



---

## **Lower Snake River Juvenile Salmon Migration Feasibility Report and Environmental Impact Statement (Final FR/EIS)**

Lead Agency: Department of the Army  
Walla Walla District Corps of Engineers  
201 North Third Avenue  
Walla Walla, WA 99362-1876

For further information contact: Lonnie Mettler  
Project Manager  
Department of the Army  
Walla Walla District, Corps of Engineers  
Walla Walla, WA 99362-1876  
(509) 527-7268

Record of Decision: At least 45 days after publishing the Notice of Availability of the Final FR/EIS in the Federal Register, the Corps will prepare a Record of Decision documenting the action resulting from the Feasibility Study process.

Abstract:

The Corps of Engineers, along with the Bonneville Power Administration, U.S. Environmental Protection Agency, and U.S. Bureau of Reclamation as cooperating agencies, analyzed four general alternatives intended to provide information on the technical, environmental, and economic effects of actions related to improving juvenile salmon passage. The four alternatives include Alternative 1—Existing Conditions (the no-action alternative) and three different ways to further improve juvenile salmon passage. The action alternatives are as follows: Alternative 2—Maximum Transport of Juvenile Salmon; Alternative 3—Major System Improvements; and Alternative 4—Dam Breaching. Based on a thorough examination of the best available biological, economic, social, and other environmental information, Alternative 3—Major System Improvements has been selected as the recommended plan (preferred alternative).



Lower Snake River Juvenile Salmon  
Migration Feasibility Study

**Final Feasibility Report/  
Environmental Impact Statement**

Part I  
Chapters 1 through 4

February 2002






---

# Contents

## PART I

<b>EXECUTIVE SUMMARY</b>	<b>ES-1</b>
<b>1. INTRODUCTION</b>	<b>1-1</b>
1.1 Historical Overview	1-2
1.1.1 Harvest	1-2
1.1.2 Loss of Habitat	1-4
1.1.3 Estuary Destruction	1-4
1.1.4 Hatchery Salmonids	1-4
1.1.5 Dams and Reservoirs	1-4
1.1.6 Other Human-related Problems	1-4
1.2 Feasibility Study Process	1-5
1.3 Purpose and Need	1-7
1.4 Background	1-8
1.4.1 1995 Biological Opinion	1-8
1.4.2 1998 Biological Opinion	1-9
1.4.3 2000 NMFS and USFWS Biological Opinions	1-10
1.5 Scope	1-11
1.5.1 Scoping and Public Involvement	1-13
1.5.2 Screening Analysis	1-13
1.5.3 Geographic and Jurisdictional Scopes	1-14
1.5.4 Regional Forum	1-17
1.5.5 Additional Fish and Wildlife Planning Groups and Activities in the Columbia River Basin	1-19
1.5.5.1 U.S. Army Corps of Engineers/Bureau of Reclamation	1-19
1.5.5.2 Federal Energy Regulatory Commission	1-19
1.5.5.3 Bonneville Power Administration	1-19
1.5.5.4 National Marine Fisheries Service	1-19
1.5.5.5 U.S. Fish and Wildlife Service	1-20
1.5.5.6 U.S. Environmental Protection Agency	1-20

1.5.5.7	Federal Caucus/Basinwide Recovery Strategy	1-20
1.5.5.8	Columbia River Basin Forum	1-20
1.5.5.9	Tribal Caucus	1-21
1.5.5.10	Columbia River Inter-Tribal Fish Commission (CRITFC)	1-21
1.5.5.11	Wy-Kan-Ush-Mi Wa-Kish-Wit	1-21
1.5.5.12	State Agencies	1-21
1.5.5.13	Columbia Basin Fish and Wildlife Authority	1-21
1.5.5.14	Northwest Power Planning Council	1-22
1.5.5.15	Multi-Species Framework/Ecosystem Diagnosis and Treatment Analysis	1-22
1.6	Alternatives	1-22
1.7	Authority	1-23
<b>2.</b>	<b>AFFECTED PROJECTS AND PROGRAMS</b>	<b>2-1</b>
2.1	Project Characteristics	2-2
2.1.1	Adult Fish	2-3
2.1.2	Juvenile Fish	2-6
2.1.3	Reservoir Operation Levels	2-9
2.1.4	Turbine Operation	2-9
2.1.5	Spill for Juvenile Passage	2-10
2.1.6	Completion of Gas Abatement Measures	2-11
2.1.7	Flow Augmentation	2-13
2.1.8	Lower Snake River Fish and Wildlife Compensation Plan	2-14
2.1.9	Surface Bypass Collector Prototype Operation	2-15
2.1.10	Power Marketing	2-18
2.1.11	Navigation	2-18
2.1.12	Recreation	2-19
2.2	Facility Operations and Structures	2-19
2.2.1	Lower Granite	2-19
2.2.2	Little Goose	2-22
2.2.3	Lower Monumental	2-24
2.2.4	Ice Harbor	2-26
<b>3.</b>	<b>PLAN FORMULATION</b>	<b>3-1</b>
3.1	Alternative 1—Existing Conditions	3-2
3.2	Alternative 2—Maximum Transport of Juvenile Salmon	3-6
3.3	Alternative 3—Major System Improvements (Adaptive Migration)	3-6
3.4	Alternative 4—Dam Breaching	3-12
3.4.1	Reservoir Drawdown	3-14
3.4.2	Required Modifications	3-14

3.4.2.1	Bulkheads	3-16
3.4.2.2	Turbines/Generators	3-16
3.4.2.3	Channel Preparation	3-17
3.4.2.4	Embankment Removal	3-17
3.4.2.5	River Channelization	3-17
3.4.2.6	Changes to Other Facilities	3-18
3.4.3	Lower Snake River Compensation Plan	3-18
3.5	Implementation Schedule and Costs	3-19
3.5.1	Alternatives 1 and 2	3-19
3.5.2	Alternative 3—Major System Improvements (Adaptive Migration)	3-19
3.5.3	Alternative 4—Dam Breaching	3-21
3.5.4	Average Annual Cost Comparison	3-22
3.6	Other Potential Actions Outside the Scope of the FR/EIS	3-22
3.7	Alternative Actions Eliminated from Further Consideration	3-23
<b>4.</b>	<b>AFFECTED ENVIRONMENT</b>	<b>4.1-1</b>
4.1	General Setting	4.1-1
4.1.1	Physical Environment	4.1-1
4.1.2	Human Environment	4.1-4
4.2	Geology and Soils	4.2-1
4.2.1	Introduction	4.2-1
4.2.2	Regional Geology	4.2-1
4.2.3	Regional Soils	4.2-2
4.2.4	Erosion and Sedimentation	4.2-3
4.3	Air Quality	4.3-1
4.3.1	Air Quality Regulations	4.3-1
4.3.1.1	Regulated Air Pollutants	4.3-1
4.3.1.2	Greenhouse Gases	4.3-2
4.3.2	Sources of Air Pollution	4.3-2
4.3.3	Ambient Air Pollutant Concentrations	4.3-3
4.3.4	Climatic Factors	4.3-4
4.4	Water Resources	4.4-1
4.4.1	Hydrology	4.4-1
4.4.1.1	Climate	4.4-1
4.4.1.2	Description and Hydrology of Drainage Area	4.4-3
4.4.1.3	Historical Flows Prior to Impoundment	4.4-3
4.4.2	Water Quality	4.4-4
4.4.2.1	Activities in the Lower Snake River Affecting Water Quality	4.4-5

4.4.2.2	Water Quality Parameters and Standards	4.4-9
4.4.2.3	Water Quality Monitoring Programs and Historical Data	4.4-16
4.4.2.4	Hazardous Materials, Substances, Chemicals, and Wastes	4.4-43
4.5	Aquatic Resources	4.5-1
4.5.1	Anadromous Fish	4.5-1
4.5.1.1	Life History	4.5-4
4.5.1.2	Run Status	4.5-20
4.5.1.3	Lyons Ferry Hatchery	4.5-37
4.5.2	Resident Fish and Aquatic Community	4.5-38
4.5.2.1	Species Composition	4.5-38
4.5.2.2	Habitat Use	4.5-41
4.5.2.3	Aquatic Food Chain	4.5-46
4.5.2.4	Resident Fish Species Listed Under ESA	4.5-48
4.6	Terrestrial Resources	4.6-1
4.6.1	Vegetation	4.6-1
4.6.1.1	Riparian Communities	4.6-4
4.6.1.2	Emergent Wetland Community	4.6-6
4.6.1.3	Upland Community	4.6-6
4.6.2	Wildlife	4.6-7
4.6.2.1	Current Terrestrial Mitigation and Habitat Evaluation Procedures	4.6-7
4.6.2.2	Game Birds	4.6-12
4.6.2.3	Waterfowl	4.6-13
4.6.2.4	Shorebirds	4.6-14
4.6.2.5	Colonial-nesting Birds	4.6-14
4.6.2.6	Raptors	4.6-15
4.6.2.7	Other Non-Game Birds	4.6-15
4.6.2.8	Big Game Mammals	4.6-17
4.6.2.9	Small Mammals	4.6-18
4.6.2.10	Furbearers	4.6-19
4.6.2.11	Amphibians and Reptiles	4.6-19
4.6.3	Species with Federal Status	4.6-20
4.6.3.1	Threatened and Endangered Plant Species	4.6-21
4.6.3.2	Threatened and Endangered Wildlife Species	4.6-23
4.7	Cultural Resources	4.7-1
4.7.1	Cultural Resource Definition	4.7-1
4.7.2	Cultural Resource Significance	4.7-2



