

COVER SHEET

FEDERAL ENERGY REGULATORY COMMISSION
DRAFT ENVIRONMENTAL IMPACT STATEMENT
FOR THE KLAMATH HYDROELECTRIC PROJECT
Docket No. P-2082-027

Table of Contents
Pages ix to xxvi
DEIS

TABLE OF CONTENTS

2	LIST OF FIGURES	xiii
3	LIST OF TABLES	xv
4	ACRONYMS AND ABBREVIATIONS	xviii
5	SUMMARY	xviii
6	1.0 PURPOSE OF ACTION AND NEED FOR POWER	1-1
7	1.1 PURPOSE OF ACTION.....	1-1
8	1.2 NEED FOR POWER.....	1-1
9	1.3 INTERVENTIONS	1-3
10	1.4 SCOPING	1-4
11	1.5 RECOMMENDATIONS, TERMS, AND CONDITIONS.....	1-5
12	2.0 PROPOSED ACTION AND ALTERNATIVES	2-1
13	2.1 NO-ACTION ALTERNATIVE	2-1
14	2.1.1 Existing Project Facilities.....	2-1
15	2.1.1.1 East Side and West Side Developments	2-1
16	2.1.1.2 Keno Development.....	2-5
17	2.1.1.3 J.C. Boyle Development.....	2-7
18	2.1.1.4 Copco No. 1 Development.....	2-8
19	2.1.1.5 Copco No. 2 Development.....	2-11
20	2.1.1.6 Fall Creek Development.....	2-12
21	2.1.1.7 Iron Gate Development.....	2-12
22	2.1.1.8 Project Safety	2-14
23	2.1.2 Existing Project Operations.....	2-14
24	2.1.3 Existing Environmental Measures	2-15
25	2.2 PACIFICORP'S PROPOSAL.....	2-16
26	2.2.1 Proposed Project Facilities	2-16
27	2.2.1.1 East Side and West Side Developments	2-17
28	2.2.1.2 Keno Development.....	2-17
29	2.2.1.3 J.C. Boyle Development.....	2-17
30	2.2.1.4 Copco No. 2 Development.....	2-18
31	2.2.1.5 Fall Creek Development.....	2-18
32	2.2.1.6 Iron Gate Development.....	2-18
33	2.2.2 Proposed Project Operations.....	2-19
34	2.2.3 Proposed Environmental Measures.....	2-19
35	2.2.4 Proposed Project Boundary	2-22
36	2.2.4.1 East Side and West Side Developments	2-22
37	2.2.4.2 Keno Development.....	2-22
38	2.2.4.3 J.C. Boyle Development.....	2-23
39	2.2.4.4 Copco No. 1 Development.....	2-23
40	2.2.4.5 Copco No. 2 Development.....	2-24
41	2.2.4.6 Fall Creek Development.....	2-25
42	2.2.4.7 Iron Gate Development.....	2-25
43	2.3 MODIFICATIONS TO THE PROPOSED ACTION	2-26
44	2.3.1 Mandatory Conditions.....	2-26
45	2.3.1.1 Water Quality Certification.....	2-26
46	2.3.1.2 Section 18 Fishway Prescriptions.....	2-26
47	2.3.1.3 Alternative Section 18 Fishway Prescriptions Pursuant to the	

1	Energy Policy Act of 2005.....	2-30
2	2.3.1.4 Section 4(e) Federal Land Management Conditions	2-31
3	2.3.2 Staff Alternative.....	2-44
4	2.3.3 Staff Alternative with Mandatory Conditions	2-50
5	2.3.4 Retirement of Copco No. 1 and Iron Gate Developments.....	2-51
6	2.4 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED	
7	STUDY	2-52
8	2.4.1 Federal Government Takeover	2-52
9	2.4.2 Nonpower License	2-52
10	2.4.3 Decommissioning of Project with Dams Remaining in Place	2-53
11	2.4.4 Retirement of Additional Developments.....	2-53
12	3.0 ENVIRONMENTAL CONSEQUENCES	3-1
13	3.1 GENERAL DESCRIPTION OF THE KLAMATH RIVER BASIN	3-1
14	3.2 SCOPE OF THE CUMULATIVE EFFECTS ANALYSIS.....	3-2
15	3.2.1 Geographic Scope.....	3-3
16	3.2.2 Temporal Scope.....	3-4
17	3.3 PROPOSED ACTION AND ACTION ALTERNATIVES	3-5
18	3.3.1 Geology and Soils.....	3-5
19	3.3.1.1 Affected Environment	3-5
20	3.3.1.2 Environmental Effects	3-27
21	3.3.1.3 Cumulative Effects	3-57
22	3.3.1.4 Unavoidable Adverse Effects.....	3-58
23	3.3.2 Water Resources	3-58
24	3.3.2.1 Affected Environment	3-58
25	3.3.2.2 Environmental Effects	3-122
26	3.3.2.3 Cumulative Effects	3-155
27	3.3.2.4 Unavoidable Adverse Effects.....	3-157
28	3.3.3 Aquatic Resources	3-158
29	3.3.3.1 Affected Environment	3-158
30	3.3.3.2 Environmental Effects	3-230
31	3.3.3.3 Cumulative Effects	3-310
32	3.3.3.4 Unavoidable Adverse Effects.....	3-312
33	3.3.4 Terrestrial Resources.....	3-313
34	3.3.4.1 Affected Environment	3-313
35	3.3.4.2 Environmental Effects	3-341
36	3.3.4.3 Unavoidable Adverse Effects.....	3-363
37	3.3.5 Threatened and Endangered Species.....	3-363
38	3.3.5.1 Affected Environment	3-363
39	3.3.5.2 Environmental Effects	3-376
40	3.3.5.3 Cumulative Effects	3-386
41	3.3.5.4 Unavoidable Adverse Effects.....	3-387
42	3.3.6 Recreational Resources	3-388
43	3.3.6.1 Affected Environment	3-388
44	3.3.6.2 Environmental Effects	3-410
45	3.3.6.3 Unavoidable Adverse Effects.....	3-448
46	3.3.7 Land Use and Aesthetic Resources	3-448
47	3.3.7.1 Affected Environment	3-448
48	3.3.7.2 Environmental Effects	3-457
49	3.3.7.3 Unavoidable Adverse Effects.....	3-470
50	3.3.8 Socioeconomic Resources.....	3-470

