US Army Corps
of Engineers®
Walla Walla District

FINAL

Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement

APPENDIX T

Clean Water Act, Section 404(b)(1) Evaluation

February 2002

FEASIBILITY STUDY DOCUMENTATION

	Document Title
Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement	
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.

The documents listed above, as well as supporting technical reports and other study information, are available on our website at http://www.nww.usace.army.mil/lsr. Copies of these documents are also available for public review at various city, county, and regional libraries.

STUDY OVERVIEW

Purpose and Need

Between 1991 and 1997, due to declines in abundance, the National Marine Fisheries Service (NMFS) made the following listings of Snake River salmon or steelhead under the Endangered Species Act (ESA) as amended:

- sockeye salmon (listed as endangered in 1991)
- spring/summer chinook salmon (listed as threatened in 1992)
- fall chinook salmon (listed as threatened in 1992)
- steelhead (listed as threatened in 1997).

In 1995 NMFS issued a Biological Opinion on operations of the Federal Columbia River Power System (FCRPS). Additional opinions were issued in 1998 and 2000. The Biological Opinions established measures to halt and reverse the declines of ESA-listed species. This created the need to evaluate the feasibility, design, and engineering work for these measures.

The Corps implemented a study after NMFS's Biological Opinion in 1995 of alternatives associated with lower Snake River dams and reservoirs. This study was named the Lower Snake River Juvenile Salmon Migration Feasibility Study (Feasibility Study). The specific purpose and need of the Feasibility Study is to evaluate and screen structural alternatives that may increase survival of juvenile anadromous fish through the Lower Snake River Project (which includes the four lowermost dams operated by the Corps on the Snake River—Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams) and assist in their recovery.

Development of Alternatives

The Corps' response to the 1995 Biological Opinion and, ultimately, this Feasibility Study, evolved from a System Configuration Study (SCS) initiated in 1991. The SCS was undertaken to evaluate the technical, environmental, and economic effects of potential modifications to the configuration of Federal dams and reservoirs on the Snake and Columbia Rivers to improve survival rates for anadromous salmonids.

The SCS was conducted in two phases. Phase I was completed in June 1995. This was a reconnaissance-level assessment of multiple concepts including drawdown, upstream collection, additional reservoir storage, migratory canal, and other alternatives for improving conditions for anadromous salmonid migration.

The Corps completed a Phase II interim report on the Feasibility Study in December 1996. The report evaluated the feasibility of drawdown to natural river levels, spillway crest, and other improvements to existing fish passage facilities.

Based in part on a screening of actions conducted for the Phase I report and the Phase II interim report, the study now focuses on four courses of action:

- Existing Conditions
- Maximum Transport of Juvenile Salmon

- Major System Improvements
- Dam Breaching.

The results of these evaluations are presented in the combined Feasibility Report (FR) and Environmental Impact Statement (EIS). The FR/EIS provides the support for recommendations that will be made regarding decisions on future actions on the Lower Snake River Project for passage of juvenile salmonids. This appendix is a part of the FR/EIS.

Geographic Scope

The geographic area covered by the FR/EIS generally encompasses the 140-mile long lower Snake River reach between Lewiston, Idaho and the Tri-Cities in Washington. The study area does slightly vary by resource area in the FR/EIS because the affected resources have widely varying spatial characteristics throughout the lower Snake River system. For example, socioeconomic effects of a permanent drawdown could be felt throughout the whole Columbia River Basin region with the most effects taking place in the counties of southwest Washington. In contrast, effects on vegetation along the reservoirs would be confined to much smaller areas.