4.7.3	Prehistory	4.7-2
4.7.4	Historic Period	4.7-3
4.7.5	Identified Historic and Archaeological Sites	4.7-4
4.8	Native American Indians	4.8-1
4.8.1	Overview	4.8-3
4.8.1.1	Tribal Summaries	4.8-3
4.8.2	Tribal Resources	4.8-9
4.8.2.1	Land	4.8-9
4.8.2.2	Salmon	4.8-10
4.8.3	Current Tribal Circumstances	4.8-10
4.8.4	Government to Government	4.8-12
4.9	Transportation	4.9-1
4.9.1	Navigation	4.9-1
4.9.1.1	Navigation Facilities	4.9-1
4.9.1.2	Ports	4.9-3
4.9.1.3	Shipping Operations	4.9-3
4.9.1.4	Commodity Movements	4.9-4
4.9.1.5	Upper River Navigation	4.9-8
4.9.2	Railroads	4.9-8
4.9.3	Highways	4.9-10
4.9.3.1	Eastern Washington Grain Shipments	4.9-10
4.9.3.2	Local and Regional Highways	4.9-12
4.10	Electric Power	4.10-1
4.10.1	Generation	4.10-1
4.10.2	Regional Power Supply and Sales	4.10-2
4.10.2.1	Firm Sales	4.10-3
4.10.2.2	Nonfirm Sales	4.10-4
4.10.2.3	Regional Exports	4.10-4
4.10.3	Lower Snake River Facilities	4.10-5
4.10.3.1	Project Characteristics and Combined Capacity	4.10-5
4.10.3.2	Average Monthly Generation	4.10-6
4.10.3.3	Annual Generation	4.10-7
4.10.3.4	Daily Generation and Ancillary Services	4.10-7
4.11	Water Supply	4.11-1
4.11.1	Irrigated Agriculture	4.11-1
4.11.2	Municipal, Industrial, and Other Water Uses	4.11-5
4.12	Land Ownership and Use	4.12-1
4.12.1	Regional Land Use	4.12-1
4.12.2	Lower Snake River Corridor	4.12-4
4.12.3	Lower Snake River Reservoirs	4.12-4

4.13	Recreation and Tourism	4.13-1
4.13.1	Recreation	4.13-1
4.13.1.1	Recreation Facilities and Activities	4.13-1
4.13.1.2	Visitation	4.13-4
4.13.2	Tourism	4.13-6
4.14	Social Resources	4.14-1
4.14.1	Regional Demographics and Employment	4.14-1
4.14.1.1	Employment	4.14-2
4.14.1.2	Income	4.14-7
4.14.1.3	Population	4.14-8
4.14.2	Communities	4.14-10
4.14.2.1	Lower Snake River Study Area	4.14-11
4.14.2.2	Coastal Region	4.14-14
4.14.2.3	Southern Idaho	4.14-18
4.14.3	Low Income and Minority Populations	4.14-18
4.14.3.1	Poverty	4.14-18
4.14.3.2	Race and Ethnicity	4.14-19
4.15	Aesthetics	4.15-1
4.15.1	Landscape Character	4.15-1
4.15.2	Project Aesthetic Conditions	4.15-1
4.15.3	Views and Viewers	4.15-2

## **PART II**

<b>5.</b>	<b>ENVIRONMENTAL EFFECTS OF ALTERNATIVES</b>	<b>5.1-1</b>
5.1	Introduction	5.1-1
5.1.1	Uncertainties in Environmental Effects of Alternatives	5.1-1
5.1.2	Cumulative Effects	5.1-2
5.1.3	Short- and Long-term Effects	5.1-2
5.2	Geology and Soils	5.2-1
5.2.1	Alternative 1—Existing Conditions	5.2-1
5.2.2	Alternative 2—Maximum Transport of Juvenile Salmon and Alternative 3—Major System Improvements	5.2-2
5.2.3	Alternative 4—Dam Breaching	5.2-2
5.2.4	Cumulative Effects	5.2-2
5.2.5	Uncertainties in Potential Geology and Soils Effects	5.2-3
5.3	Air Quality	5.3-1
5.3.1	Study Methods	5.3-2
5.3.1.1	Construction-related Fugitive Emissions	5.3-2
5.3.1.2	Emissions Associated with Loss of Barge Transportation	5.3-3

5.3.1.3	Fugitive Dust from Exposed Sediments	5.3-3
5.3.1.4	Replacement of Power Generation	5.3-3
5.3.2	Impacts of the Alternatives	5.3-4
5.3.2.1	Alternative 1—Existing Conditions	5.3-4
5.3.2.2	Alternative 2—Maximum Transport of Juvenile Salmon	5.3-5
5.3.2.3	Alternative 3—Major System Improvements	5.3-6
5.3.2.4	Alternative 4—Dam Breaching	5.3-7
5.3.3	Cumulative Effects	5.3-9
5.3.4	Uncertainties in Potential Air Quality Effects	5.3-10
5.4	Water Resources	5.4-1
5.4.1	Hydrology	5.4-1
5.4.1.1	Alternative 1—Existing Conditions	5.4-1
5.4.1.2	Alternative 2—Maximum Transport of Juvenile Salmon and Alternative 3—Major System Improvements	5.4-1
5.4.1.3	Alternative 4—Dam Breaching	5.4-3
5.4.2	Water Quality	5.4-3
5.4.2.1	Sediment (Turbidity and Total Suspended Solids)	5.4-4
5.4.2.2	Water Temperature	5.4-6
5.4.2.3	Contaminants	5.4-16
5.4.2.4	Total Dissolved Gas	5.4-16
5.4.3	Cumulative Effects	5.4-18
5.4.4	Uncertainties in Potential Water Resources Effects	5.4-18
5.5	Aquatic Resources	5.5-1
5.5.1	Anadromous Fish	5.5-1
5.5.1.1	Alternative 1—Existing Conditions	5.5-3
5.5.1.2	Alternative 2—Maximum Transport of Juvenile Salmon	5.5-34
5.5.1.3	Alternative 3—Major Systems Improvements	5.5-36
5.5.1.4	Alternative 4—Dam Breaching	5.5-42
5.5.1.5	Model Analysis of All Alternatives	5.5-67
5.5.1.6	Cumulative Risk Analysis	5.5-95
5.5.1.7	Cumulative Effects	5.5-113
5.5.1.8	Uncertainties in Potential Anadromous Fish Effects	5.5-113
5.5.2	Resident Fish	5.5-115
5.5.2.1	Total Dissolved Gas	5.5-117
5.5.2.2	Spill and Entrainment	5.5-117
5.5.2.3	Dam Breaching	5.5-118

	5.5.2.4	Effects of the Alternatives	5.5-119
	5.5.2.5	ESA-listed Resident Fish Species	5.5-126
	5.5.2.6	Cumulative Effects	5.5-126
	5.5.2.7	Uncertainties in Potential Resident Fish Effects	5.5-127
5.6		Terrestrial Resources	5.6-1
	5.6.1	Vegetation	5.6-1
	5.6.1.1	Alternative 1—Existing Conditions	5.6-2
	5.6.1.2	Alternative 2—Maximum Transport of Juvenile Salmon and Alternative 3—Major System Improvements	5.6-3
	5.6.1.3	Alternative 4—Dam Breaching	5.6-4
	5.6.2	Wildlife	5.6-8
	5.6.2.1	Alternative 1—Existing Conditions	5.6-8
	5.6.2.2	Alternative 2—Maximum Transport of Juvenile Salmon	5.6-9
	5.6.2.3	Alternative 3—Major System Improvements	5.6-9
	5.6.2.4	Alternative 4—Dam Breaching	5.6-10
	5.6.3	Species with Federal Status	5.6-18
	5.6.3.1	Plant Species	5.6-18
	5.6.3.2	Wildlife Species	5.6-19
	5.6.4	Cumulative Effects	5.6-20
	5.6.5	Uncertainties in Potential Terrestrial Resources Effects	5.6-21
5.7		Cultural Resources	5.7-1
	5.7.1	Cultural Resources Impact Issues	5.7-1
	5.7.2	The Alternatives and Their Impacts	5.7-4
	5.7.2.1	Alternative 1—Existing Conditions	5.7-4
	5.7.2.2	Alternative 2—Maximum Transport of Juvenile Salmon	5.7-5
	5.7.2.3	Alternative 3—Major System Improvements	5.7-6
	5.7.2.4	Alternative 4—Dam Breaching	5.7-6
	5.7.3	Cultural Resources Management	5.7-7
	5.7.4	The Cultural Resources Protection Plan	5.7-7
	5.7.5	Avoidance or Protection	5.7-7
	5.7.6	Data Recovery and Curation	5.7-8
	5.7.7	Consultation with Indian Tribes	5.7-8
	5.7.8	Coordination with Mitigation Efforts for Other Resources	5.7-8
	5.7.9	Cultural Resources Monitoring	5.7-8
	5.7.10	Cumulative Effects	5.7-8
	5.7.11	Uncertainties in Potential Cultural Resources Effects	5.7-8

5.8	Native American Indians	5.8-1
5.8.1	Tribal Salmon Harvest	5.8-2
5.8.1.1	Projected Harvest Numbers	5.8-2
5.8.1.2	The Alternatives and Their Effects	5.8-5
5.8.2	Tribal Land Use	5.8-7
5.8.2.1	Alternative 1—Existing Conditions	5.8-7
5.8.2.2	Alternative 2—Maximum Transport of Juvenile Salmon	5.8-7
5.8.2.3	Alternative 3—Major System Improvements	5.8-7
5.8.2.4	Alternative 4—Dam Breaching	5.8-7
5.8.3	Cumulative Effects	5.8-8
5.8.4	Uncertainties in Potential Effects on Native American Indians	5.8-9
5.9	Transportation	5.9-1
5.9.1	Navigation	5.9-2
5.9.1.1	Methodology	5.9-2
5.9.1.2	The Alternatives and Their Effects	5.9-4
5.9.2	Railroads	5.9-7
5.9.2.1	Mainline Railroads	5.9-8
5.9.2.2	Short-Line Railroads	5.9-8
5.9.2.3	Rail Car Capacity	5.9-9
5.9.2.4	Rail System Congestion	5.9-9
5.9.2.5	Export and Country Elevators	5.9-9
5.9.3	Highways	5.9-9
5.9.3.1	Change in Highway Use	5.9-9
5.9.3.2	Highway Infrastructure Improvement Needs	5.9-10
5.9.3.3	River Elevator Improvements	5.9-11
5.9.3.4	Highway Traffic Congestion and Safety	5.9-12
5.9.3.5	Potential Spills	5.9-13
5.9.4	Summary of Transportation-Related Economic Effects	5.9-15
5.9.4.1	Transportation Costs	5.9-15
5.9.4.2	Infrastructure Capital Costs	5.9-16
5.9.4.3	Average Annual NED Costs	5.9-17
5.9.5	Cumulative Effects	5.9-17
5.9.6	Uncertainties in Potential Transportation Effects	5.9-17
5.9.7	Findings of Other Studies	5.9-18
5.10	Electric Power	5.10-1
5.10.1	Methodology	5.10-2
5.10.1.1	Hydroregulation Models	5.10-2
5.10.1.2	Power System Models	5.10-3

