cover under Climate Change for the LTEMP  
8 Alternatives and Associated Long-Term Strategies ..... G-50  
9  
10 H-1 Wind Transport of Sediment Index Values for the LTEMP Alternatives and  
11 Associated Long-Term Strategies ..... H-6  
12  
13 H-2 Average Number of HFEs in the 20-Year LTEMP Period ..... H-7  
14  
15 H-3 Daily Maximum Discharge in a Typical 8.23-maf Water Volume Release Year  
16 from the Glen Canyon Dam during the Windy Season of March–June..... H-8  
17  
18 H-4 Number of Days per Year Flows Would Be >23,200 cfs under LTEMP  
19 Alternatives and Long-Term Strategies..... H-10  
20  
21 H-5 Average Number of Days of an HFE Event per Year ..... H-11  
22  
23 H-6 Modeled Glen Canyon Dam Discharge for the Same Year ..... H-12  
24  
25 H-7 Time Off River Index Values for All LTEMP Alternatives and Associated  
26 Long-Term Strategies..... H-14  
27  
28 H-8 Daily Average Discharge for Representative Long-Term LTEMP Strategies..... H-15  
29  
30 I-1 Riparian Diversity for the LTEMP Alternatives and Associated Long-Term  
31 Strategies ..... I-6  
32  
33 I-2 Riparian Diversity under Climate Change Assumptions for the LTEMP  
34 Alternatives and Associated Long-Term Strategies ..... I-7  
35  
36 I-3 Wetland Abundance for the LTEMP Alternatives and Associated Long-Term  
37 Strategies ..... I-9  
38  
39 I-4 Wetland Abundance under Climate Change Assumptions for the LTEMP  
40 Alternatives and Associated Long-Term Strategies ..... I-10  
41  
42 I-5 Frequency of Trout Management Flows for the LTEMP Alternatives and  
43 Associated Long-Term Strategies ..... I-12  
44  
45 I-6 Frequency of Trout Management Flows under Climate Change Assumptions  
46 for the LTEMP Alternatives and Associated Long-Term Strategies ..... I-13

**FIGURES (Cont.)**

1  
2  
3  
4 I-7 Frequency of Mechanical Removal for the LTEMP Alternatives and Associated  
5 Long-Term Strategies..... I-14  
6  
7 I-8 Frequency of Mechanical Removal under Climate Change Assumptions for the  
8 LTEMP Alternatives and Associated Long-Term Strategies..... I-15  
9  
10 I-9 Lake Powell Water Levels for the LTEMP Alternatives and Associated Long-  
11 Term Strategies..... I-16  
12  
13 I-10 Lake Powell Water Levels under Climate Change Assumptions for the LTEMP  
14 Alternatives and Associated Long-Term Strategies..... I-17  
15  
16 J-1 Camping Area Index for LTEMP Long-Term Strategies..... J-8  
17  
18 J-2 Sand Load Index for LTEMP Long-Term Strategies..... J-9  
19  
20 J-3 Navigational Risk Index Values for the LTEMP Long-Term Strategies..... J-11  
21  
22 J-4 Fluctuation Index for LTEMP Long-Term Strategies..... J-13  
23  
24 J-5 Time Off River Index for LTEMP Long-Term Strategies..... J-15  
25  
26 J-6 Average Daily Discharge for All Modeled Traces and Years under LTEMP  
27 Alternatives..... J-16  
28  
29 J-7 Glen Canyon Rafting Metric for All LTEMP Long-Term Strategies..... J-18  
30  
31 J-8 Average Number of HFES in the 20-Year LTEMP Period for LTEMP  
32 Long-Term Strategies..... J-19  
33  
34 J-9 Glen Canyon Inundation Metric for All LTEMP Long-Term Strategies..... J-21  
35  
36 J-10 Percentage of Traces Lake Powell Elevation Equal to or below 3,580 ft AMSL  
37 for the Summer Season..... J-23  
38  
39 J-11 Percentage of Traces Lake Powell Elevation Equal to or below 3,580 ft AMSL  
40 for the Fall and Spring Seasons..... J-23  
41  
42 J-12 Percentage of Traces Lake Mead Elevation Equal to or below 1,050 ft AMSL  
43 for the Summer Season..... J-24  
44  
45 J-13 Percentage of Traces Lake Mead Elevation Equal to or below 1,050 ft AMSL  
46 for the Fall and Spring Seasons..... J-24



**FIGURES (Cont.)**

1  
2  
3  
4 K.1-1 Network Topology Used by the AURORA Western Interconnection Model..... K-10  
5  
6 K.1-2 SLCA/IP LTF Customer Capacity Ownership Percentages..... K-12  
7  
8 K.1-3 Simplified Network Topology of the SLCA/IP Market System ..... K-13  
9  
10 K.1-4 Percent of SLCA/IP Federal Hydropower Nameplate Capacity by Facility..... K-16  
11  
12 K.1-5 Flow Diagram of the Power Systems Methodology Used in the LTEMP DEIS ..... K-18  
13  
14 K.1-6 Illustration of a Typical GTMax-Lite Result for a 24-Hour Period ..... K-24  
15  
16 K.1-7 GTMax-Lite Network Topology for the Large SLCA/IP Hydropower  
17 Resources Other Than Glen Canyon Dam ..... K-26  
18  
19 K.1-8 Illustration of Temporal Modeling Method Used in the GTMax-Lite Five Large  
20 SLCA/IP Plant Configuration..... K-28  
21  
22 K.1-9 Example of the Load Scaling Algorithm LDC..... K-31  
23  
24 K.1-10 Example of the Load Scaling Algorithm Chronological Hourly Loads..... K-32  
25  
26 K.1-11 Projected Annual Average Calibrated AURORA LMPs at the Palo Verde  
27 Market Hub..... K-36  
28  
29 K.1-12 Historical Palo Verde On- and Off-Peak Electricity Prices Compared to Natural  
30 Gas Prices ..... K-36  
31  
32 K.1-13 2014 AEO Projected Delivered Utility Natural Gas Prices..... K-38  
33  
34 K.1-14 Comparison of Modeled and Actual Annual Aggregated Generation Levels for  
35 Natural Gas, Coal, and Nuclear Powerplants under the No Action Alternative ..... K-43  
36  
37 K.1-15 Total Non-coincidental Peak Loads for the SLCA/IP Market System..... K-49  
38  
39 K.1-16 Total Monthly Loads for the SLCA/IP Market System ..... K-49  
40  
41 K.1-17 Projected 2014 AEO Natural Gas Prices at the Henry Hub ..... K-55  
42  
43 K.1-18 2014 AEO Electricity Market Module Regions and the Mapping of States to  
44 Regions ..... K-56  
45  
46 K.1-19 Projected AEO 2014 Coal Prices by Electricity Market Module Region ..... K-58