Identification of Alternatives

Since 1995, numerous alternatives have been identified and evaluated. Over time, the alternatives have been assigned numbers and letters that serve as unique identifiers. However, different study groups have sometimes used slightly different numbering or lettering schemes and this has led to some confusion when viewing all the work products prepared during this long period. The primary alternatives that are carried forward in the FR/EIS currently involve the following four major courses of action:

Alternative Name	PATH[1/] Number	Corps Number	FR/EIS Number
Existing Conditions	A-1	A-1	1
Maximum Transport of Juvenile Salmon	A-2	A-2a	2
Major System Improvements	A-2’	A-2d	3
Dam Breaching	A-3	A-3a	4

[1/] Plan for Analyzing and Testing Hypotheses

Summary of Alternatives

The **Existing Conditions Alternative** consists of continuing the fish passage facilities and project operations that were in place or under development at the time this Feasibility Study was initiated. The existing programs and plans underway would continue unless modified through future actions. Project operations include fish hatcheries and Habitat Management Units (HMU) under the Lower Snake River Fish and Wildlife Compensation Plan (Comp Plan), recreation facilities, power generation, navigation, and irrigation. Adult and juvenile fish passage facilities would continue to operate.

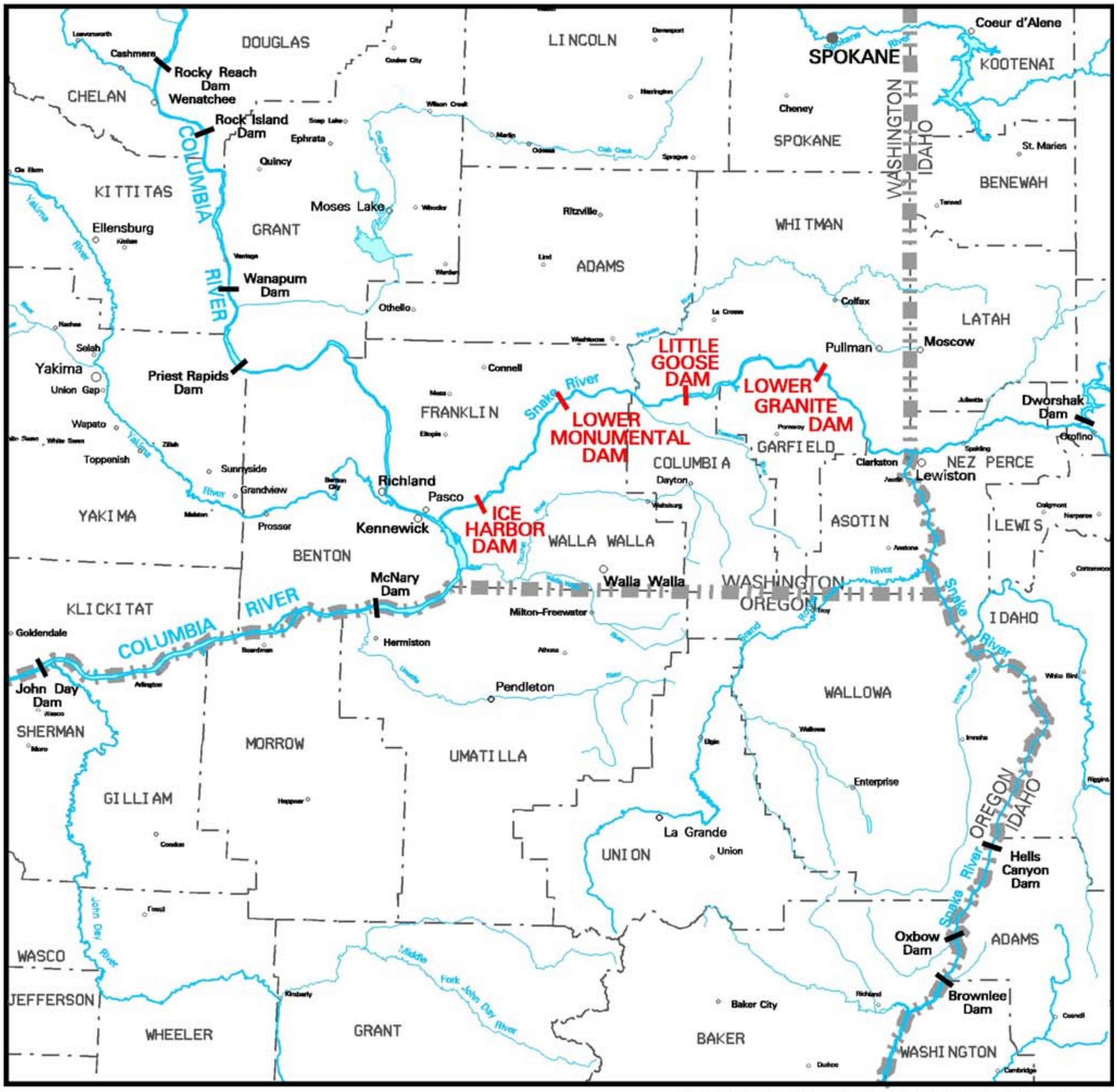
The **Maximum Transport of Juvenile Salmon Alternative** would include all of the existing or planned structural and operational configurations from the Existing Conditions Alternative. However, this alternative assumes that the juvenile fishway systems would be operated to maximize fish transport from Lower Granite, Little Goose, and Lower Monumental and that voluntary spill would not be used to bypass fish through the spillways (except at Ice Harbor). To accommodate this maximization of transport some measures would be taken to upgrade and improve fish handling facilities.