5.10.1.3	Transmission Reliability	5.10-4
5.10.1.4	Ancillary Services	5.10-5
5.10.2	The Alternatives and Their Impacts	5.10-5
5.10.2.1	Alternative 1—Existing Conditions	5.10-6
5.10.2.2	Alternative 2—Maximum Transport of Juvenile Salmon and Alternative 3—Major System Improvements	5.10-6
5.10.2.3	Alternative 4—Dam Breaching	5.10-6
5.10.2.4	Revised Biological Opinions	5.10-6
5.10.3	Financial Impacts to Ratepayers under Alternative 4—Dam Breaching	5.10-7
5.10.3.1	Possible Power Rate Increases	5.10-9
5.10.3.2	Possible Monthly Bill Increases	5.10-10
5.10.4	Power Replacement With Non-Polluting Resources	5.10-11
5.10.5	Cumulative Effects	5.10-14
5.10.6	Uncertainties in Potential Electric Power Effects	5.10-14
5.11	Water Supply	5.11-1
5.11.1	Agriculture Water Uses	5.11-1
5.11.1.1	Alternative 1—Existing Conditions	5.11-1
5.11.1.2	Alternative 2—Maximum Transport of Juvenile Salmon	5.11-2
5.11.1.3	Alternative 3—Major System Improvements	5.11-2
5.11.1.4	Alternative 4—Dam Breaching	5.11-2
5.11.2	Municipal, Industrial, and Other Uses	5.11-7
5.11.2.1	Alternative 1—Existing Conditions	5.11-7
5.11.2.2	Alternative 2—Maximum Transport of Juvenile Salmon	5.11-7
5.11.2.3	Alternative 3—Major System Improvements	5.11-7
5.11.2.4	Alternative 4—Dam Breaching	5.11-7
5.11.3	Summary of Economic Effects	5.11-9
5.11.4	Cumulative Effects	5.11-10
5.11.5	Uncertainties in Potential Agriculture, Municipal, and Industrial Water Uses	5.11-10
5.12	Land Ownership and Use	5.12-1
5.12.1	Regional Land Use	5.12-1
5.12.1.1	Alternatives 1 Through 3	5.12-1
5.12.1.2	Alternative 4—Dam Breaching	5.12-1
5.12.2	Lower Snake River Corridor	5.12-5
5.12.2.1	Alternatives 1 Through 3	5.12-5

5.12.2.2	Alternative 4—Dam Breaching	5.12-5
5.12.3	Cumulative Effects	5.12-9
5.12.4	Uncertainties in Potential Land Ownership and Use	5.12-9
5.13	Recreation and Tourism	5.13-1
5.13.1	Recreation Facilities and Sites	5.13-2
5.13.1.1	Lower Granite Lake (Lower Granite Reservoir)	5.13-4
5.13.1.2	Lake Bryan (Little Goose Reservoir)	5.13-5
5.13.1.3	Lake Herbert G. West (Lower Monumental Reservoir)	5.13-8
5.13.1.4	Lake Sacajawea (Ice Harbor Reservoir)	5.13-8
5.13.2	Dispersed Recreation Sites	5.13-10
5.13.3	Recreation Activities	5.13-10
5.13.3.1	Existing Recreational Activities and Displaced Users	5.13-10
5.13.3.2	New Recreational Activities	5.13-11
5.13.4	Future Visitation	5.13-16
5.13.4.1	Estimated General River Recreation Demand	5.13-16
5.13.4.2	Comparison of Demand Estimates with Existing Visitation to Other Rivers	5.13-17
5.13.5	Economic Effects	5.13-21
5.13.6	Cumulative Effects	5.13-23
5.13.7	Uncertainties in Potential Recreation and Tourism Effects	5.13-24
5.14	Social Resources	5.14-1
5.14.1	Regional Demographics and Employment	5.14-1
5.14.1.1	Employment	5.14-5
5.14.1.2	Income	5.14-11
5.14.1.3	Population	5.14-15
5.14.2	Communities	5.14-17
5.14.2.1	Lower Snake River Study Area	5.14-17
5.14.2.2	Coastal Region	5.14-30
5.14.2.3	Southern Idaho	5.14-31
5.14.3	Environmental Justice	5.14-33
5.14.3.1	Effects on Minority and Low Income Populations	5.14-33
5.14.3.2	Community Forum Participants	5.14-39
5.14.4	Cumulative Effects	5.14-40
5.14.5	Uncertainty	5.14-40
5.14.5.1	Regional Demographics and Employment	5.14-40
5.14.5.2	Communities	5.14-41
5.14.5.3	Environmental Justice	5.14-41
5.15	Aesthetics	5.15-1
5.15.1	Aesthetic Impact Issues	5.15-1

5.15.1.1	Shoreline Contrast	5.15-2
5.15.1.2	Erosion	5.15-3
5.15.1.3	Seep Lakes and Embayments	5.15-3
5.15.1.4	Water Characteristics	5.15-3
5.15.1.5	Waterside Facilities	5.15-3
5.15.1.6	Dust and Odors	5.15-3
5.15.2	The Alternatives and Their Impacts	5.15-3
5.15.2.1	Alternative 1—Existing Conditions	5.15-3
5.15.2.2	Alternative 2—Maximum Transport of Juvenile Salmon	5.15-4
5.15.2.3	Alternative 3—Major System Improvements	5.15-4
5.15.2.4	Alternative 4—Dam Breaching	5.15-4
5.15.3	Cumulative Effects	5.15-5
5.16	Economic Overview	5.16-1
5.16.1	National Economic Development	5.16-2
5.16.1.1	Overview and Results	5.16-2
5.16.1.2	Uncertainty	5.16-5
5.16.2	Passive Use Values	5.16-5
5.16.2.1	Overview and Results	5.16-5
5.16.2.2	Uncertainty	5.16-6
5.17	Cumulative Effects	5.17-1
5.17.1	Snake River Flow Augmentation Analysis	5.17-4
5.17.2	Interior Columbia Basin Ecosystem Management Project	5.17-6
5.17.3	Hells Canyon Relicensing Project	5.17-7
5.17.4	Nez Perce Tribal Hatchery Program	5.17-7
5.17.5	Conservation of Columbia Basin Fish—Federal Final Basinwide Salmon Recovery Strategy	5.17-8
5.17.6	Starbuck Power Project	5.17-9
5.17.7	Wallula Power Plant	5.17-9
5.17.8	Oregon Plan for Salmon and Steelhead	5.17-10
5.17.9	Uncertainties in Cumulative Effects	5.17-10
5.18	Relationship Between Short-term Uses and Long-term Productivity	5.18-1
<b>6.</b>	<b>PLAN SELECTION AND IMPLEMENTATION</b>	<b>6-1</b>
6.1	Recommended Plan (Preferred Alternative)	6-2
6.1.1	Description of the Recommended Plan (Preferred Alternative)	6-3
6.1.1.1	Structural Measures	6-4
6.1.1.2	Operational Measures	6-5
6.1.2	Consistency with Biological Opinions	6-7
6.1.3	Mitigation	6-9



6.2	Plan Selection Rationale	6-10
6.2.1	High Current Juvenile Salmon Survival Rates Through the Lower Snake River Project	6-10
6.2.2	Effectiveness of Structural Modifications	6-11
6.2.3	Uncertainty in Current Biological Information	6-13
6.2.4	Economic Effects	6-14
6.2.5	NMFS and USFWS 2000 Biological Opinions	6-14
6.2.6	Environmental Effects	6-14
6.2.7	Social, Community, and Native American Indians	6-15
6.2.8	Regional Acceptability and Public Comments	6-15
6.2.9	Other Considerations	6-16
6.3	Plan Selection Process	6-16
6.4	Comparison of Alternatives	6-18
6.4.1	General	6-18
6.4.2	Trade-Off Analysis	6-19
6.4.2.1	Aquatic Resources—Anadromous Fish	6-19
6.4.2.2	Aquatic Resources—Resident Fish	6-24
6.4.2.3	Water Resources	6-24
6.4.2.4	Air Quality	6-26
6.4.2.5	Terrestrial Resources	6-28
6.4.2.6	Cultural Resources	6-30
6.4.2.7	Electric Power	6-31
6.4.2.8	Transportation (Navigation)	6-31
6.4.2.9	Recreation and Tourism	6-31
6.4.2.10	Water Supply/Irrigation	6-31
6.4.2.11	Commercial Harvest	6-31
6.4.2.12	Implementation and Avoided Costs	6-33
6.4.2.13	Social Effects	6-33
6.4.2.14	Native American Indians (Tribal Values)	6-34
6.4.2.15	Geological Resources	6-35
6.4.2.16	Aesthetic Resources	6-36
6.4.2.17	Summary Trade-Off Analysis	6-36
6.4.3	Other Considerations	6-39
6.4.3.1	Regional Acceptability	6-39
6.4.3.2	Implementation Duration	6-39
6.4.3.3	Short-term Uses and Long-term Productivity	6-40
6.4.3.4	Irreversible and/or Irretrievable Commitment of Resources	6-40
6.4.3.5	Best Information or Science Available	6-40

6.4.3.6	Environmentally Preferable Alternative	6-40
6.4.3.7	Accordance With Declared Policies of NEPA and Compliance With Federal Laws and Regulations	6-42
6.5	Implementation Plan	6-43
6.6	Other Actions/Studies Outside this Process	6-44
6.6.1	Water Quality Plan	6-45
6.6.2	Lower Monumental Stilling Basin Repairs	6-46
6.6.3	Powerhouse Rehabilitations	6-46
6.6.4	Dredged Material Management Study	6-46
6.6.5	Lower Snake River Project Management Plan (PMP) for Possible Re-evaluation Study/Supplemental Environmental Impact Statement (SEIS)	6-47
<b>7.</b>	<b>REGIONAL COORDINATION AND PUBLIC OUTREACH</b>	<b>7-1</b>
7.1	Regional Coordination	7-2
7.1.1	Lead and Cooperating Agencies	7-2
7.1.2	Regional Roundtable Workshops	7-2
7.1.3	Work Groups	7-3
7.1.4	Coordination with Other Regional Salmon Recovery Efforts	7-3
7.2	Public Outreach Program	7-3
7.2.1	Public Outreach Plan	7-4
7.2.2	Public Information Techniques	7-5
7.2.2.1	Informational Video	7-5
7.2.2.2	Web Site	7-5
7.2.2.3	Mailing List	7-5
7.2.2.4	Newsletter and Brochure	7-5
7.2.2.5	Traveling Displays	7-6
7.2.2.6	Information Sheets and Information Packets	7-6
7.2.2.7	Media Coverage	7-6
7.2.2.8	Newspaper Insert and Advertising	7-7
7.2.3	Public Involvement Techniques	7-7
7.2.3.1	Scoping Meetings	7-7
7.2.3.2	Public Information Meetings	7-8
7.2.3.3	Formal Public Meetings	7-9
7.2.3.4	Community Assessment Forums	7-10
7.2.3.5	Briefings and Presentations	7-11
7.2.3.6	Tours of Facilities	7-11
7.3	Monitoring Public Outreach Effectiveness	7-11
7.4	Public Comment Process	7-11
7.4.1	Processing the Comment Documents	7-12