1	3.3.8.1	Affected Environment	3-470
2	3.3.8.2	Environmental Effects	3-483
3	3.3.8.3	Cumulative Effects	3-491
4	3.3.8.4	Unavoidable Adverse Effects.....	3-493
5	3.3.9	Cultural Resources	3-493
6	3.3.9.1	Affected Environment	3-493
7	3.3.9.2	Environmental Effects	3-500
8	3.3.9.3	Unavoidable Adverse Effects.....	3-509
9	3.4	NO-ACTION ALTERNATIVE	3-509
10	3.5	IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES ...	3-509
11	3.6	RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY.....	3-509
12	4.0	DEVELOPMENTAL ANALYSIS	4-1
14	4.1	POWER AND ECONOMIC BENEFITS OF THE NO-ACTION ALTERNATIVE	4-3
15	4.2	POWER AND ECONOMIC BENEFITS OF PACIFICORP'S PROPOSAL	4-3
16	4.3	POWER AND ECONOMIC BENEFITS OF THE STAFF ALTERNATIVE.....	4-3
17	4.4	POWER AND ECONOMIC BENEFITS OF THE STAFF ALTERNATIVE WITH MANDATORY CONDITIONS.....	4-4
19	4.5	POWER AND ECONOMIC BENEFITS OF RETIREMENT OF COPCO NO. 1 AND IRON GATE DEVELOPMENTS.....	4-4
21	4.6	CONCEPTUAL COSTS OF PROJECT DAM REMOVAL.....	4-4
22	4.6.1	Keno Development	4-5
23	4.6.2	J.C. Boyle Development.....	4-5
24	4.6.3	Copco No. 1 Development	4-6
25	4.6.4	Copco No. 2 Development	4-6
26	4.6.5	Fall Creek Development.....	4-7
27	4.6.6	Iron Gate.....	4-7
28	4.7	KENO DEVELOPMENT ANALYSIS	4-10
29	4.8	GREENHOUSE GAS EMISSIONS.....	4-20
30	5.0	STAFF'S CONCLUSIONS	5-1
31	5.1	SUMMARY COMPARISON OF APPLICANT'S PROPOSAL AND STAFF ALTERNATIVE	5-1
33	5.1.1	Description of Alternatives.....	5-1
34	5.1.1.1	PacifiCorp's Proposal	5-1
35	5.1.1.2	Staff Alternative	5-1
36	5.1.1.3	Staff Alternative with Mandatory Conditions.....	5-9
37	5.1.1.4	Retirement of Copco No. 1 and Iron Gate Developments with Staff Measures.....	5-9
39	5.1.2	Summary of Effects	5-11
40	5.2	DISCUSSION OF KEY ISSUES	5-19
41	5.2.1	Flushing Flows and Gravel Management.....	5-19
42	5.2.2	Restoration of Slopes and Channel at the J.C. Boyle Bypassed Reach.....	5-21
43	5.2.3	Project Operation Management	5-23
44	5.2.4	Water Quality Management.....	5-25
45	5.2.5	Instream Flows.....	5-26
46	5.2.6	Anadromous Fish Restoration	5-35
47	5.2.7	Fish Disease Management	5-38
48	5.2.8	Resident Fish Passage	5-39
49	5.2.9	Hatchery Management	5-41
50	5.2.10	Aquatic Habitat Enhancement	5-43

1	5.2.11	Aquatic Resources Monitoring.....	5-45
2	5.2.12	Vegetation Management.....	5-47
3	5.2.13	Wildlife Management.....	5-48
4	5.2.14	Recreational Resource Management.....	5-50
5	5.2.15	Aesthetic Resource Management.....	5-51
6	5.2.16	Road Management	5-52
7	5.2.17	Cultural Resources Management	5-53
8	5.2.18	East Side and West Side Development Decommissioning.....	5-54
9	5.2.19	Keno Development	5-54
10	5.2.20	Project Boundary Changes	5-55
11	5.2.21	Dam Removal	5-56
12	5.3	PREFERRED ALTERNATIVE.....	5-58
13	5.4	SUMMARY OF SECTION 10(J) RECOMMENDATIONS AND 4(E) CONDITIONS	58
14	5.4.1	Fish and Wildlife Agency Recommendations.....	58
15	5.4.2	U.S. Bureau of Land Management and U.S Bureau of Reclamation Section 4(e) Conditions	5-76
16	5.5	CONSISTENCY WITH COMPREHENSIVE AND OTHER RESOURCE PLANS ..	5-82
17	5.6	RELATIONSHIP OF LICENSE PROCESS TO LAWS AND POLICIES.....	5-86
18	5.6.1	Section 401 of the Clean Water Act—Water Quality Certification.....	5-86
19	5.6.2	Coastal Zone Management Act—Consistency Certification.....	5-87
20	5.6.3	Section 18 of the Federal Power Act—Authority to Prescribe Fishways	5-87
21	5.6.4	Endangered Species Act.....	5-87
22	5.6.5	Essential Fish Habitat.....	5-88
23	5.6.6	National Historic Preservation Act	5-89
24	5.6.7	Wild and Scenic Rivers Act.....	5-89
25	6.0	LITERATURE CITED	6-1
26	7.0	LIST OF PREPARERS	7-1
27	8.0	LIST OF RECIPIENTS.....	8-1
28	APPENDIX A	COSTS OF PROPOSED, RECOMMENDED, PRESCRIBED, AND SPECIFIED ENVIRONMENTAL MEASURES FOR THE KLAMATH HYDROELECTRIC PROJECT.....	A-1