The **Major System Improvements Alternative** would provide additional improvements to what is considered under the Existing Conditions Alternative. These improvements would be focused on using surface bypass facilities such as surface bypass collectors (SBC) and removable spillway weir (RSW) in conjunction with extended submerged bar screens (ESBS) and behavioral guidance structure (BGS). The intent of these facilities is to provide more effective diversion of juvenile fish away from the turbines. Under this alternative, an adaptive migration strategy would allow flexibility for either in-river migration or collection and transporting downstream in barges and trucks.

The **Dam Breaching Alternative** has been referred to as the "Drawdown Alternative" in many of the study groups since late 1996 and the resulting FR/EIS reports. These two terms essentially refer to the same set of actions. Because the term drawdown can refer to many types of drawdown, the term dam breaching was created to describe the action behind the alternative. The Dam Breaching Alternative would involve significant structural modifications at the four lower Snake River dams allowing the reservoirs to be drained and resulting in a free-flowing yet controlled river. Dam breaching would involve removing the earthen embankment sections of the four dams and then developing a channel around the powerhouses, spillways, and navigation locks. With dam breaching, the navigation locks would no longer be operational and navigation for large commercial vessels would be eliminated. Some recreation facilities would close while others would be modified and new facilities could be built in the future. The operation and maintenance of fish hatcheries and HMUs would also change although the extent of change would probably be small and is not known at this time.

Authority

The four Corps dams of the lower Snake River were constructed and are operated and maintained under laws that may be grouped into three categories: 1) laws initially authorizing construction of the project, 2) laws specific to the project passed subsequent to construction, and 3) laws that generally apply to all Corps reservoirs.



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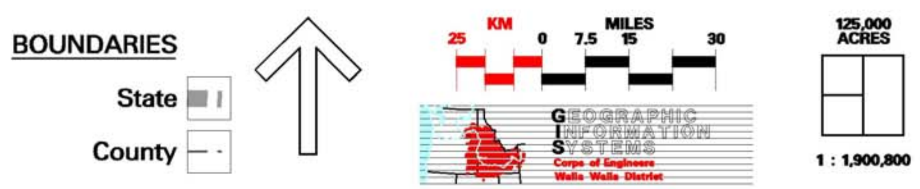

LOWER SNAKE RIVER
Juvenile Salmon Migration Feasibility Study

REGIONAL BASE MAP

US Army Corps
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Walla Walla District

Final
Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement

Appendix T
Clean Water Act, Section 404(b)(1) Evaluation

Produced by

U.S. Army Corps of Engineers
Walla Walla District

February 2002

FOREWORD

Appendix T was prepared by the U.S. Army Corps of Engineers (Corps), Walla Walla District. This appendix is one part of the overall effort of the Corps to prepare the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement (FR/EIS).