7.4.2	Evaluating the Comment Documents	7-12
7.4.2.1	Identifying and Categorizing Comments	7-12
7.4.2.2	Responding to Comments	7-13
<b>8.</b>	<b>COMPLIANCE WITH APPLICABLE FEDERAL ENVIRONMENTAL STATUTES AND REGULATIONS</b>	<b>8-1</b>
8.1	National Environmental Policy Act	8-2
8.2	Endangered and Threatened Species and Critical Habitat	8-3
8.3	Fish and Wildlife Conservation	8-3
8.3.1	Fish and Wildlife Coordination Act	8-3
8.3.2	Fishery Conservation and Management Act of 1976	8-4
8.3.3	Migratory Bird Conservation Act	8-4
8.3.4	Pacific Northwest Electric Power Planning and Conservation Act (Northwest Power Act)	8-4
8.4	Heritage Conservation	8-5
8.4.1	National Historic Preservation Act	8-5
8.4.2	Archeological Resources Protection Act	8-5
8.4.3	Native American Graves Protection and Repatriation Act	8-6
8.4.4	American Indian Religious Freedom Act	8-6
8.5	State, Area-Wide, and Local Plan and Program Consistency	8-6
8.6	Coastal Zone Management Consistency	8-6
8.7	Environmental Justice	8-7
8.8	Flood Plain Management	8-7
8.9	Wetlands Protection	8-7
8.10	Farmland Protection	8-8
8.10.1	Farmland Protection Policy Act	8-8
8.10.2	CEQ Memorandum, August 11, 1990, on Analysis of Impacts on Prime or Unique Agricultural Lands	8-8
8.11	Recreation Resources	8-8
8.11.1	Wild and Scenic Rivers Act	8-8
8.11.2	Columbia River Gorge National Scenic Area Act	8-9
8.11.3	Wilderness Act	8-9
8.11.4	Water Resources Development Act	8-9
8.11.5	Federal Water Project Recreation Act	8-10
8.11.6	Land and Water Conservation Fund Act	8-10
8.12	Navigable Waters	8-10
8.13	Pollution Control at Federal Facilities	8-11
8.13.1	Federal Water Pollution Control Act (Clean Water Act)	8-11
8.13.2	Clean Air Act	8-11
8.14	Relevant Agreements	8-12
8.14.1	Canadian Entitlement Allocation Agreement	8-12

8.14.1.1	Description	8-12
8.14.1.2	Discussion of Impacts	8-13
8.14.2	Pacific Northwest Coordination Agreement (PNCA)	8-14
8.14.2.1	Description	8-14
8.14.2.2	Discussion of Impacts	8-14
8.14.3	Memorandum of Agreement on the Bonneville Power Administration's (BPA) Financial Commitment for Fish and Wildlife Costs	8-15
8.14.3.1	Description	8-15
8.14.3.2	Discussion of Impacts	8-17
8.14.4	MOA on Direct Funding of Power Operation and Maintenance Costs at Corps Projects	8-17
8.14.4.1	Description	8-17
8.14.4.2	Discussion of Impacts	8-18
8.14.5	Tribal Treaties	8-18
8.14.5.1	Description	8-18
8.14.5.2	Discussion of Impacts	8-19
8.14.6	Water Rights Agreements	8-19
8.14.6.1	Description	8-19
8.14.6.2	Discussion of Impacts	8-20
8.14.7	Pacific Salmon Treaty	8-20
8.14.7.1	Description	8-20
8.14.7.2	Discussion of Impacts	8-21
<b>9.</b>	<b>LITERATURE CITED</b>	<b>9-1</b>
<b>10.</b>	<b>GLOSSARY</b>	<b>10-1</b>
<b>11.</b>	<b>LIST OF PREPARERS</b>	<b>11-1</b>
<b>12.</b>	<b>DISTRIBUTION LIST</b>	<b>12-1</b>
<b>13.</b>	<b>INDEX</b>	<b>13-1</b>

## **APPENDICES (Bound Separately)**

APPENDIX A (BOUND WITH B)	ANADROMOUS FISH MODELING
APPENDIX B (BOUND WITH A)	RESIDENT FISH
APPENDIX C	WATER QUALITY
APPENDIX D	NATURAL RIVER DRAWDOWN ENGINEERING
APPENDIX E	EXISTING SYSTEMS AND MAJOR SYSTEM IMPROVEMENTS ENGINEERING
APPENDIX F (BOUND WITH G, H)	HYDROLOGY/HYDRAULICS AND SEDIMENTATION
APPENDIX G (BOUND WITH F, H)	HYDROREGULATIONS
APPENDIX H (BOUND WITH F, G)	FLUVIAL GEOMORPHOLOGY
APPENDIX I	ECONOMICS
APPENDIX J	PLAN FORMULATION
APPENDIX K	REAL ESTATE
APPENDIX L (BOUND WITH M)	LOWER SNAKE RIVER MITIGATION HISTORY AND STATUS
APPENDIX M (BOUND WITH L)	FISH AND WILDLIFE COORDINATION ACT REPORT
APPENDIX N (BOUND WITH O, P)	CULTURAL RESOURCES
APPENDIX O (BOUND WITH N, P)	PUBLIC OUTREACH PROGRAM
APPENDIX P (BOUND WITH N, O)	AIR QUALITY
APPENDIX Q (BOUND WITH R, T)	TRIBAL CONSULTATION AND COORDINATION
APPENDIX R (BOUND WITH Q, T)	HISTORICAL PERSPECTIVES
APPENDIX S*	SNAKE RIVER MAPS
APPENDIX T (BOUND WITH R, Q)	CLEAN WATER ACT, SECTION 404(B)(1) EVALUATION
APPENDIX U	RESPONSE TO PUBLIC COMMENTS

\*APPENDIX S, LOWER SNAKE RIVER MAPS, IS BOUND SEPARATELY (OUT OF ORDER) TO ACCOMMODATE A SPECIAL 11 X 17 FORMAT.

# Figures

Figure 1-1.	Project Vicinity	1-15
Figure 1-2.	Regional Base Map	1-16
Figure 1-3.	Regional Implementation Organization Chart	1-18
Figure 2-1.	Existing Adult Fish Passage Systems	2-3
Figure 2-2a.	Existing Fish Passage Systems	2-6
Figure 2-2b.	Juvenile Fish Bypass Facilities	2-7
Figure 2-3.	Spillway Flow Deflector (flip lip), Lower Granite Dam Spillway	2-12
Figure 2-4.	Regional Hatcheries	2-16
Figure 2-5.	Regional Habitat Management Units	2-17
Figure 2-6.	Looking Upstream at Lower Granite Facility	2-20
Figure 2-7.	Schematic of Lower Granite Facility	2-21
Figure 2-8.	Looking South at Little Goose Facility	2-22
Figure 2-9.	Schematic of Little Goose Facility	2-23
Figure 2-10.	Looking South at Lower Monumental Facility	2-24
Figure 2-11.	Schematic of Lower Monumental Facility	2-25
Figure 2-12.	Looking Northeast at Ice Harbor Facility	2-26
Figure 2-13.	Schematic of Ice Harbor Facility	2-28
Figure 3-1.	Lower Snake River Juvenile Salmon Migration Feasibility Study, Alternatives Matrix	3-4
Figure 3-2a.	Surface Bypass Collector Prototype System	3-8
Figure 3-2b.	Behavioral Guidance Structure Underwater View	3-8
Figure 3-3a.	Overview of the Lower Granite 2001 Surface Bypass and Removable Spillway Weir Prototype	3-10
Figure 3-3b.	Spillway without Removable Spillway Weir (Typical Spillway Operation) (Cross-Sectional View)	3-10
Figure 3-3c.	Spillway with Removable Spillway Weir Deployed (Operating Position) (Cross-Sectional View)	3-11
Figure 3-3d.	Spillway with Removable Spillway Weir Removed (Flood Control) (Cross-Sectional View)	3-11
Figure 3-4.	Dam Breaching	3-13
Figure 4.1-1.	Regional Dams	4.1-2
Figure 4.4-1.	Average Daily Flows for Ice Harbor Dam, 10/1/78 to 10/1/85	4.4-4
Figure 4.4-2.	Water Quality Sampling Sites	4.4-6
Figure 4.4-3.	Major Sources of Heat Loss and Gain to a River System	4.4-13