1	LIST OF FIGURES	
2	Figure 1-1. Klamath River Basin showing major rivers, reservoirs, and lakes within the watershed.....	1-2
4	Figure 2-1. Schematic of existing PacifiCorp project facilities	2-2
5	Figure 2-2. General site location of the Klamath Hydroelectric Project, Link River dam to Keno reservoir.....	2-4
7	Figure 2-3. General site location of the Klamath Hydroelectric Project, Keno reservoir to downstream of J.C. Boyle powerhouse (the peaking reach).....	2-6
9	Figure 2-4. Schematic showing movement of water through the Klamath Irrigation Project area	2-7
11	Figure 2-5. General site location of the Klamath Hydroelectric Project, from the J.C. Boyle peaking reach to Copco reservoir.....	2-9
13	Figure 2-6. General site location of the Klamath Hydroelectric Project, from Copco reservoir to Iron Gate dam	2-10
15	Figure 2-7. Locations of project facilities, Fall Creek development.....	2-13
16	Figure 3-1. Klamath River profile.....	3-7
17	Figure 3-2. Klamath River pebble counts, median (D50) particle size longitudinal distribution.....	3-8
19	Figure 3-3. Conceptual diagram of the box model for riparian recruitment.....	3-50
20	Figure 3-4. NMFS BiOp Phase III flow regimes for Iron Gate dam based on water year	3-54
21	Figure 3-5. Upper Klamath Lake historical lake levels	3-61
22	Figure 3-6. Keno reservoir March and July median inflows and outflows upstream of Keno dam.....	3-68
24	Figure 3-7. Keno reservoir daily water surface elevations	3-70
25	Figure 3-8. J.C. Boyle reservoir daily water surface elevations for January 2, 1990, to December 5, 2004	3-72
27	Figure 3-9. Klamath River flows (cfs) during July for the J.C. Boyle peaking reach for water years 1990 to 2004	3-74
29	Figure 3-10. Copco reservoir daily water surface elevations.....	3-76
30	Figure 3-11. Iron Gate reservoir daily water surface elevations.....	3-78
31	Figure 3-12. Flow below Iron Gate dam for water years 1963 to 2004	3-79
32	Figure 3-13. Iron Gate flows for April 1 through September 30, 2003	3-81
33	Figure 3-14. Iron Gate flows for April 1 though September 30, 2004	3-81
34	Figure 3-15. Iron Gate flows for April 1 though September 30, 2005	3-82
35	Figure 3-16. Daily Klamath River flow at Seiad Valley (USGS gage no. 11520500) for water years 1963 to 2004	3-86
37	Figure 3-17. Daily Klamath River flow at Orleans (USGS gage no. 11523000) for water years 1963 to 2004	3-87

1	Figure 3-18.	Yearly flow exceedance curves for gage no. 11530000 Trinity River at Hoopa, CA, representing pre- and post-TRD flow conditions.....	3-88
3	Figure 3-19.	Daily inflow from the Trinity River at the confluence with the Klamath River for water years 1963 to 2004.....	3-89
5	Figure 3-20.	Flow release schedule from Lewiston reservoir based on the 2000 Record of Decision.....	3-91
7	Figure 3-21.	Daily flow at USGS gage no. 11530500 Klamath River at Klamath, CA for water years 1963 to 2004.....	3-92
9	Figure 3-22.	Water temperatures measured above and below the J.C. Boyle development during peaking operation (top) and during non-peaking flow (bottom), 2002.....	3-98
11	Figure 3-23.	Average monthly temperature profiles for Copco (2002-top) and Iron Gate (2001-bottom)	3-99
13	Figure 3-24.	Daily average water temperature data from below Iron Gate dam and from a depth of 10 feet in the Iron Gate reservoir.....	3-100
15	Figure 3-25.	June minimum, average, and maximum temperatures along the Klamath River in 1996 and 1997	3-101
17	Figure 3-26.	July minimum, average, and maximum temperature along the Klamath River in 1996 and 1997	3-101
19	Figure 3-27.	August minimum, average, and maximum temperature along the Klamath River in 1996 and 1997	3-102
21	Figure 3-28.	Average DO concentrations at 1 meter intervals in Copco (top) and Iron Gate (bottom) reservoirs from March through November, 2002	3-106
23	Figure 3-29.	Total phosphorous values measured during 1991 to 1999 in Upper Klamath Lake and its outflow	3-107
25	Figure 3-30.	Upper Klamath Lake mean total phosphorus concentrations (1991 – 1998)	3-107
26	Figure 3-31.	Minimum, mean and maximum total phosphorous (top) and orthophosphate (bottom) concentrations (mg/L) in the Klamath River between Upper Klamath Lake and Keno dam during June, July, August, and September 2000-2003	3-109
29	Figure 3-32.	Minimum, mean and maximum total phosphorous (top) and orthophosphate (bottom) concentrations (mg/L) in the Klamath River from Keno dam to the confluence with the Shasta River during June, July, August, and September 2000-2003	3-110
33	Figure 3-33.	Minimum, mean, and maximum total nitrate (top) and ammonia (bottom) nitrogen (mg/L) concentrations in the Klamath River between Upper Klamath Lake and Keno dam during June, July, August, and September 2000–2003	3-111
36	Figure 3-34.	Minimum, mean, and maximum total nitrate (top) and ammonia (bottom) nitrogen (mg/L) concentrations in the Klamath River between Keno dam and the confluence with the Shasta River during June, July, August, and September 2000-2003	3-112
40	Figure 3-35.	Box plot showing the distribution by month of combined chlorophyll a values measured in Copco and Iron Gate reservoirs during 2000 to 2003	3-116