**FIGURES (Cont.)**

1  
2  
3  
4 K.1-20 Western SLCA/IP Hydropower Powerplants ..... K-62  
5  
6 K.1-21 SLCA/IP Federal Hydropower Capacity Uses and Variability Factors ..... K-63  
7  
8 K.1-22 Reductions in Operating Range when Providing Ancillary Services..... K-65  
9  
10 K.1-23 Illustration of the Trapezoidal Method Used to Compute Capacity at Flaming  
11 Gorge Dam ..... K-71  
12  
13 K.1-24 Illustration of Ramping Time Increase as a Function of Increasing Water  
14 Volumes at Flaming Gorge Dam..... K-72  
15  
16 K.1-25 Capacity Values at Flaming Gorge Dam Calculated over a Wide Range of  
17 Daily Water Releases Using the Trapezoidal Method ..... K-73  
18  
19 K.1-26 Average Historical Non-coincidental Annual Peak Loads for the Eight Large  
20 Customers and Percentages Relative to the Total ..... K-75  
21  
22 K.1-27 Historical Coincidental Annual and Average Peak Loads for the Eight Large  
23 Customers during the CY 2006 through CY 2009 Time Period ..... K-76  
24  
25 K.1-28 Historical Coincidental Annual and Average Peak Loads for Six Large  
26 Customers during the CY 2010 through CY 2012 Time Period ..... K-76  
27  
28 K.1-29 SLCA/IP Models Used for Estimating SHP Capacity ..... K-78  
29  
30 K.1-30 Historical SHP Capacity Obligation and Western Estimated Risk Level in July ..... K-79  
31  
32 K.1-31 Historical SHP Capacity Obligation and Western Estimated Risk Level in  
33 August..... K-80  
34  
35 K.1-32 Comparison of Firm Marketable Capacity Determinations across Alternatives,  
36 Exceedance Levels, and Summer Peak Months ..... K-80  
37  
38 K.1-33 Timing of Capacity Additions in AURORA ..... K-83  
39  
40 K.1-34 Annual Average Hydropower Generation for the Glen Canyon Dam Powerplant  
41 and the Aggregate Generation for all other SLCA/IP Resources..... K-87  
42  
43 K.1-35 Average Daily Glen Canyon Dam Powerplant Hydropower Generations by  
44 Month Based on the Average of All 21 CRSS/SBM Hydrology Traces ..... K-88  
45

**FIGURES (Cont.)**

1  
2  
3  
4 K.1-36 Average Annual Glen Canyon Dam Powerplant Generation for the  
5 Representative CRSS/SBM Hydrology Trace..... K-91  
6  
7 K.1-37 Representative Trace Average Daily Glen Canyon Dam Powerplant  
8 Generations by Month ..... K-92  
9  
10 K.1-38 Average Daily Generation by Month for Each Alternative..... K-96  
11  
12 K.1-39 Palo Verde Average Daily Electricity Market Price Statistics by Month during  
13 the 20-Year LTEMP Period..... K-97  
14  
15 K.1-40 Typical Hourly Winter/Summer Price Patterns in the Western United States ..... K-98  
16  
17 K.1-41 Average Number of HFEs by Alternative for All 21 Hydrology Traces of  
18 Sediment Trace 2 ..... K-99  
19  
20 K.1-42 Average Amount of Water Spilled by Alternative for All 21 Hydrology Traces  
21 of Sediment Trace 2..... K-99  
22  
23 K.1-43 Average Annual Number of Hours the Lake Powell Elevation Is below the  
24 Penstock Intake by Alternative for All 21 Hydrology Traces of Sediment  
25 Trace 2 ..... K-100  
26  
27 K.1-44 2014 Annual Energy Outlook Projections of Capacity Additions in the Western  
28 Interconnection over the LTEMP Period ..... K-103  
29  
30 K.1-45 Cumulative Capacity Additions for Alternative A ..... K-105  
31  
32 K.1-46 Cost Difference of Alternatives Compared to Alternative A at 50% Exceedance  
33 Level and 3.375% Discount Rate ..... K-117  
34  
35 K.1-47 Cost Difference of Alternatives Compared to Alternative A at 90% Exceedance  
36 Level and 3.375% Discount Rate ..... K-118  
37  
38 K.1-48 Cost Difference of Alternatives Compared to Alternative A at 99% Exceedance  
39 Level and 3.375% Discount Rate ..... K-118  
40  
41 K.1-49 Cost Difference of Alternatives Compared to Alternative A at 90% Exceedance  
42 Level and 1.4% Discount Rate ..... K-120  
43  
44 K.1-50 Cost Difference of Alternatives Compared to Alternative A at 90% Exceedance  
45 Level and 3.375% Discount Rate, Assuming All Alternative A New Capacity  
46 Additions Are Advanced Combustion Turbines ..... K-122