Figure 4.4-4.	Total Dissolved Gas Measured Below Ice Harbor Dam, 1996 to 1998	4.4-20
Figure 4.4-5.	Total Dissolved Gas Measured Below Ice Harbor Dam, 1998 to 1999	4.4-20
Figure 4.4-6.	Dissolved Oxygen for Select Stations in 1997	4.4-22
Figure 4.4-7.	Lower Snake River Water Temperature Data Collection Periods	4.4-23
Figure 4.4-8.	Average Daily Maximum Water Temperature for Spalding and Anatone (1974 to 1999)	4.4-24
Figure 4.4-9.	Average Maximum Water Temperatures in Degrees Celsius—1974 to 1981	4.4-27
Figure 4.4-10.	Average Maximum Water Temperatures in Degrees Celsius—1995 to 1999	4.4-27
Figure 4.4-11.	Average Daily Water Temperature Differences (Between Daily Maximum and Daily Minimum) at Burbank and Ice Harbor Dam	4.4-28
Figure 4.4-12.	Mean Concentrations and 95% Confidence Limits of In River Water and In Sediment Elutriate at Ambient pH	4.4-40
Figure 4.4-13.	Total Suspended Solids Data Measured in 1997 at Selected Stations throughout the Study Area	4.4-41
Figure 4.4-14.	Total Nitrogen Measured in 1997 at Selected Water Quality Sampling Sites throughout the Study Area	4.4-43
Figure 4.4-15.	Total Phosphorus Data Measured in 1997 at Selected Stations throughout the Study Area	4.4-43
Figure 4.5-1.	Salmon Life Cycle	4.5-2
Figure 4.5-2.	Snake River Salmon Range	4.5-3
Figure 4.5-3.	Adult Salmonid Main Upstream Periods	4.5-8
Figure 4.5-4.	Peak Periods of Downstream Migration of Salmonid Smolts	4.5-8
Figure 4.5-5.	Minimum Numbers (in Thousands) of Salmon and Steelhead Entering the Columbia River, 1938 to 1999	4.5-24
Figure 4.5-6.	Index Streams Spring and Summer Chinook Redd Counts in Northeast Oregon and Idaho, 1957 to 1999	4.5-26
Figure 4.5-7.	Estimated Wild and Hatchery Adult Spring Chinook Passing Lower Granite Dam, 1977 to 2000	4.5-27
Figure 4.5-8.	Estimated Wild and Hatchery Adult Summer Chinook Passing Lower Granite Dam, 1977 to 2000	4.5-28
Figure 4.5-9.	Estimated Wild and Hatchery Adult Fall Chinook Passing Lower Granite Dam, 1977 to 1999	4.5-30
Figure 4.5-10.	Estimated Sockeye Passing the Uppermost Dam on the Snake River (Lower Granite Dam after 1974), 1962 to 2000 (May Include Kokanee Prior to 1992)	4.5-32

Figure 4.5-11.	Estimated Wild and Hatchery A-Run (A) B-Run (B) Summer Steelhead Passing Lower Granite Dam, 1985-1986 to 1998-1999	4.5-34
Figure 4.6-1.	Regional Vegetation	4.6-3
Figure 4.6-2.	Pre-project (1958) Acreage of Vegetation Types in the Study Area	4.6-5
Figure 4.6-3.	Current (1995) Acreage of Vegetation Types within the Study Area	4.6-5
Figure 4.6-4a.	Lower Granite Lake Land Classification	4.6-8
Figure 4.6-4b.	Lake Bryan Land Classification	4.6-9
Figure 4.6-4c.	Lake West Land Classification	4.6-10
Figure 4.6-4d.	Lake Sacajawea Land Classification	4.6-11
Figure 4.8-1.	Tribal Reservations	4.8-11
Figure 4.9-1.	Average Annual Tonnage Transported on the Shallow-Draft Portion of the Columbia-Snake Inland Waterway by Commodity Group, 1992 through 1996	4.9-5
Figure 4.9-2.	Average Annual Tonnage Transported on the Lower Snake River above Ice Harbor Dam by Commodity Group, 1992 through 1996	4.9-5
Figure 4.9-3.	Regional Railroads	4.9-11
Figure 4.9-4.	Roads, Highways, and Ports	4.9-14
Figure 4.10-1.	Pacific Northwest Electric Generation by Resource Type	4.10-3
Figure 4.10-2.	Combined Plant Capacity of the Four Lower Snake River Facilities	4.10-6
Figure 4.10-3.	Average Monthly Generation by the Lower Snake River Facilities (combined)	4.10-7
Figure 4.10-4.	Annual Variation in Lower Snake River Project Average Monthly Generation	4.10-8
Figure 4.11-1.	Regional Land Use and Cover	4.11-3
Figure 4.12-1.	Number and Average Size of Farms in the Downriver Subregion, 1959 to 1992	4.12-3
Figure 4.12-2.	Number and Average Size of Farms in the Reservoir Subregion, 1959 to 1992	4.12-3
Figure 4.12-3.	Number and Average Size of Farms in the Upriver Subregion, 1959 to 1992	4.12-3
Figure 4.14-1.	Regional Analysis	4.14-3
Figure 4.14-2.	River Study Area Communities by Size	4.14-11
Figure 4.14-3.	Distribution of Lower Snake River Study Area Communities by Economic Diversity	4.14-12
Figure 4.14-4.	Distribution of Lower Snake River Study Area Communities by Percentage of Direct Employment in Selected Industrial Sectors	4.14-13



Figure 4.14-5.	Sources of Total Personal Income in Clatsop County, Oregon, 1993	4.14-17
Figure 4.14-6.	Sources of Total Personal Income in Grays Harbor County, Washington, 1995	4.14-17
Figure 5.4-1.	Estimated Timing of Sediment Transport Resulting from Breaching of the Lower Snake River Dams	5.4-7
Figure 5.4-2.	1995 RBM10 Temperature Modeling Results and 1995 Temperature Monitoring Data	5.4-8
Figure 5.4-3.	Temperatures Predicted by RBM10 at RM 10 with and without Lower Snake River Dams for Years Prior to Dworshak Flow Augmentation	5.4-9
Figure 5.4-4.	Temperatures Predicted by RBM10 at RM 10 with and without Lower Snake River Dams for Years Since Dworshak Flow Augmentation	5.4-10
Figure 5.4-5.	The MASS 2 Simulated Temperatures for Lower Snake River with Near-Natural River Conditions at RM 10	5.4-12
Figure 5.4-6.	The MASS 2 Simulated Temperatures for Lower Snake River with Reservoirs in Place at RM 10	5.4-12
Figure 5.5-1.	Estimated Survival (Includes Extrapolation Outside Area Measured) of Juvenile Spring/Summer and Fall Chinook, and Steelhead from the Upper Dam on the Snake River to the Tailrace of Bonneville Dam (no transport fish)	5.5-14
Figure 5.5-2	Spill Effectiveness (Empirically Estimated Curve from Ice Harbor Reservoir, Lower Monumental, and Lower Granite PIT-tag Hydroacoustic, and Radio-tag Studies)	5.5-41
Figure 5.5-3.	Total Direct Survival (Transported plus In-River Migrants) of Juvenile Spring/Summer Chinook Salmon to Below Bonneville Dam, Graphed as 5 year Moving Averages	5.5-75
Figure 5.5-4.	Frequency of Exceeding the 24-year Survival Escapement Level for Spring/Summer Chinook Salmon under Alternatives 1, 2, 3, and 4, According to the PATH Prospective Lifecycle Model	5.5-81
Figure 5.5-5.	Equally Weighted Frequency of Exceeding the 48-year Recovery Escapement Level for Spring/Summer Chinook Salmon under Alternatives 1, 2, 3, and 4, According to the PATH Prospective Lifecycle Model	5.5-82
Figure 5.5-6.	Relationship between Different Combinations of Assumptions and the Average Frequency of Exceeding the 48-year Recovery Escapement Level, as Predicted by the PATH Lifecycle Model	5.5-84

Figure 5.5-7.	NMFS (In-river) Reach Survival Estimates, Expanded to Represent Survival Through All Lower Snake River and Lower Columbia River Projects in Existence During a Particular Period Using the Method in Smith and Williams (1999)	5.5-89
Figure 5.5-8.	Probability that Model Runs Resulting in 100-year Median Escapement SAR (Generated by PATH Lifecycle Model as SAR to the Upper Dam) Meet Survival and Recovery Criteria for Snake River Spring/Summer Chinook Salmon	5.5-92
Figure 5.5-9.	Numerical Experiments Exploring 100 Percent Survival During In-river Migration	5.5-105
Figure 5.5-10.	Effectiveness of Past Management Actions Targeting In-river Survival of Snake River Spring/Summer Chinook Salmon	5.5-105
Figure 5.5-11.	Isoclines Calibrating Improvements in First Year ( $s_1$ ) and Early Ocean/Estuarine ( $s_e$ ) Survival for Poverty Flat Index Stock of Snake River Spring/Summer Chinook Salmon	5.5-106
Figure 5.5-12.	Population Growth Rate ( $\lambda$ ) for Fall Chinook Salmon and Percent Change in Population Growth Rate with 10 percent Reduction in Mortality During Different Life Stages	5.5-108
Figure 5.5-13.	Percent Increase in Fall Chinook Salmon Population Growth Rate ( $\lambda$ ) Relative to an Extinction Risk Threshold over a Range of Ocean and Mainstem Harvest Reductions	5.5-110
Figure 5.5-14.	Percent Increase in Fall Chinook Salmon Population Growth Rate ( $\lambda$ ) Relative to an Extinction Risk Threshold Over a Range of Relative Increases in Egg to Early Ocean (First Year) Survivals	5.5-111
Figure 5.5-15.	Proportional Distribution of Predicted River Velocities in a Near-natural Lower Snake River Determined by a Two-Dimensional Model	5.5-121
Figure 5.7-1.	Reservoir Impact Zones and Potential Impacts on Historic and Cultural Properties	5.7-3
Figure 5.8-1.	Estimated Tribal Harvest of Wild and Hatchery Salmon and Steelhead	5.8-4
Figure 5.9-1.	Percent of Lower Snake River Barged Grain by State	5.9-7
Figure 5.9-2.	Percent of Increased Transportation Costs	5.9-7
Figure 5.10-1.	Schematic of the Models Used in the DREW HIT Analysis	5.10-3
Figure 5.10-2.	Difference in Snake River Generation (2000 Biological Opinion – 1995 Biological Opinion)	5.10-8
Figure 5.13-1.	Comparison Between Middle Estimates 1 and 2 and Existing Visitation to Free-flowing Rivers and the Lower Snake River Reservoirs (Number of Visits)	5.13-19

Figure 5.14-1.	Net Annual Short-term Employment Change in the Lower Snake River Study Area (2001 to 2010) under Alternative 4—Dam Breaching	5.14-8
Figure 5.14-2.	Net Annual Employment Change in the Lower Snake River Study Area (2001-2051) under Alternative 4—Dam Breaching	5.14-10
Figure 5.14-3.	Net Annual Total Regional Employment Change (2001 to 2051)	5.14-11
Figure 5.15-1.	Current Photograph of the Lower Granite Dam Representative of the First Three Alternatives	5.15-6
Figure 5.15-2.	Site Condition During Construction of Lower Granite Dam That May Be Similar to the Breached Condition	5.15-6
Figure 6-1.	Lower Snake River Water Temperatures for an “Average” Water Year at River Mile 10. Predicted By RBM10, with and without Lower Snake River Dams, for Years Since Dworshak Flow Augmentation	6-28