1	Figure 3-36.	Maximum, mean, and minimum chlorophyll <i>a</i> concentrations at four stations below Iron Gate dam from data collected in 1996 and 1997	3-117
3	Figure 3-37.	Simulated hourly water temperature below Iron Gate dam (RM 190.5) based on 2002 (considered a dry year) for existing conditions compared to hypothetical conditions without the existing Klamath Hydroelectric Project.....	3-135
6	Figure 3-38.	Simulated hourly DO levels below Iron Gate dam based on the year 2002 (a dry year) for existing conditions compared to hypothetical conditions without the Klamath Hydroelectric Project.....	3-139
9	Figure 3-39.	Composite box plots of two week summaries of modeled water temperature from April to November for the years 2000 through 2004 below Keno dam.....	3-152
11	Figure 3-40.	Shasta River estimated spawning escapement of grilse and adult fall Chinook salmon, 1930 to 2002.....	3-184
13	Figure 3-41.	Shasta River weir counts of coho salmon, 1930 to 2002	3-185
14	Figure 3-42.	Shasta River weir counts of adult steelhead, 1930 to 1996.....	3-186
15	Figure 3-43.	Salmon River estimated spawning escapement of grilse and adult spring Chinook salmon, 1980 to 2002	3-188
17	Figure 3-44.	Salmon River estimated spawning escapement of steelhead, 1980 to 200	3-189
18	Figure 3-45.	Trinity River estimated spawning escapement of naturally spawning and hatchery spawned spring Chinook salmon, 1978 to 2002	3-191
20	Figure 3-46.	Trinity River estimated spawning escapement of grilse and adult coho salmon above Willow Creek, 1977 to 2002	3-192
22	Figure 3-47.	Weekly abundance index for natural and hatchery fall Chinook smolts during screw-trap sampling conducted at Big Bar (RM 49.7) on the Klamath River, 1997-2000	3-195
25	Figure 3-48.	Weekly abundance index for fall Chinook smolts during screw-trap sampling conducted at Willow Creek (RM 21.1) on the Trinity River, 1997-2000.....	3-196
27	Figure 3-49.	Weekly abundance index for natural and hatchery coho smolts during screw-trap sampling conducted at Big Bar (RM 49.7) on the Klamath River, 1997-2000	3-200
30	Figure 3-50.	Eulachon commercial landings in the Columbia River and tributaries, 1936 to 2001	3-204
32	Figure 3-51.	Fall Chinook production at Iron Gate Hatchery, 1965 to 2001	3-208
33	Figure 3-52.	Coho salmon production at Iron Gate Hatchery, 1965 to 2001	3-208
34	Figure 3-53.	Steelhead production at Iron Gate Hatchery, 1965 to 2001	3-209
35	Figure 3-54.	Adult salmon and steelhead returns to the Iron Gate Hatchery	3-210
36	Figure 3-55.	Pacific coast ports and management zones	3-215
37	Figure 3-56.	Klamath River adult fall Chinook salmon river return and spawning escapements, 1978 to 2005	3-216
39	Figure 3-57.	Natural and hatchery Sacramento River fall Chinook escapement to mouth of Sacramento River	3-217

1	Figure 3-58.	Klamath River total fall Chinook spawning escapement (hatchery and natural combined) and ocean landings by PFMC management zone	3-220
3	Figure 3-59.	Oregon production index area salmon abundance estimates by stratified random survey (SRS) accounting methods, 1970 to 2005	3-224
5	Figure 3-60.	Total invertebrate density measured during fall 2002 and spring 2003 in the Klamath River between Link River and the confluence with the Shasta River	3-227
7	Figure 3-61.	Number of species of mayflies, stoneflies and caddisflies (EPT richness) measured during fall 2002 and spring 2003 in the Klamath River between Link River and the confluence with the Shasta River.....	3-228
10	Figure 3-62.	Flows measured below Keno dam in 1992 (dry year).....	3-233
11	Figure 3-63.	Flows measured below Keno dam in 1995 (average year)	3-233
12	Figure 3-64.	Flows measured below Keno dam in 1998 (above average year)	3-234
13	Figure 3-65.	Median channel temperatures versus river mile for Klamath River, CA/OR, along with the location of surface water inflows (represented by red squares) on July 15, 2001	3-236
16	Figure 3-66.	Rainbow/redband trout WUA for the J.C. Boyle bypassed reach. Discharge equals release from J.C. Boyle dam	3-236
18	Figure 3-67.	Hourly flows in the J.C. Boyle peaking reach for representative dry (1992), average (1995), and wet (1998) years.....	3-241
20	Figure 3-68.	Rainbow/redband trout WUA versus discharge for the J.C. Boyle peaking reach.	3-242
22	Figure 3-69.	Length frequency of sampled trout, from 1979 to 1982 Oregon Fish & Wildlife angler surveys	3-244
24	Figure 3-70.	Length frequency of trout collected by hook-and-line sampling in 2002.....	3-245
25	Figure 3-71.	Sucker WUA versus discharge for the J.C. Boyle peaking reach	3-246
26	Figure 3-72.	WUA for rainbow trout and suckers in the Copco No. 2 bypassed reach	3-249
27	Figure 3-73.	WUA versus discharge for rainbow trout in Fall Creek	3-253
28	Figure 3-74.	Seven-day moving average water temperatures from 1995 recorded in Jenny Creek above and below the confluence with Spring Creek.....	3-255
30	Figure 3-75.	Seven-day moving average water temperatures from 1996 recorded in Jenny Creek above and below the confluence with Spring Creek.	3-255
32	Figure 3-76.	Seven-day moving average water temperatures from 1997 recorded in Jenny Creek above and below the confluence with Spring Creek	3-256
34	Figure 3-77.	Average monthly flows below Iron Gate dam for 1997, 2000, 2002, 2004, 2005 and 2006 to date	3-259
36	Figure 3-78.	Daily minimum DO conditions in Keno reservoir. Daily minima calculated from hourly data and averaged over 1-3 sites in Keno reservoir from January 2002 – December 2004. Standard deviations calculated from daily averages	3-264
39	Figure 3-79.	Potential fish passage and gravel transport barrier formed by boulder sidecast material in the J.C. Boyle bypassed reach, approximately 2.5 miles upstream of the J.C. Boyle powerhouse.....	3-273