**FIGURES (Cont.)**

1  
2  
3  
4 K.1-51 Cost Difference of Alternatives Compared to Alternative A at 90% Exceedance  
5 Level and 3.375% Discount Rate, Assuming All Alternative A New Capacity  
6 Additions Are Advanced Combined Cycle .....K-123  
7  
8 K.1-52 Cost Difference of Alternatives Compared to Alternative A at 90% Exceedance  
9 Level and 3.375% Discount Rate Assuming Average Hydropower Conditions.....K-124  
10  
11 K.2-1 Determination of Energy Hourly Expense or Revenue .....K-136  
12  
13 K.2-2 Determination of Total Net Expense or Revenue by Year for Each Alternative .....K-138  
14  
15 K.3-1 Flowchart Diagram of Rate Impact Analysis Process .....K-152  
16  
17 K.3-2 Projected Carrying Charge Rates Used in Rate Impact Analysis.....K-157  
18  
19 K.3-3 Flowchart Diagram of Allocation Process .....K-158  
20  
21 K.3-4 Load Factors of SLCA/IP Power.....K-161  
22  
23 K.3-5 Scatter Plot of Preference Ratio and Annual Retail Sales.....K-165  
24  
25 K.3-6 Scatter Plots of Percent Retail Rate Change and the Preference Ratio .....K-167  
26  
27 K.3-7 Retail Rate Distribution under Alternative A.....K-168  
28  
29 K.3-8 Monthly Residential Bill Distribution under Alternative A .....K-169  
30  
31 K.3-9 Average Retail Rate Impacts under LTEMP Alternatives Relative to  
32 Alternative A .....K-170  
33  
34 K.3-10 Average Residential Bill Impacts under LTEMP alternatives Relative to  
35 Alternative A .....K-170  
36  
37 K.3-11 Average Retail Percent Revenue Increase Relative to Alternative A .....K-171  
38  
39 K.3-12 Average Monthly Residential Bill Changes Relative to Alternative A.....K-172  
40  
41 K.3-13 Retail Rates under Alternative A.....K-183  
42  
43 K.4-1 Calculation of Change in Tribal Benefit Resulting from LTEMP DEIS  
44 Alternatives.....K-190  
45

**FIGURES (Cont.)**

1  
2  
3  
4 K.4-2 Financial Impacts under Alternative B Relative to Alternative A for Tribal and  
5 Non-Tribal Entities .....K-199  
6  
7 K.4-3 Financial Impacts under Alternative C Relative to Alternative A for Tribal and  
8 Non-Tribal Entities .....K-199  
9  
10 K.4-4 Financial Impacts under Alternative D Relative to Alternative A for Tribal and  
11 Non-Tribal Entities .....K-200  
12  
13 K.4-5 Financial Impacts under Alternative E Relative to Alternative A for Tribal and  
14 Non-Tribal Entities .....K-200  
15  
16 K.4-6 Financial Impacts under Alternative F Relative to Alternative A for Tribal and  
17 Non-Tribal Entities .....K-201  
18  
19 K.4-7 Financial Impacts under Alternative G Relative to Alternative A for Tribal and  
20 Non-Tribal Entities .....K-201  
21  
22 K.5-1 Comparison of Alternative A and Alternative F Lake Powell Average Monthly  
23 Water Releases over the 20-Year Study Period and 21 Hydrology Traces.....K-203  
24  
25 K.5-2 Impact of Changed Lake Powell Month Water Release Volumes on Mead  
26 Average EOM Pool Elevations .....K-203  
27  
28 K.5-3 Lake Mead Storage Elevation Curve and Change in Elevation as a Function of  
29 Lake Mead Water Storage .....K-204  
30  
31 K.5-4 Results of Water-to-Power Conversion Factor Back-casting Exercise.....K-207  
32  
33 K.5-5 Average Monthly Water-to-Power Conversion Factor and Energy Production  
34 per ac-ft of Total Mead Reservoir Release.....K-209  
35  
36 K.5-6 Average Monthly Turbine and Bypass Water Releases .....K-209  
37  
38 K.5-7 Average Monthly Change in Turbine Water Releases .....K-210  
39  
40 K.5-8 Monthly Probability of a Water Bypass Event Due to a Low Mead Pool  
41 Elevation.....K-210  
42  
43 K.5-9 Average Monthly Generation per ac-ft of Total Mead Reservoir Release for All  
44 Power Systems Primary LTEMP DEIS Alternatives .....K-211  
45

**FIGURES (Cont.)**

1  
2  
3  
4 K.5-10 Alternative F Changes in Monthly Hoover Powerplant Turbine Water Releases  
5 under Hydrology Trace 8.....K-212  
6  
7 K.5-11 Average Monthly Hoover Powerplant Generation for All Power Systems  
8 Primary LTEMP DEIS Alternatives.....K-213  
9  
10 K.5-12 Hoover Powerplant Maximum Physical Output as a Function of Lake Mead  
11 Pool Elevation .....K-213  
12  
13 K.5-13 Hoover Powerplant Maximum Output Exceedance Curve for the Month of  
14 August.....K-214  
15  
16 K.5-14 Average Monthly Change in Hoover Powerplant Energy Economic Value  
17 Relative to Alternative A for All Power Systems Primary LTEMP SEIS  
18 Alternatives.....K-215  
19  
20 K.5-15 NPV of Hoover Powerplant Benefits Relative to Alternative A Resulting from  
21 LTEMP Alternatives .....K-216  
22  
23 K.5-16 NPV Comparison of SLCA/IP Costs and Hoover Powerplant Benefits  
24 Resulting from Changed Operating Criteria at Glen Canyon Dam.....K-217  
25  
26 K.5-17 NPV Comparison of SLCA/IP Costs and Hoover Powerplant Benefits  
27 Resulting from LTEMP Alternatives .....K-217  
28  
29 L-1 Elements of the Lake\_Full Utility Model..... L-5  
30  
31 L-2 Elements of the GCRec\_Full Utility Model..... L-6  
32  
33 L-3 Elements of the Regional Recreation Impacts Analysis..... L-9  
34  
35 L-4 Elements of the Regional Electricity Price Impacts Analysis..... L-14  
36  
37 L-5 Elements of the Regional Electricity Generating Capacity Expansion Impacts  
38 Analysis..... L-16  
39  
40