# Tables

Table 1-1.	Federally Listed, Proposed, or Candidate Anadromous Fish Species (Evolutionarily Significant Units [ESUs]) in the Columbia River Basin	1-3
Table 1-2.	Alternative Designations for this FR/EIS and Previous Designations in Other Reports	1-23
Table 1-3.	Authorized Uses of Lower Snake River Project Facilities	1-24
Table 2-1.	Characteristics of the Four Lower Snake River Facilities	2-3
Table 2-2.	Components of Juvenile and Adult Fish Passage Facilities at the Lower Snake River Project	2-4
Table 2-3.	Number of HMUs per Facility	2-15
Table 2-4.	Facility Operations and Structures	2-20
Table 3-1.	Implementation Costs and Schedules	3-20
Table 3-2.	Summary of Implementation Costs (1998 dollars) (\$1,000s)	3-23
Table 4.3-1.	Major Air Emission Sources within the Lower Snake River Region	4.3-3
Table 4.4-1.	Climate Data for the Lower Snake River Study Area	4.4-2
Table 4.4-2.	Snake River Drainage Characteristics	4.4-3
Table 4.4-3.	Washington Water Quality Standards for Parameters of Concern and 303(d) Listings in the Lower Snake River	4.4-7
Table 4.4-4.	Maximum Water Temperatures	4.4-25
Table 4.4-5.	Water Temperatures at Corps Dams	4.4-29
Table 4.4-6.	Distribution of Sediment Carried by the Lower Snake River and Deposited in McNary and the Lower Snake River Project from 1953 through 1998	4.4-30
Table 4.4-7.	Summary of Sieve Test Results for Sediment Samples Collected from the Lower Snake River in 1997	4.4-32
Table 4.4-8.	Summary of Mean Nutrient Concentrations for Sediment Samples Collected in the Lower Snake River	4.4-36
Table 4.4-9.	Summary of Mean Metal Concentrations for Ambient pH Elutriate Samples Collected of the Lower Snake River Project	4.4-38
Table 4.4-10.	Summary of Mean Nutrient Concentrations for Ambient pH Elutriate Samples Collected during Phase 2 (1997) in the Lower Snake River	4.4-39
Table 4.4-11.	Critical Values for Total Ammonia CCC Values that are Protective of Salmonids and Sensitive Life Stages	4.4-40
Table 4.4-12.	1997 Turbidity Measurements (NTU) in Surface Waters at Selected Snake River Stations	4.4-42

Table 4.5-1.	Wild and Hatchery Races of Salmon and Steelhead in the Columbia River Basin	4.5-22
Table 4.5-2.	Federally Listed, Proposed, or Candidate Anadromous Fish Species in the Columbia River Basin	4.5-23
Table 4.5-3.	List of Resident Fish Species Present in Lower Snake River Reservoirs	4.5-39
Table 4.5-4.	Physical Characteristics of Lower Snake River Reservoirs	4.5-42
Table 4.5-5.	Characteristics of Habitat Use Guilds for Resident Fish Currently Present in the Snake River System	4.5-45
Table 4.6-1.	Acreages of Habitat Types within the Boundaries of the Lower Snake River Project Based on Cover Type	4.6-2
Table 4.6-2.	Threatened and Endangered Plant and Animal Species Potentially Occurring within the Study Area	4.6-22
Table 4.8-1.	Study Tribe Reservations and Enrolled Populations	4.8-10
Table 4.8-2.	Relative Circumstances of the Five Tribal Circumstances Report Tribes	4.8-12
Table 4.9-1.	Lock Characteristics of the Columbia-Snake River System	4.9-2
Table 4.9-2.	Barge Transportation on the Shallow–Draft Portion of the Columbia-Snake Inland Waterway in 1995	4.9-3
Table 4.9-3.	Tonnage of Shipments by Commodity Group on the Shallow Draft Portion of the Columbia-Snake Inland Waterway from 1992 to 1996	4.9-4
Table 4.9-4.	Tonnage by Commodity Group Passing through Ice Harbor Lock 1987-1996 (in thousand tons)	4.9-6
Table 4.9-5.	Grain Shipments on the lower Snake River by State of Origin and Reservoir (in bushels)	4.9-7
Table 4.9-6.	Receipts of Wheat and Barley at Columbia River Export Houses by Mode of Transportation (in thousands of bushels)	4.9-9
Table 4.9-7.	Existing Rail and Barge Grain Unloading Capacities at Columbia River Deep Water Ports	4.9-9
Table 4.9-8.	Eastern Washington Grain Shipments: Ton-miles and Highway Infrastructure Needs	4.9-12
Table 4.9-9.	Potentially Affected Highways	4.9-13
Table 4.10-1.	Pacific Northwest Electric Generating Resources	4.10-3
Table 4.10-2.	Hydroelectric Power Plant Characteristics	4.10-5
Table 4.11-1.	Agricultural Acreage in Southeast Washington Counties, 1997	4.11-1
Table 4.11-2.	Acreage and Crops Grown on Farms Irrigated from Ice Harbor Reservoir	4.11-4

Table 4.11-3.	Estimated Crop Acreage Irrigated from Ice Harbor Reservoir by Type	4.11-4
Table 4.11-4.	M&I Pump Stations on Lower Granite Reservoir	4.11-5
Table 4.11-5.	Irrigated HMUs Along the Lower Snake River	4.11-6
Table 4.11-6.	Well Reports by Use and County (Number of Wells)	4.11-6
Table 4.12-1.	Land Use in the Reservoir Subregion	4.12-2
Table 4.12-2.	Agricultural Land Use in the Reservoir Subregion	4.12-2
Table 4.12-3.	Acreage by Type of Acquisition and Project	4.12-5
Table 4.12-4.	Real Estate Outgrants Associated with the Lower Snake River Project	4.12-5
Table 4.13-1.	Lower Snake River Recreation Facilities	4.13-2
Table 4.13-2.	Visitor Distribution by Activity at the Lower Snake River Reservoirs (%)	4.13-4
Table 4.13-3.	Visitation at Recreation Areas	4.13-5
Table 4.14-1.	Regional Analysis Study Area and Subregions by State and County	4.14-2
Table 4.14-2.	Employment in Washington, Oregon, and Idaho, 1969 and 1998	4.14-4
Table 4.14-3.	Employment in the Lower Snake River Study Area, 1969 and 1998	4.14-5
Table 4.14-4.	Employment in the Lower Snake River Study Area by Subregion, 1998	4.14-6
Table 4.14-5.	Sources of Personal Income, 1969 and 1998	4.14-7
Table 4.14-6.	Per Capita Income by Subregion, 1970 to 1995 (1995 dollars)	4.14-8
Table 4.14-7.	Population, 1970 to 2000	4.14-9
Table 4.14-8.	Age by Subregion, 1980 to 1990	4.14-10
Table 4.14-9.	Community Type Descriptions	4.14-15
Table 4.14-10.	Base Case Conditions for Selected Lower Snake River Study Area Focus Communities by Community Type	4.14-16
Table 4.14-11.	Base Case Conditions for Selected Southern Idaho Focus Communities by Community Type	4.14-18
Table 4.14-12.	Poverty Rates, 1979, 1989, and 1997	4.14-19
Table 4.14-13.	Race and Ethnicity in the United States and Pacific Northwest States, 2000	4.14-19
Table 4.14-14.	Race and Ethnicity by Subregion, 2000	4.14-20
Table 4.14-15.	Race and Ethnicity in the 25 Study Counties 1980 to 1990	4.14-20
Table 5.2-1.	Summary of Potential Effects of the Alternatives on Geology and Soils	5.2-1
Table 5.2-2.	Areas of Current Reservoirs and Exposed Reservoir Bottom	5.2-2

Table 5.3-1.	Summary of Potential Effects of the Alternatives on Air Quality	5.3-2
Table 5.3-2.	Percent Increase in Year 2010 Electrical Generating Emissions throughout WSCC Region	5.3-5
Table 5.3-3.	Estimated Deconstruction PM <sub>10</sub> Emissions	5.3-7
Table 5.3-4.	Transportation-Related Emissions (tons per year)	5.3-8
Table 5.3-5.	Annual Average PM <sub>10</sub> Emissions by Reservoir under Alternative 4—Dam Breaching (tons per year)	5.3-8
Table 5.3-6.	Summary of Emissions (tons per year)	5.3-10
Table 5.4-1.	Summary of Potential Effects of the Alternatives on Water Resources	5.4-2
Table 5.4-2.	Temperature Modeling Simulations That Were Available for This Analysis	5.4-11
Table 5.4-3.	Comparison of Number of Days Temperature is Expected to Exceed 68°C Benchmark and the Magnitude of Exceedances (Based on RBM-10 model simulations)	5.4-14
Table 5.5-1.	Summary of Potential Effects of the Alternatives on Anadromous Fish	5.5-4
Table 5.5-2.	Season Survival Estimates for the Reach Lower Granite Tailwater to McNary Tailwater	5.5-11
Table 5.5-3.	Modeled Effects of Suspended Sediment (in mg/l) on Salmon and Steelhead Based on Newcombe and Jensen (1996)	5.5-45
Table 5.5-4.	Summary of Estimates of Duration, Juvenile Survival, and Adult Survival for the Four Time Periods for the Lower Snake River Reach Only	5.5-79
Table 5.5-5.	Average Fraction of Runs (Across All, Equally Weighted Assumption Sets) Exceeding NMFS Survival and Recovery Escapement Criteria for Spring/Summer Chinook Salmon for Alternatives 1, 2, 3, and 4	5.5-80
Table 5.5-6.	D-Value Hypotheses Used to Estimate Effects on Each Alternative	5.5-85
Table 5.5-7.	Summary of Major Quantitative Results by Alternative for Fall Snake River Chinook Salmon	5.5-87
Table 5.5-8.	SAR Estimates to Upper Dam (Escapement SAR) During Historical and Recent Periods for Snake River Spring/Summer Chinook Salmon and Snake River Steelhead	5.5-93
Table 5.5-9.	Estimated Population Size (Wild Only), Growth Rate ( $\lambda$ ), Risk of Extinction and 90% Decline in Abundance, and Needed Improvements in $\lambda$ to Reduce Risk of Decline or Extinction in 100 Years to below 5% for Snake River Basin Stocks	5.5-99