1	Figure 3-80.	Percent of weekly frame-trap catch of Chinook salmon that were dead, percent of remaining live Chinook examined that exhibited outward clinical signs of disease, and weekly average discharge at the Kinsman trap site (RM 146) on the Klamath River near the mouth of the Scott River in 2004.....	3-286
5	Figure 3-81.	Trends in wild spawning escapement and wild pre-harvest abundance of Rogue River coho salmon, 1980-2001	3-367
7	Figure 3-82.	Klamath Hydroelectric Project recreation facilities: Link River dam to Keno reservoir	3-393
9	Figure 3-83.	Klamath Hydroelectric Project recreation facilities: Keno reservoir to downstream of J.C. Boyle powerhouse	3-394
11	Figure 3-84.	Klamath Hydroelectric Project recreation facilities: J.C. Boyle peaking reach to Copco reservoir	3-395
13	Figure 3-85.	Klamath Hydroelectric Project recreation facilities: Copco reservoir to Iron Gate dam.....	3-396
15	Figure 3-86.	Below average water year type, Link River bypassed reach optimal angling	3-431
16	Figure 3-87.	Average water year type, Link River bypassed reach optimal angling	3-431
17	Figure 3-88.	Above average water year type, Link River bypassed reach optimal angling	3-432
18	Figure 3-89.	Below average water year type, J.C. Boyle bypassed reach optimal range of flows for angling	3-433
20	Figure 3-90.	Average water year type, J.C. Boyle bypassed reach, optimal range of flows for angling	3-433
22	Figure 3-91.	Above average water year type, J.C. Boyle bypassed reach optimal range of flows for angling	3-434
24	Figure 3-92.	Below average water year type, J.C. Boyle bypassed reach acceptable range of flows for angling	3-434
26	Figure 3-93.	Average water year type, J.C. Boyle bypassed reach acceptable range of flows for angling.....	3-435
28	Figure 3-94.	Above average water year type, J.C. Boyle bypassed reach acceptable range of flows for angling	3-435
30	Figure 3-95.	Below average water year type, J.C. Boyle bypassed reach acceptable range of flows for technical kayaking.....	3-436
32	Figure 3-96.	Average water year type, J.C. Boyle bypassed reach acceptable range of flows for technical kayaking	3-436
34	Figure 3-97.	Above average water year type, J.C. Boyle bypassed reach acceptable range of flows for technical kayaking.....	3-437
36	Figure 3-98.	Below average water year type, J.C. Boyle peaking reach optimal flows for commercial rafting	3-439
38	Figure 3-99.	Average water year type, J.C. Boyle peaking reach, optimal range of flows for commercial rafting	3-439
40	Figure 3-100.	Above average water year type, J.C. Boyle peaking reach optimal range of flows for commercial rafting.....	3-440

1	Figure 3-101.	Below average water year type, J.C. Boyle peaking reach acceptable range of flows for angling	3-440
3	Figure 3-102.	Average water year type, J.C. Boyle peaking reach acceptable range of flows for angling	3-441
5	Figure 3-103.	Above average water year type, J.C. Boyle peaking reach acceptable range of flows for angling	3-441
7	Figure 3-104.	Below average water year type, J.C. Boyle peaking reach optimal range of flows for angling	3-442
9	Figure 3-105.	Average water year type, J.C. Boyle peaking reach optimal range of flows for angling	3-442
11	Figure 3-106.	Above average water year type, J.C. Boyle peaking reach optimal range of flows for angling	3-443
13	Figure 3-107.	Below average water year type, Copco No. 2 bypassed reach acceptable range of flows for standard whitewater	3-444
15	Figure 3-108.	Average water year type, Copco No. 2 bypassed reach acceptable range of flows for standard whitewater boating	3-444
17	Figure 3-109.	Above average water year type, Copco No. 2 bypassed reach acceptable range of flows for standard whitewater boating	3-445
19	Figure 3-110.	Below average water year type, Copco No. 2 bypassed reach acceptable range of flows for angling	3-445
21	Figure 3-111.	Average water year type, Copco No. 2 bypassed reach acceptable range of flows for angling	3-446
23	Figure 3-112.	Above average water year type, Copco No. 2 bypassed reach acceptable range of flows for angling	3-446
25	Figure 3-113.	Socioeconomic study region and subregions	3-471
26	Figure 4-1.	Flows entering Keno reservoir via Link River and in the Klamath River downstream of Keno development at USGS gage no. 11509500 and J.C. Boyle development at USGS gage no. 11510700 for water year 1996	4-14
29	Figure 4-2.	Relationship between inflow to Keno reservoir, USGS gages at Keno and below J.C. Boyle powerhouse, and storage at J.C. Boyle and Keno reservoirs—June 1, 1996, until September 12, 1996	4-16
32	Figure 4-3.	Relationship between inflow to Keno reservoir, USGS gages at Keno and below J.C. Boyle powerhouse, and storage at J.C. Boyle and Keno reservoirs—October 18, 1995, until October 28, 1995	4-17
35	Figure 4-4.	Relationship between net inflow to Keno reservoir, USGS gages at Keno and below J.C. Boyle powerhouse—October 18, 1995, until October 28, 1995	4-19