**TABLES**

1  
2  
3  
4 1-1 Glen Canyon Dam Release Constraints under Modified Low Fluctuating Flows ..... 1-21  
5  
6 1-2 Selected Documents Included in the Law of the River ..... 1-32  
7  
8 2-1 Operational Characteristics of LTEMP Alternatives ..... 2-9  
9  
10 2-2 Condition-Dependent and Experimental Elements of LTEMP Alternatives ..... 2-11  
11  
12 2-3 Flow Parameters under Alternative A in an 8.23-maf Year ..... 2-16  
13  
14 2-4 Flow Parameters under Alternative B in an 8.23-maf Year ..... 2-20  
15  
16 2-5 Flow Parameters under Alternative C in an 8.23-maf Year ..... 2-25  
17  
18 2-6 Implementation Criteria for Experimental Treatments of Alternative C ..... 2-30  
19  
20 2-7 Flow Parameters for a Year with Low Summer Flows under Alternative C  
21 in an 8.23-maf Year ..... 2-41  
22  
23 2-8 Flow Parameters under Alternative D in an 8.23-maf Year ..... 2-44  
24  
25 2-9 Implementation Criteria for Experimental Treatments of Alternative D ..... 2-48  
26  
27 2-10 Flow Parameters for a Year with Low Summer Flows under Alternative D  
28 in an 8.23-maf Year ..... 2-65  
29  
30 2-11 Flow Parameters under Alternative E in an 8.23-maf Year ..... 2-70  
31  
32 2-12 Flow Parameters under Alternative F in an 8.23-maf Year ..... 2-79  
33  
34 2-13 Flow Parameters under Alternative G in an 8.23-maf Year ..... 2-80  
35  
36 2-14 Summary of Impacts of LTEMP Alternatives on Resources ..... 2-89  
37  
38 3.5-1 Native Fish of the Colorado River through Glen and Grand Canyons ..... 3-68  
39  
40 3.5-2 Nonnative Fish Found in Colorado River through Glen and Grand Canyons ..... 3-86  
41  
42 3.5-3 Mean Water Temperature and Turbidity for Selected Sites in the Colorado  
43 River Mainstem from 2006 to 2009 ..... 3-89  
44  
45 3.5-4 Nonnative Warmwater Fish Species Reported from the Little Colorado River  
46 Watershed ..... 3-96

**TABLES (Cont.)**

1  
2  
3  
4 3.6-1 Plant Communities Occurring on Reattachment Bars, Separation Bars, and  
5 Channel Margins .....3-107  
6  
7 3.6-2 Special Status Plant Species Known to Occur along the Colorado River from  
8 Glen Canyon Dam to Lake Mead .....3-116  
9  
10 3.7-1 Habitat and Distribution of Threatened, Endangered, and Sensitive Wildlife  
11 Species along the Colorado River Corridor between Glen Canyon Dam and  
12 Lake Mead .....3-127  
13  
14 3.10-1 Colorado River Discovery Commercial Rafting Passengers 2009–2013 .....3-169  
15  
16 3.10-2 Tolerable Daily Flow Fluctuations Reported by Commercial and Private  
17 Trip Leaders .....3-176  
18  
19 3.13-1 Energy and Capacity Characteristics of the Eight Largest Western  
20 Customers, 2013 .....3-199  
21  
22 3.14-1 Population in the Six-County Region .....3-202  
23  
24 3.14-2 Income in the Six-County Region .....3-203  
25  
26 3.14-3 Employment in the Six-County Region .....3-204  
27  
28 3.14-4 Employment by Sector in 2011 .....3-205  
29  
30 3.14-5 Unemployment Rates in the Six-County Region .....3-206  
31  
32 3.14-6 Minority and Low-Income Populations in the 11-County Area .....3-209  
33  
34 3.14-7 Population in the Seven-State Region of Influence .....3-213  
35  
36 3.14-8 Income in the Seven-State Region of Influence .....3-214  
37  
38 3.14-9 Employment in the Seven-State Region of Influence .....3-215  
39  
40 3.14-10 Employment by Sector in 2011 in the Seven-State Region of Influence .....3-216  
41  
42 3.14-11 Unemployment in the Seven-State Region of Influence .....3-217  
43  
44 3.14-12 State Minority and Low-Income Populations, 2010 .....3-218  
45  
46 3.15-1 Clean Air Act Prevention of Significant Deterioration Designations .....3-221



**TABLES (Cont.)**

1  
2  
3  
4 3.15-2 Criteria Pollutant and VOC Emissions in Counties Encompassing Grand  
5 Canyon National Park and for the Navajo Generating Station, 2011.....3-221  
6  
7 3.15-3 Criteria Pollutant and VOC Emissions for 2011, and GHG Emissions for 2010,  
8 over the 11-State Affected Area within the Western Interconnect.....3-226  
9  
10 4.1-1 Experimental Elements Included in Long-Term Strategies Associated with  
11 Each LTEMP Alternative ..... 4-4  
12  
13 4.2-1 Summary of the Impacts of LTEMP Alternatives on Hydrology and Water  
14 Quality ..... 4-13  
15  
16 4.2-2 Summary of Seasonal Temperature Data for LTEMP Alternatives from Lees  
17 Ferry to Diamond Creek..... 4-47  
18  
19 4.3-1 Summary of Impacts of LTEMP Alternatives on Sediment Resources ..... 4-69  
20  
21 4.4-1 Indicators Used To Examine Natural Processes under Each LTEMP Alternative ..... 4-86  
22  
23 4.4-2 Summary of Impacts of LTEMP Alternatives on Natural Processes Associated  
24 with Flow, Water Temperature, Water Quality, and Sediment Resources ..... 4-88  
25  
26 4.5-1 Summary of Impacts of LTEMP Alternatives on Aquatic Ecology.....4-103  
27  
28 4.5-2 Impact of High-Flow Experiments from Glen Canyon Dam on the Aquatic  
29 Food Base .....4-110  
30  
31 4.6-1 Vegetation States, Plant Associations, and Corresponding Submodels .....4-153  
32  
33 4.6-2 Vegetation States and Corresponding Mapped Vegetation Types .....4-156  
34  
35 4.6-3 Summary of Impacts on Old High-Water Zone, New High-Water Zone, and  
36 Wetland Plant Community Types .....4-158  
37  
38 4.6-4 Transitions between Riparian Community Types and the Flows That Initiate  
39 Transitions .....4-166  
40  
41 4.6-5 Priority Nonnative Species Identified for Control within the Colorado River  
42 Corridor .....4-171  
43  
44 4.6-6 Summary of Impacts on Special Status Plant Species under LTEMP  
45 Alternatives.....4-174  
46