Table 5.5-10.	Estimated Population Size (Wild and Hatchery), Growth Rate ( $\lambda$ ), Risk of Extinction and 90% Decline in Abundance, and Needed Improvements in $\lambda$ to Reduce Risk of Decline or Extinction in 100 Years to below 5% for Snake River Basin Stocks	5.5-101
Table 5.5-11.	Summary of the Potential Effects of the Alternatives on Resident Fish	5.5-115
Table 5.5-12.	Summary of the Amount of Expected Habitat Types in a Near-natural Lower Snake River after Dam Breaching, Assuming Summertime 24 kcfs Flows	5.5-120
Table 5.5-13.	Comparison of Estimated Biomass for Native and Introduced Fishes in the Free-flowing Snake River above Asotin and in the Lower Granite Reservoir	5.5-126
Table 5.6-1.	Summary of Potential Effects of the Alternatives on Terrestrial Resources	5.6-2
Table 5.6-2.	Estimated Short-term Habitat Losses and Long-term Habitat Gains in the Study Area Under Alternative 4—Dam Breaching	5.6-7
Table 5.7-1.	Summary of Potential Effects of the Alternatives on Cultural Resources	5.7-2
Table 5.8-1.	Estimated Tribal Harvest of Wild Snake River Stocks in Pounds by Species	5.8-3
Table 5.8-2.	Estimated Tribal Harvest of Wild and Hatchery Snake River Stocks in Pounds by Species	5.8-3
Table 5.9-1.	Summary of Potential Effects of the Alternatives on Transportation	5.9-2
Table 5.9-2.	Waterborne Traffic Projections above Ice Harbor Lock 2002 to 2022 (in thousand tons)	5.9-3
Table 5.9-3.	Grain Diverted from the Lower Snake River in 2007 under Alternative 4—Dam Breaching	5.9-5
Table 5.9-4.	Grain Transportation Cost Comparison by State for 2007	5.9-6
Table 5.9-5.	Percentage of Diverted Grain and Increased Transportation Costs by State under Alternative 4—Dam Breaching	5.9-6
Table 5.9-6.	Non-Grain Commodity Transportation Cost Comparison for 2007	5.9-6
Table 5.9-7.	Projected Changes in Truck Miles by State	5.9-10
Table 5.9-8.	Traffic Increases for Selected Highways under Alternative 4—Dam Breaching	5.9-12
Table 5.9-9.	Estimated Traffic Accidents by Selected Highway under Alternative 4—Dam Breaching	5.9-13
Table 5.9-10.	Projected Shipments of Petroleum Products and Chemicals	5.9-14



Table 5.9-11.	Potential Spills of Petroleum Products and Chemicals from Barge Transportation under Alternatives 1 through 3	5.9-14
Table 5.9-12.	Potential Spills of Petroleum Products and Chemicals from Truck Transportation under Alternative 4 – Dam Breaching	5.9-15
Table 5.9-13.	Total Transportation Cost Comparison for 2007	5.9-16
Table 5.9-14.	Summary of Estimated Costs of Infrastructure Improvements Needed with Dam Breaching (1998 dollars)	5.9-16
Table 5.9-15.	Transportation—Average Annual Economic Effects by Discount Rate (1998 Dollars) (\$1,000s of Dollars)	5.9-17
Table 5.10-1.	Summary of Potential Effects of the Alternatives on Electric Power	5.10-2
Table 5.10-2.	Power Resource Additions by Alternative for Selected Years	5.10-4
Table 5.10-3.	Average Annual Economic Effects by Discount Rate (1000s of Dollars)	5.10-5
Table 5.10-4.	Examination of Lower Snake River Plant Average Generation with 1995, 1998, and 2000 Biological Opinions Based on HYSSR Model Runs	5.10-7
Table 5.10-5.	Possible Wholesale Rate Impacts under Alternative 4—Dam Breaching	5.10-10
Table 5.10-6.	Possible Monthly Bill Increases by Sector under Alternative 4—Dam Breaching	5.10-11
Table 5.10-7.	Possible Monthly Bill Increases for Selected Commercial and Public Buildings under Alternative 4—Dam Breaching	5.10-12
Table 5.11-1.	Summary of Potential Effects of the Alternatives on Agricultural, Municipal, and Industrial Water Uses	5.11-2
Table 5.11-2.	Cost of Modifying Ice Harbor Agricultural Pumping Stations, 1998 Dollars	5.11-4
Table 5.11-3.	Farmland Value Estimates for Selected Crops	5.11-5
Table 5.11-4.	Economic Impact to Pump Irrigators based on Change in Farmland Values under Alternative 4—Dam Breaching	5.11-6
Table 5.11-5.	Modifications Required for M&I Pump Stations at Lower Granite	5.11-8
Table 5.11-6.	Well Modification Costs by Pool, 1998 Dollars	5.11-8
Table 5.11-7.	Average Annual Economic Effects by Discount Rate (1,000s of dollars)	5.11-10
Table 5.12-1.	Summary of Potential Effects of the Alternatives on Land Ownership and Use	5.12-2
Table 5.12-2.	Increased Transportation Costs and Total Costs per Acre by County under Alternative 4—Dam Breaching	5.12-3

Table 5.12-3.	Average Increased Transportation Cost per Farm by County under Alternative 4—Dam Breaching	5.12-4
Table 5.12-4.	Project Lands	5.12-5
Table 5.12-5.	Real Estate Administrative Costs (dollars)	5.12-8
Table 5.13-1.	Summary of Potential Effects of the Alternatives on Recreation	5.13-2
Table 5.13-2.	Estimated Changes in River Elevation under Alternative 4—Dam Breaching by Reservoir and Developed Recreation Area	5.13-3
Table 5.13-3.	A Summary of the Likely Effects of Alternative 4—Dam Breaching on Recreation Areas on Lower Granite Lake (Lower Granite Reservoir)	5.13-6
Table 5.13-4.	A Summary of the Likely Effects of Alternative 4—Dam Breaching on Recreation Areas on Lake Bryan (Little Goose Reservoir)	5.13-7
Table 5.13-5.	A Summary of the Likely Effects of Alternative 4—Dam Breaching on Recreation Areas on Lake Herbert G. West (Lower Monumental Reservoir)	5.13-9
Table 5.13-6.	A Summary of the Likely Effects of Alternative 4—Dam Breaching on Recreation Areas on Lake Sacajawea (Ice Harbor Reservoir)	5.13-9
Table 5.13-7.	Recreation Suitability Recovery after Dam Removal	5.13-14
Table 5.13-8.	Estimated Net Average Annual Recreation Benefits, 1998 Dollars (\$1,000s of dollars) (6.875 percent discount rate)	5.13-23
Table 5.13-9.	Estimated Total Net Average Annual Recreation Benefits, 1998 dollars (\$1,000s of dollars)	5.13-24
Table 5.14-1.	Summary of the Potential Effects of the Alternatives on Social Resources	5.14-2
Table 5.14-2.	Short-term Subregion Employment Effects under Alternative 4—Dam Breaching (Jobs)	5.14-7
Table 5.14-3.	Long-term Subregion Employment Impacts under Alternative 4—Dam Breaching (Jobs)	5.14-9
Table 5.14-4.	Annual State-level Employment Impacts for Alternative 4—Dam Breaching Excluding those Impacts Modeled for the Subregions (Jobs)	5.14-10
Table 5.14-5.	Short-term Subregion Personal Income Impacts under Alternative 4—Dam Breaching (1998 dollars) (\$ million per year)	5.14-13
Table 5.14-6.	Long-term Subregion Personal Income Impacts under Alternative 4—Dam Breaching (1998 dollars) (\$ million)	5.14-14

Table 5.14-7.	Annual State-level Personal Income Impacts for Alternative 4— Dam Breaching Excluding those Impacts Modeled for the Subregions (1998 dollars) (\$ million)	5.14-15
Table 5.14-8.	Population Projections 2000 to 2020 (in thousands)	5.14-16
Table 5.14-9.	Significance of Changes in the Physical, Biological, and Socioeconomic Environment	5.14-19
Table 5.14-10.	Perceptions of Change by Community and Community Type	5.14-23
Table 5.14-11.	Economic Impacts of the Proposed Alternatives for Astoria and Westport (Project Year 25)	5.14-31
Table 5.14-12.	Summary of Tribal Environmental Justice Effects Associated with Alternatives 1 and 2	5.14-35
Table 5.14-13.	Summary of Tribal Environmental Justice Effects Associated with Alternative 4—Dam Breaching	5.14-36
Table 5.14-14.	Employment and Acreage on Farms Irrigated by Water from the Ice Harbor Reservoir	5.14-37
Table 5.14-15.	Estimated Hispanic Labor Force on Farms Irrigated from the Ice Harbor Reservoir	5.14-38
Table 5.14-16.	Potentially Affected Hispanic/Latino Labor Force as a Percent of Hispanic/Latino Population by Geographic Area	5.14-38
Table 5.15-1.	Summary of the Potential Effects of the Alternatives on Aesthetics	5.15-2
Table 5.16-1.	Summary—Average Net Annual Economic Effects, 1998 Dollars (\$1,000s of dollars) (6.875% Discount Rate)	5.16-3
Table 5.16-2.	Summary—Average Net Annual Economic Effects, 1998 Dollars (\$1,000s of dollars) (4.75% Discount Rate)	5.16-4
Table 5.16-3.	Summary—Average Net Annual Economic Effects, 1998 Dollars (\$1,000s of dollars) (0.0% Discount Rate)	5.16-4
Table 6-1.	Comparison of Recommended Plan (Preferred Alternative) and NMFS 2000 Biological Opinion	6-8
Table 6-2.	Juvenile Survival by Dam (Percent Dam and Reservoir Survival)	6-10
Table 6-3.	Resource Valuation for Aquatic Resources—Anadromous Fish	6-22
Table 6-4.	Resource Valuation for Aquatic Resources—Resident Fish	6-24
Table 6-5.	Resource Valuation for Water Resources	6-27
Table 6-6.	Resource Valuation for Air Quality	6-28
Table 6-7.	Resource Valuation for Terrestrial Resources	6-29
Table 6-8.	Resource Valuation for Cultural Resources	6-30
Table 6-9.	The NED Economic Valuations	6-32
Table 6-10.	Resource Valuation for Social Resources	6-34
Table 6-11.	Resource Valuation for Native American Indians	6-35