1	LIST OF TABLES
2	Table 2-1. River reaches, reservoirs, and major tributaries proceeding downstream within 3 the Klamath River Basin..... 2-3
4	Table 2-2. Summary of preliminary fishway prescriptions and timetable for the Klamath 5 Hydroelectric..... 2-29
6	Table 2-3. Environmental measures specified by the Bureau of Land Management pursuant 7 to section 4(e) of the Federal Power Act and PacifiCorp's and others' 8 corresponding alternative conditions pursuant to the Energy Policy Act of 2005 ... 2-32
9	Table 2-4. Environmental measures specified by Reclamation pursuant to section 4(e) of 10 the Federal Power Act and PacifiCorp's and others' corresponding alternative 11 conditions, pursuant to the Energy Policy Act of 2005 2-42
12	Table 3-1. Computation of tributary sediment yields from reservoir delta deposits..... 3-19
13	Table 3-2. Measured landslide sediment volumes in the J.C. Boyle bypassed reach 3-20
14	Table 3-3. Estimated loss in reservoir volume based on comparison of current bathymetry 15 with historic topography for four of the five study sites..... 3-21
16	Table 3-4. Tracer gravel sites, deployment, and recovery..... 3-24
17	Table 3-5. Flow at threshold of mobility for with- and without-project conditions..... 3-35
18	Table 3-6. Frequency when flows exceeded the threshold of mobility 3-37
19	Table 3-7. Sediment budget modeling results 3-43
20	Table 3-8. Estimate of sediment thickness in Iron Gate reservoir, as modeled by DREAM-1 . 3-56
21	Table 3-9. Average flows in the Upper Klamath Lake and Keno reservoir area..... 3-59
22	Table 3-10. Reclamation's Upper Klamath Lake operational plan per water year type 3-60
23	Table 3-11. Monthly discharge (cfs) statistics for East Side and West Side powerhouses and 24 Link River downstream of the East Side powerhouse for January 2, 1990, 25 through December 5, 2004..... 3-62
26	Table 3-12. Minimum flow and ramping rates for Link River dam 3-63
27	Table 3-13. General information on dams and canals within the Klamath Irrigation Project 3-63
28	Table 3-14. Monthly discharge (cfs) statistics for canals in the Klamath Irrigation Project 29 area for January 2, 1990, through December 5, 2004..... 3-65
30	Table 3-15. Water bank summary for 2003 through 2005 3-67
31	Table 3-16. Reservoir area, inflow, storage, and retention times 3-69
32	Table 3-17. Monthly discharge (cfs) statistics in the Klamath Project area 3-71
33	Table 3-18. Average spillage at J.C. Boyle, Copco No. 1, and Iron Gate dams for January 2, 34 1990, through December 5, 2004 3-73
35	Table 3-19. Monthly discharge (cfs) statistics for J.C. Boyle, Copco No. 1, and Iron Gate 36 powerhouses..... 3-75
37	Table 3-20. Ramping rate requirements for Iron Gate dam..... 3-79
38	Table 3-21. NMFS 2002 BiOp Iron Gate dam releases criteria based on water year 3-80

1	Table 3-22.	Phase III, NMFS 2002 BiOp Iron Gate dam releases criteria based on water year..	3-83
2	Table 3-23.	Monthly discharge (cfs) statistics for USGS gages along the Lower Klamath River and for the Shasta, Scott, Salmon, and Trinity rivers.....	3-84
3			
4	Table 3-24.	Applicable water quality criteria and objectives for Klamath Basin in the vicinity of the Klamath Hydroelectric Project	3-94
5			
6	Table 3-25.	Average water temperature data for stream reaches within the Klamath River Basin affected by project operation, 2000–2004.....	3-97
7			
8	Table 3-26.	Average DO data for stream reaches and the top 9 meters of reservoirs within the Klamath River Basin affected by project operation, 2000–2004.....	3-103
9			
10	Table 3-27.	Average DO data within Keno reservoir, 2000-2004	3-104
11	Table 3-28.	Average DO concentrations from representative profiles in Keno reservoir during May, July, and October, 2002	3-104
12			
13	Table 3-29.	Mean total phosphate, orthophosphate, and ammonia (mg/L) in Copco and Iron Gate reservoirs from samples collected between 2000 and 2004.....	3-113
14			
15	Table 3-30.	Water quality constituents at sites sampled downstream from Iron Gate dam	3-114
16	Table 3-31.	Secchi depth measurements at representative locations along the Klamath River in 2001 to 2003	3-119
17			
18	Table 3-32.	Mean turbidity (NTUs) in the Klamath River, 2002-2003	3-120
19	Table 3-33.	Total PCBs found in composite fish tissue samples in Project reservoirs, 2003....	3-121
20	Table 3-34.	Perceived effect of water quality on recreational visits in the Klamath Hydroelectric Project study area	3-122
21			
22	Table 3-35.	Current gages in the vicinity of the Klamath Hydroelectric Project	3-123
23	Table 3-36.	Fish species known to occur in the Klamath River and reservoirs upstream of Iron Gate dam and that are likely to occur downstream of Iron Gate dam.....	3-159
24			
25	Table 3-37.	Estimated lifestage periodicity of key fish species occurring in the Klamath River	3-162
26			
27	Table 3-38.	Summary of fishery sampling conducted in the Link River using electrofishing techniques	3-166
28			
29	Table 3-39.	Keno reservoir electrofishing catch during fall 2001, and spring, summer and fall 2002	3-167
30			
31	Table 3-40.	Summary of fishery sampling conducted in the Keno reach using backpack electrofishing techniques	3-168
32			
33	Table 3-41.	Number of fish collected by gear type during 1998 and 1999 in the J.C. Boyle reservoir	3-170
34			
35	Table 3-42.	Fishery sampling conducted in the J.C. Boyle bypassed reach using backpack electrofishing techniques	3-171
36			
37	Table 3-43.	Fishery sampling conducted in the J.C. Boyle peaking reach using backpack and boat electrofishing techniques.....	3-172
38			
39	Table 3-44.	Number of fish collected by gear type during 1998 and 1999 in Copco reservoir	3-174
40			