**TABLES (Cont.)**

1  
2  
3  
4 4.7-1 Summary of Impacts of LTEMP Alternatives on Wildlife .....4-189  
5  
6 4.7-2 Summary of Impacts of LTEMP Alternatives on Special Status Wildlife  
7 Species .....4-199  
8  
9 4.8-1 Summary of Impacts of LTEMP Alternatives on Cultural Resources in Glen  
10 and Grand Canyons .....4-221  
11  
12 4.9-1 Vegetation Community Diversity and Change in Tamarisk Cover.....4-233  
13  
14 4.9-2 Summary of Impacts on Tribal Resources .....4-243  
15  
16 4.10-1 Summary of Impacts of LTEMP Alternatives on Visitor Use and Experience .....4-259  
17  
18 4.11-1 Summary of Impacts of LTEMP Alternatives on Wilderness Experience.....4-283  
19  
20 4.13-1 Summary of the Impacts of LTEMP Alternatives on Hydropower Resources .....4-307  
21  
22 4.14-1 Summary of Impacts of LTEMP Alternative on Socioeconomics and  
23 Environmental Justice .....4-328  
24  
25 4.14-2 Mean Annual Net Economic Value of Recreation Associated with LTEMP  
26 Alternatives.....4-336  
27  
28 4.14-3 Recreational Visitation by Activity in Lake Powell, Upper and Lower Grand  
29 Canyon, and Lake Mead, 2012.....4-339  
30  
31 4.14-4 Mean Annual Employment Associated with Recreational Expenditures  
32 under LTEMP Alternatives .....4-339  
33  
34 4.14-5 Mean Annual Income Associated with Recreational Expenditures  
35 under LTEMP Alternatives .....4-340  
36  
37 4.14-6 Seven-State Economic Impacts under LTEMP Alternatives of Additional  
38 Generating Capacity for the Eight Largest Customer Utilities, 2015–2033 .....4-341  
39  
40 4.14-7 Average Annual Impacts on Economic Activity from Changes to Residential  
41 Electricity Bills of Largest Eight Customer Utilities, 2015–2033, Relative to  
42 Alternative A .....4-342  
43  
44 4.14-8 Financial Impacts on Tribal and Non-Tribal Electricity Customers .....4-347  
45  
46

**TABLES (Cont.)**

1  
2  
3  
4 4.15-1 Summary of Impacts of LTEMP Alternatives on Visibility and Regional Air  
5 Quality .....4-361  
6  
7 4.15-2 Distributions of SO<sub>2</sub> and NO<sub>x</sub> Emissions Averaged over the 20-Year LTEMP  
8 Period by Alternative.....4-364  
9  
10 4.16-1 Summary of Impacts of LTEMP Alternatives on GHG Emissions .....4-373  
11  
12 4.16-2 Expected Impact of LTEMP Alternatives on Downstream Resources under  
13 Climate Change Compared to Those under Historic Conditions .....4-378  
14  
15 4.17-1 Impacting Factors Associated with Past, Present, and Reasonably Foreseeable  
16 Future Actions and Basin-Wide Trends in the LTEMP Project Area .....4-383  
17  
18 4.17-2 Summary of Cumulative Impacts and Incremental Contributions from LTEMP  
19 Alternatives.....4-399  
20  
21 5.1-1 Summary of Cooperating Agency Involvement..... 5-3  
22  
23 B-1 Tolerable Flow Fluctuations for Recreational River Use..... B-13  
24  
25 D-1 Initial Reservoir Conditions ..... D-5  
26  
27 D-2 Monthly Release Volumes by Water Year Release for Alternative A ..... D-11  
28  
29 D-3 Monthly Release Volumes by Water Year Release for Alternative B ..... D-12  
30  
31 D-4 Monthly Release Volumes by Water Year Release for Alternative C ..... D-13  
32  
33 D-5 Monthly Release Volumes by Water Year Release for Alternative C with Low  
34 Summer Flows..... D-14  
35  
36 D-6 Monthly Release Volumes by Water Year Release for Alternative D ..... D-15  
37  
38 D-7 Monthly Release Volumes by Water Year Release for Alternative D with Low  
39 Summer Flows..... D-16  
40  
41 D-8 Monthly Release Volumes by Water Year Release for Alternative E ..... D-17  
42  
43 D-9 Monthly Release Volumes by Water Year Release for Alternative E with Low  
44 Summer Flows..... D-18  
45  
46 D-10 Monthly Release Volumes by Water Year Release for Alternative F..... D-19

**TABLES (Cont.)**

1  
2  
3  
4 D-11 Monthly Release Volumes by Water Year Release for Alternative G..... D-20  
5  
6 D-12 Minimum Release Constraints Used for Each Alternative..... D-21  
7  
8 D-13 Input Demands, by State..... D-27  
9  
10 E-1 Sources for Historical Tributary Sediment Load Data ..... E-38  
11  
12 E-2 Historical Periods Used for Paria Sediment Traces s1, s2, and s3 ..... E-38  
13  
14 E-3 Historical Periods Used for Little Colorado River Sediment Traces s1,  
15 s2, and s3 ..... E-38  
16  
17 E-4 List of HFEs Available for Sediment-Triggered Events ..... E-39  
18  
19 F-1 Average Mean Habitat-Weighted Invertebrate Biomass at Select Sites in the  
20 Colorado River, July 2006–June 2009 ..... F-8  
21  
22 F-2 Average Mean Habitat-Weighted Invertebrate Production at Select Sites in the  
23 Colorado River, July 2006–June 2009 ..... F-9  
24  
25 F-3 Average Mean Habitat-Weighted Invertebrate Abundance at Select Sites in the  
26 Colorado River, July 2006–June 2009 ..... F-10  
27  
28 F-4 Distribution, Ecological Importance, and Favorable Temperature Range for  
29 Select Primary Producers ..... F-11  
30  
31 F-5 Temperature Requirements for Common Zooplankton ..... F-24  
32  
33 F-6 Distribution, Importance to Higher Trophic Levels, and Temperature Range for  
34 Common Benthic Macroinvertebrates Downstream of Glen Canyon Dam..... F-25  
35  
36 F-7 Temperature Requirements for the Asian Tapeworm, Anchor Worm, and Trout  
37 Nematode..... F-26  
38  
39 F-8 Summary of Metrics Values from the Rainbow Trout-Humpback Chub Model..... F-53  
40  
41 F-9 Description of Input Parameters for the LTEMP Temperature Suitability Model..... F-66  
42  
43 F-10 Humpback Chub Aggregation Locations ..... F-67  
44  
45 F-11 Locations Used for Temperature Suitability Modeling of Native Fish,  
46 Nonnative Fish, and Parasites..... F-73