Table 6-12.	Resource Valuation for Geological Resources	6-36
Table 6-13.	Resource Valuation for Aesthetic Resources	6-37
Table 6-14.	Summary Resource Comparisons	6-38
Table 6-15.	Relationship of Recommended Plan (Preferred Alternative) Hydrosystem Implementation Plan	6-44
Table 7-1.	Regional Roundtable Workshops	7-3
Table 7-2.	Public Information Meetings, September 1997 and November 1998	7-8
Table 7-3.	Formal Public Meeting Locations	7-9
Table 7-4.	Community Forum Participation	7-10

# Acronyms and Abbreviations

$\lambda$	(lambda) population growth rate
°F	degrees Fahrenheit
$\mu\text{g}/\text{m}^3$	micrograms per cubic meter
AAQS	ambient air quality standards
ACHP	Advisory Council on Historic Preservation
ADP	acoustic Doppler profiler
AET	apparent effects threshold
AIRFA	American Indian Religious Freedom Act
AMPA	aminomethylphosphoric acid
aMW	average megawatt
ARPA	Archaeological Resources Protection Act
BA	Biological Assessment
BGS	behavioral guidance structure
BIA	Bureau of Indian Affairs
BKD	bacterial kidney disease
BLM	Bureau of Land Management
BNSF	Burlington Northern – Santa Fe Railroad
BOD	biochemical oxygen demand
BOR	U.S. Bureau of Reclamation
BOT	Board of Trustees
BP	before present
BPA	Bonneville Power Administration
BSM	Bayesian Simulation Model
CAA	Clean Air Act
CBB	Columbia Basin Bulletin
CBFWA	Columbia Basin Fish and Wildlife Authority
CC	combined-cycle combustion
CCAP	U.S. Climate Change Action Plan
CCC	criteria continuous concentration
CEAA	Canadian Entitlement Allocation Agreement
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFC	chlorofluorocarbons
CFR	Code of Federal Regulations
cfs	cubic feet per second

## Acronyms and Abbreviations (continued)

CH <sub>4</sub>	methane
CLR	Columbia River Mile
CMC	criteria maximum concentration
CO	carbon monoxide
CO <sub>2</sub>	carbon dioxide
Comp Plan	Lower Snake River Fish and Wildlife Compensation Plan
Corps	U.S. Army Corps of Engineers
CR	County Road
CRBG	Columbia River Basalt Group
CRFMP	Columbia River Fish Mitigation Program
CRI	Cumulative Risk Initiative
CRITFC	Columbia River Inter-Tribal Fisheries Commission
CRMP	Cultural Resources Management Plan
CSPE	Columbia Storage Power Exchange
CTCIR	Confederated Tribes of the Colville Indian Reservation
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CWA	Clean Water Act
DDT	dichloro-diphenyl-trichloroethane
DGAS	Dissolved Gas Abatement Study
DMEF	Dredged Material Evaluation Framework
DO	dissolved oxygen
DREW HIT	Drawdown Regional Economic Workgroup Hydropower Impact Team
DREW	Drawdown Regional Economic Workgroup
DSI	direct service industries
Ecology	Washington Department of Ecology
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EQ	environmental quality
ESA	Endangered Species Act
ESBS	extended submerged bar screen
ESL	Endangered Species List
ESU	Evolutionarily Significant Unit
EWITS	Eastern Washington Intermodal Transportation Study
FCRPS	Federal Columbia River Power System

## Acronyms and Abbreviations (continued)

Feasibility Study	Lower Snake River Juvenile Salmon Migration Feasibility Study
FELCC	firm energy load-carrying capacity
FERC	Federal Energy Regulatory Commission
FGE	fish guidance efficiency
FIRE	finance, insurance, and real estate
FIRFA	Federal Insecticide, Fungicide, and Rodenticide Act
FPC	Fish Passage Center
FPE	fish passage efficiency
FPOM	Fish Passage Operations and Maintenance Coordination Team
FR	Federal Register
FR/EIS	Lower Snake River Juvenile Salmon Migration Study Feasibility Report and Environmental Impact Statement
ft/sec	feet per second
FTE	full-time equivalent
FTU	Formazin Turbidity Unit
FWCA	Fish and Wildlife Coordination Act
FWCAR	Fish and Wildlife Coordination Act Report
GBD	gas bubble disease
GBT	gas bubble trauma
GHG	greenhouse gas
GIS	geographic information system
GSA	General Services Administration
HCFC	partially halogenated fluorocarbons
HEP	Habitat Evaluation Procedures
HIT	Hydropower Impact Team
HMU	habitat management unit
HTRW	hazardous, toxic, or radioactive wastes
HU	habitat unit
HYDROSIM	Hydro Simulation Program
HYSSR	Hydro System Seasonal Regulation Program
ICBEMP	Interior Columbia Basin Ecosystem Management Project
IEAB	Independent Economic Analysis Board of the Northwest Power Planning Council

## Acronyms and Abbreviations (continued)

IPP	Independent Power Producer
ISAB	Independent Scientific Advisory Board
ISG	Independent Scientific Group
ISRT	Integrated Scientific Review Team
IT	Implementation Team
JFTP	Juvenile Fish Transportation Program
KAF	thousand acre-feet
kdfs	thousand cubic feet per second
kg/m <sup>2</sup>	kilogram per meter squared
KW	kilowatt
KWh	kilowatt hour
LOA	Letter of Agreement
LPMS	Lock Performance Monitoring System
LWCFA	Land and Water Conservation Fund Act
M&I	municipal and industrial
MAF	million acre-feet
mills/kWh	mils per kilowatt hour
mm	millimeter
MOP	minimum operating pool
msl	mean sea level
MW	megawatt
MWh	megawatt hour
N <sub>2</sub> O	nitrous oxide
NAGPRA	Native American Graves Protection and Repatriation Act
NED	national economic development
NEPA	National Environmental Policy Act
Nez Perce	Nez Perce Tribe
NGVD29	National Geodetic Vertical Datum 1929
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO <sub>2</sub>	nitrogen dioxide
NO <sub>x</sub>	nitrogen oxide
NPPC	Northwest Power Planning Council
NPS	National Park Service
NPTEC	Nez Perce Tribe Executive Council



## Acronyms and Abbreviations (continued)

NRHP	National Register of Historic Places
NTMB	neotropical migratory bird
NTU	nephelometric turbidity unit
O&M	operation and maintenance
O <sub>3</sub>	ozone
OA	Columbia River Salmon Flow Measures Options Analysis
OSE	other social effects
PAH	polynuclear aromatic hydrocarbon
PATH	Plan for Analyzing and Testing Hypotheses
Pb	lead
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo dioxins
PCDF	polychlorinated dibenzo furans
PDO	Pacific Decadal Oscillation
PIT	passive integrated transponder
PM	particulate matter
PM <sub>10</sub>	particulate matter with aerodynamic diameters less than 10 micrometers
PMOA	Programmatic Memorandum of Agreement
PNCA	Pacific Northwest Coordination Agreement
PNI	Pacific Northwest Index
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
PSEP	Puget Sound Estuary Program
PUD	Public Utility District
RCRA	Resource Conservation and Recovery Act
RED	regional economic development
RM	River Mile
ROCASOD	Record of Consultation and Statement of Decision
RPA	reasonable and prudent alternative
RSW	removable spillway weir
SAR	smolt-to-adult survival ratio
SBC	surface bypass collector
Scenic Area	Columbia River Gorge National Scenic Area

## Acronyms and Abbreviations (continued)

SCS	System Configuration Study
SCT	System Configuration Team
SDWA	Safe Drinking Water Act
Shoshone-Bannock	Shoshone Bannock Tribes
SHPO	State Historic Preservation Office
SIA	social impact assessment
SNL	speed no load
SNR	Snake River Mile
SO <sub>2</sub>	sulfur dioxide
SOR	System Operation Review
SR	State Route
SRP	Science Review Panel
STS	submerged traveling screen
SWI	simulated Wells Dam intake
TAP	toxic air pollutant
TCDD	tetra chloro dibenzo-p-dioxin
TCDF	2,3,7,8-tetra chloro dibenzo furan
TCM	Travel Cost Method
TCR	transport:control ratio
TDG	total dissolved gas
TDGMS	total dissolved gas monitoring station
TEQ	toxicity equivalency quotient
TIR	transport to in-river ratio
TKN	total Kjeldahl nitrogen
TMDL	Total Maximum Daily Load
TMT	Technical Management Team
TPH	total petroleum hydrocarbons
TPY	tons per year
TSCA	Toxic Substance Control Act
TSS	total suspended solid
TVA	Tennessee Valley Authority
UI	University of Idaho
Union Pacific	Union Pacific Railroad
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

## **Acronyms and Abbreviations (continued)**

VOC	volatile organic compound
WAC	Washington Administrative Code
Warm Springs	Confederated Tribes of the Warm Springs of Oregon
WCSC	Waterborne Commerce Statistics Center
WDFW	Washington Department of Fish and Wildlife
WQT	Water Quality Team
WRC	U.S. Water Resources Council
WRDA	Water Resources Development Act
WSCC	Western Systems Coordinating Council
WSU	Washington State University
WTP	willingness to pay
Yakama	Yakama Nation

## ENGLISH TO METRIC CONVERSION FACTORS

<u>To Convert From</u> <u>By</u>	<u>To</u>	<u>Multiply</u>
<u>LENGTH CONVERSIONS:</u>		
Inches	Millimeters	25.4
Feet	Meters	0.3048
Miles	Kilometers	1.6093
<u>AREA CONVERSIONS:</u>		
Acres	Hectares	0.4047
Acres	Square meters	4047
Square Miles	Square kilometers	2.590
<u>VOLUME CONVERSIONS:</u>		
Gallons	Cubic meters	0.003785
Cubic yards	Cubic meters	0.7646
Acre-feet	Hectare-meters	0.1234
Acre-feet	Cubic meters	1234
<u>OTHER CONVERSIONS:</u>		
Feet/mile	Meters/kilometer	0.1894
Tons	Kilograms	907.2
Tons/square mile	Kilograms/square kilometer	350.2703
Cubic feet/second	Cubic meters/sec	0.02832
Degrees Fahrenheit	Degrees Celsius	(Deg F -32) x (5/9)

## UNIT DEFINITIONS

parts per million (ppm)  $\cong$  mg/L  
 parts per billion (ppb)  $\cong$   $\mu$ g/L  
 parts per trillion (ppt)  $\cong$  ng/L