1	Table 3-45.	Fishery sampling conducted in the Copco No. 2 bypassed reach using backpack electrofishing techniques	3-175
3	Table 3-46.	Number of fish collected by gear type during 1998 and 1999 in the Iron Gate reservoir	3-177
5	Table 3-47.	Annual escapement of fall Chinook by sub-basin and hatchery, 1978 through 2002	3-179
7	Table 3-48.	Distribution of fall Chinook spawning redds observed from 1993 through 2002 from Iron Gate dam to Indian Creek	3-180
9	Table 3-49.	Non-target species (excluding Chinook salmon, coho salmon, and steelhead) collected during screw-trap sampling conducted at Big Bar (RM 49.7) on the Klamath River and at Willow Creek (RM 21.1) on the Trinity River, 1997-2000.....	3-182
13	Table 3-50.	Pools containing juvenile coho salmon, Chinook salmon, and steelhead on the mainstem Klamath River in 2001, as determined in snorkeling surveys.....	3-199
15	Table 3-51.	Harvest of green sturgeon from California, Oregon, and Washington from 1985 to 2003	3-203
17	Table 3-52.	Iron Gate Fish Hatchery production.....	3-206
18	Table 3-53.	PFMC stock management quotas for 2001-2005 for Klamath River fall Chinook.	3-218
20	Table 3-54.	Harvest (# fish) of age-3 and age-4 Klamath River fall Chinook	3-219
21	Table 3-55.	Estimates of Yurok and Hoopa Valley Reservation gillnet harvest, 1990-2005....	3-221
22	Table 3-56.	Klamath River angler harvest estimates for Chinook and coho salmon, and steelhead 1983 to 1987 seasons.....	3-223
24	Table 3-57.	Sampling sites where bivalve species were observed during macroinvertebrate sampling and focused bivalve surveys	3-229
26	Table 3-58.	Estimated water temperatures, wetted perimeter, and modeled rainbow trout WUA in the lower J.C. Boyle bypassed reach based on the volume of water released at J.C. Boyle dam.....	3-237
29	Table 3-59.	Rainbow trout catch per hour from Oregon Fish & Wildlife angler survey data from 1978 to 1984 for the Keno, J.C. Boyle bypassed, and J.C. Boyle peaking reaches.	3-239
32	Table 3-60.	Rainbow trout catch per hour from PacifiCorp hook-and-line sampling conducted in 2002 in the Keno, J.C. Boyle bypassed, and J.C. Boyle peaking reaches.	3-239
35	Table 3-61.	Modeled wetted area and rainbow trout WUA modeled for the J.C. Boyle peaking reach.	3-243
37	Table 3-62.	Peaking reach fish stranding and entrapment observations, 2002	3-247
38	Table 3-63.	Estimates of wetted perimeter and rainbow trout WUA habitat modeled for the Copco No. 2 bypassed reach.	3-250
40	Table 3-64.	Estimates of wetted perimeter and rainbow trout WUA modeled for the Fall Creek bypassed reach	3-253

1	Table 3-65.	Hardy Phase II and agency flow recommendations	3-258
2	Table 3-66.	Estimates of existing and recoverable anadromous fish habitat in tributaries to Upper Klamath Lake	3-263
4	Table 3-67.	Criteria for water temperature and DO concentration used to classify levels of stress for anadromous salmonids.	3-265
6	Table 3-68.	Thermal stress level for juvenile Chinook salmon based on temperature and DO levels predicted by the Klamath River water quality model.....	3-266
8	Table 3-69.	Thermal stress level for juvenile steelhead based on temperature and DO levels predicted by the Klamath River water quality model.....	3-267
10	Table 3-70.	Thermal stress level for adult anadromous salmonids based on temperature and DO levels predicted by the Klamath River water quality model.....	3-268
12	Table 3-71.	Disease management recommendations.....	3-283
13	Table 3-72.	Comparison of the benefits of three alternative approaches to anadromous fish restoration	3-295
15	Table 3-73.	Cumulative average survival estimates for all-volitional and collection and transport alternatives used in the KlamRAS fish passage model for fall Chinook salmon originating above Upper Klamath Lake.....	3-296
18	Table 3-74.	Estimated adult anadromous fish abundance under volitional passage and trap and transport alternatives	3-296
20	Table 3-75.	Phase 1 studies under PacifiCorp's alternative prescription.....	3-296
21	Table 3-76.	Estimated number of adult fall Chinook that could be accommodated by spawning habitat in the Iron Gate to Copco No. 2 dam, Copco No. 1 to J.C. Boyle, and J.C. Boyle to Keno reaches	3-298
24	Table 3-77.	Ratio of coded-wire tagged Chinook salmon subyearling and yearling smolt release return rates (percent) to Iron Gate Hatchery and water-year types.....	3-302
26	Table 3-78.	Cover types and habitats mapped in the vicinity of the Klamath Hydroelectric Project.....	3-314
28	Table 3-79.	Special status plant species that are known to occur in the vicinity of the Klamath Hydroelectric Project.....	3-323
30	Table 3-80.	Non-special status amphibian species that are known occur in the vicinity of the Klamath Project.....	3-327
32	Table 3-81.	Non-special status reptile species that are known to occur in the vicinity of the Klamath Project.....	3-328
34	Table 3-82.	Special status species that are known or documented to occur in the Klamath Project vicinity	3-332
36	Table 3-83.	Bald eagle territories and nesting status through 2003 in the general vicinity of the Klamath River Hydroelectric Project.....	3-372
38	Table 3-84.	Regional rivers with angling opportunities.....	3-390
39	Table 3-85.	Rivers with whitewater boating opportunities in the region.....	3-390
40	Table 3-86.	Acceptable and optimal flow ranges for various river-based activities for reaches of the Klamath River.....	3-398

1	Table 3-87.	Recreational facilities at Keno development.....	3-399
2	Table 3-88.	Recreational facilities at J.C. Boyle reservoir.....	3-401
3	Table 3-89.	Estimated annual whitewater boating use between J.C. Boyle powerhouse and	
4		Copco reservoir (1994—2001).....	3-402
5	Table 3-90.	Recreational facilities on the Klamath River between J.C. Boyle dam and Copco	
6		reservoir3-404	
7	Table 3-91.	Recreational facilities at Copco development.....	3-406
8	Table 3-92.	Recreational facilities at Fall Creek development.....	3-406
9	Table 3-93.	Recreational facilities at Iron Gate development.....	3-407
10	Table 3-94.	Annual estimated use and capacity assessment at recreational facilities at the	
11		Iron Gate development.....	3-408
12	Table 3-95.	PacifiCorp's proposed recreational improvements at J.C. Boyle development.....	3-413
13	Table 3-96.	PacifiCorp's proposed recreational improvements at Copco development.....	3-418
14	Table 3-97.	PacifiCorp's proposed recreational improvements at Fall Creek development.....	3-419
15	Table 3-98.	PacifiCorp's proposed recreational improvements at Iron Gate development.....	3-421
16	Table 3-99.	Land ownership within the proposed project boundary.....	3-450
17	Table 3-100.	Road mileage and maintenance responsibility within the Klamath River Project	
18		study area, existing project boundary, and proposed project boundary.....	3-453
19	Table 3-101.	Specified and alternative land use conditions	3-458
20	Table 3-102.	Race and ethnic distribution by county and community within the 5-mile	
21		corridor, 2000.....	3-473
22	Table 3-103.	Distribution of employment (percent) in agriculture, forestry, fishing, and	
23		hunting by community, 1990 and 2000	3-475
24	Table 3-104.	Distribution of low incomes and substandard housing (percent) by community	
25		in the 5-mile corridor, 2000	3-476
26	Table 3-105.	Annual recreation use and associated expenditures of total and non-local visitors	
27		in the upstream subregion, 2002	3-478
28	Table 3-106.	Annual recreation use and associated expenditures of total and non-local visitors	
29		in the downstream subregion, 2002	3-479
30	Table 3-107.	Estimates of KMZ coastal community personal income (in thousands of real	
31		2005 dollars) from the recreational ocean salmon fishery by port area.....	3-480
32	Table 3-108.	Estimates of KMZ coastal community personal income (in thousands of real	
33		2005 dollars) from the troll ocean salmon fishery by port area	3-481
34	Table 3-109.	Annual recreation use and associated expenditures of total and non-local visitors	
35		engaged in selected recreational activities in the upstream and downstream	
36		subregions in 2002 and with 5 and 15 percent growth	3-485
37	Table 3-110.	Annual recreation use and associated expenditures of total and non-local visitors	
38		engaged in whitewater boating and river-based angling in the upstream and	
39		downstream subregions in 2002 and with 5 percent and 15 percent growth	3-488