**TABLES (Cont.)**

1  
2  
3  
4 G-1 Vegetation States, Plant Associations, and Corresponding Submodels ..... G-15  
5  
6 G-2 Hydrologic Events Considered in the Riparian Vegetation Model ..... G-16  
7  
8 G-3 Riparian Vegetation Model Transition Rules ..... G-17  
9  
10 G-4 New High-Water Zone and Old High-Water Zone Vegetation Classes Mapped  
11 from Lees Ferry to Diamond Creek ..... G-22  
12  
13 G-5 Vegetation States and Corresponding Mapped Vegetation Types ..... G-24  
14  
15 G-6 Example Results for the Native Cover Metric ..... G-25  
16  
17 G-7 Example Results for the Arrowweed Metric ..... G-25  
18  
19 G-8 Results for Alternative A ..... G-26  
20  
21 G-9 Results for Alternative B, Long-Term Strategy B1 ..... G-27  
22  
23 G-10 Results for Alternative B, Long-Term Strategy B2 ..... G-28  
24  
25 G-11 Results for Alternative C, Long-Term Strategy C1 ..... G-29  
26  
27 G-12 Results for Alternative C, Long-Term Strategy C2 ..... G-30  
28  
29 G-13 Results for Alternative C, Long-Term Strategy C3 ..... G-31  
30  
31 G-14 Results for Alternative C, Long-Term Strategy C4 ..... G-32  
32  
33 G-15 Results for Alternative D, Long-Term Strategy D1 ..... G-33  
34  
35 G-16 Results for Alternative D, Long-Term Strategy D2 ..... G-34  
36  
37 G-17 Results for Alternative D, Long-Term Strategy D3 ..... G-35  
38  
39 G-18 Results for Alternative D, Long-Term Strategy D4 ..... G-36  
40  
41 G-19 Results for Alternative E, Long-Term Strategy E1 ..... G-37  
42  
43 G-20 Results for Alternative E, Long-Term Strategy E2 ..... G-38  
44  
45 G-21 Results for Alternative E, Long-Term Strategy E3 ..... G-39  
46

**TABLES (Cont.)**

1  
2  
3  
4 G-22 Results for Alternative E, Long-Term Strategy E4..... G-40  
5  
6 G-23 Results for Alternative E, Long-Term Strategy E5..... G-41  
7  
8 G-24 Results for Alternative E, Long-Term Strategy E6..... G-42  
9  
10 G-25 Results for Alternative F..... G-43  
11  
12 G-26 Results for Alternative G..... G-44  
13  
14 I-1 Federal Regulations and Executive Orders Pertaining to Consultation with  
15 Tribes..... I-3  
16  
17 I-2 Vegetation States..... I-5  
18  
19 J-1 Reported Mean Tolerable Daily Changes in Flow Levels for Commercial  
20 Motor Guides, Commercial Oar Guides, and Private Trip Leaders..... J-12  
21  
22 J-2 Recreation Response to Daily Maximum Flow..... J-20  
23  
24 J-3 Summary of Recreation, Visitor Use, and Experience Metrics..... J-25  
25  
26 K.1-1 Cost and Performance Characteristics of Capacity Expansion Candidates..... K-51  
27  
28 K.1-2 Cumulative Annual Percent Increase in Natural Gas Prices at the Henry Hub..... K-54  
29  
30 K.1-3 Cumulative Annual Percent Increase in Regional Coal Prices..... K-57  
31  
32 K.1-4 Cumulative Annual Percent Increase in Regional Distillate Fuel Prices..... K-59  
33  
34 K.1-5 Assumed Ancillary Services Provided by SLCA/IP Hydropower Facilities from  
35 2013 to 2030..... K-64  
36  
37 K.1-6 Summary of Utility IRPS for Four Large SLCA/IP Customers and Other Large  
38 Utilities in Areas Neighboring the SLCA/IP System..... K-86  
39  
40 K.1-7 SLCA/IP Marketable Capacity at the 90% Exceedance Level..... K-101  
41  
42 K.1-8 Difference in Cumulative Capacity Additions of Each Alternative Relative to  
43 Alternative A..... K-104  
44  
45 K.1-9 Comparison of the Amount and Timing of New Capacity Additions for  
46 Alternatives A and F..... K-106

**TABLES (Cont.)**

1  
2  
3  
4 K.1-10 Total Economic Impacts by Alternative at the 90% Exceedance Level .....K-108  
5  
6 K.1-11 Estimated Cost of LTEMP Experiments .....K-115  
7  
8 K.1-12 Comparison of Marketable Capacity, Replacement Capacity, and Capacity  
9 Additions by Exceedance Level .....K-116  
10  
11 K.1-13 Firm SLCA/IP Federal Hydropower Capacity at Various Exceedance Levels at  
12 Glen Canyon Dam by Alternative and Ancillary Service Scenarios.....K-125  
13  
14 K.1-14 Comparison of Capacity and Energy Values at Glen Canyon Dam by  
15 Alternative and Ancillary Services Scenarios at the 90% Exceedance Level.....K-126  
16  
17 K.1-15 Difference Relative to Alternative A.....K-127  
18  
19 K.1-16 Summary of Economic Rankings for Baseline and All Sensitivity Scenarios .....K-128  
20  
21 K.2-1 SHP Contractual Obligations and Project Use Required Deliveries by Month .....K-132  
22  
23 K.2-2 SHP Hourly Load Shapes by Month and Type of Day .....K-133  
24  
25 K.2-3 Total Levelized Capital and Fixed O&M Cost for System Capacity Expansion  
26 by Alternative and Year.....K-137  
27  
28 K.2-4 Total Levelized Capital and Fixed O&M Cost for System Capacity Expansion  
29 by Alternative and Year Expressed as the Difference from Alternative A .....K-139  
30  
31 K.2-5 Total Net Purchase Power Expenses by Year and Alternative for the  
32 Continuous Current Obligations Scenario .....K-143  
33  
34 K.2-6 Total Net Purchase Power Expenses by Year and Alternative for the Reduced  
35 Obligations to Match Resource Scenario .....K-144  
36  
37 K.2-7 SLCA/IP Rate Impact by Alternative.....K-147  
38  
39 K.3-1 Energy Allocations for Systems Receiving Indirect SLCA/IP Allocations .....K-153  
40  
41 K.3-2 Coverage of Retail Information from EIA Database Relative to SLCA/IP  
42 Preference Power Allocation.....K-154  
43  
44 K.3-3 Average Annual Grid Cost Relative to SLCA/IP Wholesale Revenues Relative  
45 to Alternative A .....K-164  
46