1	Table 4-1.	Staff assumptions for economic analysis of the Klamath Hydroelectric Project	4-1
2	Table 4-2.	Net investment value and operation and maintenance cost assumptions for the economic analysis of the Klamath Hydroelectric Project.....	4-2
3			
4	Table 4-3.	Summary of the annual net benefits in 2006 dollars for PacifiCorp's Proposal, the Staff Alternative, Staff Alternative with Mandatory Conditions, Retirement of Copco No. 1 and Iron Gate Developments, and the No-action Alternative for the Klamath Hydroelectric Project	4-2
5			
6			
7			
8	Table 4-4.	Dam removal recommendations and costs.....	4-8
9	Table 4-5.	Estimated annual generation (GWh) with and without operation of Keno facilities	4-12
10			
11	Table 4-6.	Data description and sources.....	4-13
12	Table 4-7.	Klamath Project carbon emissions displacement.....	4-20
13	Table 4-8.	Oregon and California greenhouse gas reduction goals	4-20
14	Table 5-1.	Summary of effects of PacifiCorp's Proposal, the Staff Alternative, the Staff Alternative with Mandatory Conditions, and Retirement of Copco No. 1 and Iron Gate Developments.....	5-12
15			
16			
17	Table 5-2.	Analysis of fish and wildlife agency recommendations for the Klamath Hydroelectric Project.....	5-60
18			
19	Table 5-3.	Bureau of Land Management and Reclamation preliminary 4(e) conditions for the Klamath Hydroelectric Project	5-76
20			
21	Table 5-4.	Summary of effect determinations for fish, plants, and wildlife.....	5-87
22	Table A-1.	Summary of capital costs, annual costs, annual energy costs, and total annualized costs of environmental measures proposed by PacifiCorp and recommended by others and considered by staff for inclusion in the Staff Alternative for the Klamath Hydroelectric Project	A-1
23			
24			
25			

ACRONYMS AND ABBREVIATIONS

ADA	Americans with Disabilities Act
Advisory Council	Advisory Council on Historic Preservation
APE	area of potential effects
BiOp	Biological Opinion
Bureau of Land Management	U.S. Bureau of Land Management
B.P.	years before present
C	Celsius
Cal Fish & Game	California Department of Fish and Game
CDP	census designated place
cfs	cubic feet per second
CIP	conservation implementation plan
CNPS	California Native Plant Society
Commission	Federal Energy Regulatory Commission
Conservation Groups	American Rivers, California Trout, Trout Unlimited, and World Wildlife Fund
CWA	Clean Water Act
DO	dissolved oxygen
EFH	essential fish habitat
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act of 2005
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FERC	Federal Energy Regulatory Commission
Forest Service	U.S. Department of Agriculture, Forest Service
FPA	Federal Power Act
FWS	U.S. Fish and Wildlife Service
HPMP	Historic Properties Management Plan
HRA	Historical Research Associates
IFR/PCFFA	Institute for Fisheries Resources/Pacific Coast Federation of Fishermen's Associations
in	inch
Interior	U.S. Department of the Interior
KFMC	Klamath Fishery Management Council
KMZ	Klamath Management Zone
KNF	Klamath National Forest
KRITFWC	Klamath River Inter-Tribal Fish and Water Commission
KWUA	Klamath Water Users Association
kV	kilovolt
mg/L	milligrams per liter
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MW	megawatt
MWh	megawatt-hours
National Register	National Register of Historic Places
NCASI	National Council for Air and Stream Improvement
NCRWQCB	California North Coast Regional Water Quality Control Board
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act

NMFS	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Service Fisheries
NPS	National Park Service
NTU	nephelometric turbidity unit
NWPP	Northwest Power Pool
OHV	Off-highway vehicle
Oregon Fish & Wildlife	Oregon Department of Fish and Wildlife
Oregon Environmental Quality	Oregon Department of Environmental Quality
Oregon Parks & Rec	Oregon Parks and Recreation Department
ORVs	outstanding remarkable values
PFMC	Pacific Fishery Management Council
Reclamation	U.S. Bureau of Reclamation
RM	river mile
RMP	Resource Management Plan
ROD	record of decision
RRMP	recreational resource management plan
RV	recreational vehicle
SCORPs	Statewide Comprehensive Outdoor Recreation Plans
SD1	Scoping Document 1
SHPO	State Historic Preservation Officer
SOD	sediment oxygen demand
TCP	Traditional Cultural Properties
TDG	total dissolved gas
TMDL	total maximum daily load
TRD	Trinity River Division
TSS	total suspended sediment
USGS	U.S. Geological Survey
VRM	visual resource management
Water Board	California State Water Resources Control Board
WECC	Western Electricity Coordinating Council
WUA	weighted usable area