**TABLES (Cont.)**

1  
2  
3  
4 K.3-4 Summary Table of Comparative Values .....K-174  
5  
6 K.3-5 Individual Systems with the Largest Percent Retail Rate Impacts Relative to  
7 Alternative A .....K-175  
8  
9 K.3-6 Individual Systems with the Smallest Percent Retail Rate Impacts Relative to  
10 Alternative A .....K-177  
11  
12 K.3-7 Individual Systems with the Largest Monthly Residential Bill Impacts Relative  
13 to Alternative A .....K-179  
14  
15 K.3-8 Individual Systems with the Smallest Monthly Residential Bill Impacts  
16 Relative to Alternative A.....K-180  
17  
18 K.3-9 Size and Preference Ratio for Utility Systems with Large Rate Impacts.....K-181  
19  
20 K.3-10 Rate Impacts for Selected Groups in Maximum Impact Year .....K-182  
21  
22 K.4-1 Monthly Change in Residential Electric Utility Bill for Tribes by Alternative .....K-192  
23  
24 K.4-2 Total Dollar Annual Impact on Tribes under LTEMP Alternatives Relative to  
25 Alternative A .....K-194  
26  
27 L-1 Total Regional Economic Impacts of Non-Local Recreation Expenditures, 2013 ..... L-12  
28  
29 L-2 Urban Population, Income, and Poverty in the Six-County Region..... L-17  
30  
31 M-1 Emission Factors by Plant for System Power Generation and Spot Market .....M-10  
32  
33 M-2 Power Generation Averaged over the 20-Year LTEMP Period by Alternative .....M-12  
34  
35 M-3 Summary of Potential Impacts of LTEMP Alternatives on Visibility and  
36 Regional Air Quality .....M-15  
37  
38 M-4 Annual SO<sub>2</sub> Emissions Averaged over the 20-Year LTEMP Period by  
39 Alternative .....M-16  
40  
41 M-5 Annual NO<sub>x</sub> Emissions Averaged over the 20-Year LTEMP Period by  
42 Alternative .....M-19  
43  
44 M-6 Distributions of SO<sub>2</sub> and NO<sub>x</sub> Emissions Averaged over the 20-Year LTEMP  
45 Period by Alternative.....M-22  
46



**TABLES (Cont.)**

1  
2  
3  
4 M-7 Annual Greenhouse Gas Emissions Averaged over the 20-Year LTEMP Period  
5 by Alternative .....M-23  
6  
7 M-8 Summary of Potential Impacts of LTEMP Alternatives on CO<sub>2</sub>e Emissions .....M-26  
8  
9 N-1 Summary of Tribal Participation Status ..... N-5  
10  
11 N-2 Summary of Tribal Correspondence ..... N-6  
12  
13 N-3 Summary of Major Face-to-Face Meetings, Webinars, and Conference Calls  
14 Involving Tribes ..... N-25  
15  
16 N-4 Summary of Individual Tribal Consultation Meetings to Date ..... N-26  
17  
18 N-5 Index of Project Tribal Government Consultation and Coordination  
19 Correspondence ..... N-28  
20

1  
2  
3  
4  
5  
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## ACRONYMS AND ABBREVIATIONS

1		
2		
3		
4	ac	acre(s)
5	ac-ft	acre-foot (feet)
6	ACHP	Advisory Council on Historic Preservation
7	AML	abandoned mine land
8	AMSL	above mean sea level
9	AMWG	Adaptive Management Work Group
10	AOP	Annual Operation Plan for Colorado River Reservoirs
11	APE	Area of Potential Effect
12	Argonne	Argonne National Laboratory
13	ASMR	Age-Structured Mark Recapture Model
14	AZGFD	Arizona Game and Fish Department
15	AZ-SGCN	Arizona Species of Greatest Conservation Need
16		
17	BA	Balancing Authority (in Chapter 3 only)
18		Biological Assessment (in all other sections)
19	BGEPA	Bald and Golden Eagle Protection Act of 1940
20	BIA	Bureau of Indian Affairs
21	BO	Biological Opinion
22		
23	C	Celsius
24	CAA	Clean Air Act
25	CAAA	Clean Air Act Amendments
26	CAEDYM	Computational Aquatic Ecosystem Dynamics Model
27	CCC	Civilian Conservation Corps
28	CEQ	Council on Environmental Quality
29	CFMP	<i>Comprehensive Fisheries Management Plan</i>
30	CFR	<i>Code of Federal Regulations</i>
31	cfs	cubic feet per second
32	CH <sub>4</sub>	methane
33	CO	carbon monoxide
34	CO <sub>2</sub>	carbon dioxide
35	CO <sub>2</sub> e	carbon dioxide equivalent
36	CPUE	catch per unit effort
37	CRBC	Colorado River Board of California
38	CRCN	Colorado River Commission of Nevada
39	CRD	Colorado River Discovery
40	CREDA	Colorado River Energy Distributors Association
41	CRMP	Colorado River Management Plan
42	CRSP	Colorado River Storage Project
43	CRSPA	Colorado River Storage Project Act of 1956
44	CRSS	Colorado River Simulation System
45	CSU	Colorado Springs Utilities
46		

1	DEIS	Draft Environmental Impact Statement
2	Deseret	Deseret Generation and Transmission Cooperative
3	DFC	desired future condition
4	DO	dissolved oxygen
5	DOE	U.S. Department of Energy
6	DOI	U.S. Department of the Interior
7	DPS	Distinct Population Segment
8		
9	EA	Environmental Assessment
10	eGRID	Emissions & Generation Resource Integrated Database
11	EIA	Energy Information Administration
12	EIR	Environmental Impact Report
13	EIS	Environmental Impact Statement
14	ELCOM	Estuary, Lake and Coastal Ocean Model
15	EMS	emergency medical services
16	E.O.	Executive Order
17	EPA	U.S. Environmental Protection Agency
18	EPT	Ephemeroptera, Plecoptera, and Trichoptera
19	ESA	Endangered Species Act of 1973, as amended
20		
21	F	Fahrenheit
22	FCPP	Four Corners Power Plant
23	FES	Firm Electric Service
24	FONSI	Finding of No Significant Impact
25	FR	<i>Federal Register</i>
26	ft	foot (feet)
27	FWS	U.S. Fish and Wildlife Service
28	FY	fiscal year
29		
30	GCDAMP	Glen Canyon Dam Adaptive Management Program
31	GCM	general circulation model
32	GCMRC	Grand Canyon Monitoring and Research Center
33	GCNP	Grand Canyon National Park
34	GCNRA	Glen Canyon National Recreation Area
35	GCPA	Grand Canyon Protection Act of 1992
36	GHG	greenhouse gas
37	GMP	General Management Plan
38	GW	gigawatt(s)
39	GWh	gigawatt-hour(s)
40	GWP	global warming potential
41		
42	H <sub>2</sub> S	hydrogen sulfide
43	HBC	humpback chub
44	HFC	hydrofluorocarbon
45	HFE	high-flow experiment
46	hr	hour(s)

1	HRR	Hualapai River Runners
2		
3	in.	inch(es)
4	IPM	Integrated Pest Management
5	IRP	integrated resource plan
6	ISM	Indexed Sequential Method
7		
8	kaf	thousand acre-feet
9	kWh	kilowatt-hour(s)
10		
11	lb	pound(s)
12	LCRMSCP	Lower Colorado River Multi-Species Conservation Program
13	LMM	Lake Mead Model
14	LMNRA	Lake Mead National Recreation Area
15	LROC	Long-Range Operating Criteria
16	LTEMP	Long-Term Experimental and Management Plan
17	LTEP	Long Term Experimental Plan
18	LTF	long-term firm
19		
20	maf	million acre-feet
21	MAMB	miscellaneous algae, macrophytes, and bryophytes
22	MBTA	Migratory Bird Treaty Act
23	MCL	maximum contaminant level
24	mi	mile(s)
25	MLFF	Modified Low Fluctuating Flow
26	MMt	million metric tons
27	MOA	Memorandum of Agreement
28	MT	metric ton(s)
29	MW	megawatt(s)
30	MWh	megawatt-hour(s)
31		
32	N <sub>2</sub> O	nitrous oxide
33	NAAQS	National Ambient Air Quality Standards
34	NAU	Northern Arizona University
35	NC	no change
36	NEPA	National Environmental Policy Act of 1969, as amended
37	NERC	North American Electric Reliability Corporation
38	NEV	net economic use value
39	NGO	nongovernmental organization
40	NHPA	National Historic Preservation Act
41	NM	national monument
42	NO <sub>2</sub>	nitrogen dioxide
43	NO <sub>3</sub>	nitrate-nitrogen
44	NOI	Notice of Intent
45	NO <sub>x</sub>	nitrogen oxides
46	NPS	National Park Service

1	NPV	net present value
2	NRHP	<i>National Register of Historic Places</i>
3	NTUA	Navajo Tribal Unit Authority
4		
5	O&M	operation and maintenance
6	O <sub>3</sub>	ozone
7	OPAC	Office of Planning and Compliance
8	OSMRE	Office of Surface Mining Reclamation and Enforcement
9		
10	PA	Programmatic Agreement
11	Pb	lead
12	PEPC	Planning, Environment, and Public Comment
13	PFC	perfluorocarbon
14	P.L.	Public Law
15	PM	particulate matter
16	PM <sub>2.5</sub>	particulate matter ≤2.5 μm in aerodynamic diameter
17	PM <sub>10</sub>	particulate matter ≤10 μm in aerodynamic diameter
18	POM	particulate organic matter
19	PSAR	preventative search and rescue
20	PSD	Prevention of Significant Deterioration
21		
22	RA	resource available
23	Reclamation	Bureau of Reclamation
24	RM	river mile
25	RMP	Resource Management Plan
26	ROD	Record of Decision
27	RSG	Reserve Sharing Group
28		
29	SAAQS	State Ambient Air Quality Standards
30	SBM	Sand Budget Model
31	SCP	Salinity Control Project
32	SD	standard deviation
33	SDA	Structured Design Analysis
34	SE	standard error
35	Secretary, the	Secretary of the Interior
36	SF <sub>6</sub>	sulfur hexafluoride
37	SHPO	State Historic Preservation Officer
38	SLCA/IP	Salt Lake City Area Integrated Projects
39	SO	Secretarial Order
40	SO <sub>2</sub>	sulfur dioxide
41	SPC	Southern Paiute Consortium
42	SRP	Salt River Project
43	SRSG	Southwest Reserve Sharing Group
44		
45	TCD	temperature control device
46	TCP	traditional cultural property

1	TDS	total dissolved solids
2	THPO	Tribal Historic Preservation Officer
3	TL	total length
4	TMF	trout management flow
5	Tri-State	Tri-State Generation and Transmission Association
6	TWG	Technical Working Group
7		
8	UAMPS	Utah Associated Municipal Power Systems
9	UBWR	Utah Board of Water Resources
10	UCRC	Upper Colorado River Commission
11	UMPA	Utah Municipal Power Agency
12	USC	<i>United States Code</i>
13	USFS	U.S. Forest Service
14	USGS	U.S. Geological Survey
15		
16	VOC	volatile organic compound
17		
18	WACM	Western Area Colorado-Missouri Region
19	WALC	Western Area Lower Colorado Region
20	WAUW	Western Area Upper Great Plains West Region
21	WECC	Western Electricity Coordinating Council
22	Western	Western Area Power Administration
23		
24	YOY	young-of-year
25	yr	year(s)
26		
27	ZHHPO	Zuni Heritage and Historic Preservation Office
28		

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