The Corps has reached out to regional stakeholders (Federal agencies, tribes, states, local governmental entities, organizations, and individuals) during the development of the FR/EIS and appendices. This effort resulted in many of these regional stakeholders providing input and comments, and even drafting work products or portions of these documents. This regional input provided the Corps with an insight and perspective not found in previous processes. A great deal of this information was subsequently included in the FR/EIS and appendices; therefore, not all of the opinions and/or findings herein may reflect the official policy or position of the Corps.

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TABLES

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
As	arsenic
ASTM	American Society for Testing and Materials
Ba	barium
BA	Biological Assessment
Be	beryllium
BGS	behavioral guidance structure
BOR	U.S. Bureau of Reclamation
BPA	Bonneville Power Administration
Co	cobalt
CoC	Chemicals of Concern
Comp Plan	Lower Snake River Fish and Wildlife Compensation Plan
Corps	U.S. Army Corps of Engineers
cy	cubic yard
Cr	chromium
Cu	copper
DDD	dichloro-diphenyl-dichloro-ethane
DDE	dichloro-diphenyl-dichloro-ethylene
DDT	dichloro-diphenyl-trichloro-ethane
DMEF	Dredged Material Evaluation Framework
DMMP/EIS	Dredged Material Management Plan and Environmental Impact Statement
DMMS	Dredged Material Management Study
DREW	Drawdown Regional Economic Workgroup
Ecology	Washington Department of Ecology
EDTA	ethylendiamine tetraacetic acid disodium salt
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESBS	extended submerged bar screen
FCRPS	Federal Columbia River Power System
Feasibility Study	Lower Snake River Juvenile Migration Feasibility Study
FR	Feasibility Report
FR/EIS	Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement
Guidelines	Clean Water Act, Section 404(b)(1) Guidelines
Hg	mercury
HMU	Habitat Management Unit
KAF	thousand acre feet
MAF	million acre feet
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
Mn	manganese

ACRONYMS AND ABBREVIATIONS

Mo	molybdenum
NEPA	National Environmental Policy Act
ng/L	nanograms per liter
Ni	nickel
NMFS	National Marine Fisheries Service
NRCC	National Resources Council Canada
NTU	Nephelometric Turbidity Unit
OHWM	Ordinary High Water Mark
PATH	Plan for Analyzing and Testing Hypotheses
Pb	lead
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo dioxins
PCDF	polychlorinated dibenzo furans
pH	parts hydronium
ppb	parts per billion
ppt	parts per trillion
QA/QC	quality assurance/quality control
RM	River Mile
RSW	removable spillway weir
SCS	System Configuration Study
SBC	surface bypass collector
Se	selenium
STS	submerged traveling screens
TCDD	tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorinated dibenzo furans
TDG	total dissolved gas
TEF	toxicity equivalence factor
TEQ	toxicity equivalence quantity
Tl	thallium
TP	total phosphorus
TPH	total petroleum hydrocarbons
TSS	total suspended solids
µg/kg	micrograms per kilogram
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
V	vanadium
WAC	Washington Administrative Code
Zn	zinc
ΔC	change in conductivity from background to observable

ENGLISH TO METRIC CONVERSION FACTORS

To Convert From	To	Multiply By
LENGTH CONVERSIONS:		
Inches	Millimeters	25.4
Feet	Meters	0.3048
Miles	Kilometers	1.6093
AREA CONVERSIONS:		
Acres	Hectares	0.4047
Acres	Square meters	4047
Square Miles	Square kilometers	2.590
VOLUME CONVERSIONS:		
Gallons	Cubic meters	0.003785
Cubic yards	Cubic meters	0.7646
Acre-feet	Hectare-meters	0.1234
Acre-feet	Cubic meters	1234
OTHER CONVERSIONS:		
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) ≅ mg/L
parts per billion (ppb) ≅ µg/L
parts per trillion (ppt) ≅ ng/L

Executive Summary

The U.S. Army Corps of Engineers (Corps), Walla Walla District, operates four lock and dam facilities on the lower Snake River. These include the Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dams. In response to the National Marine Fisheries Service (NMFS) 1995 Biological Opinion concerning the operation of the Federal Columbia River Power System, the Corps evaluated structural and operational alternatives to improve the downstream migration of juvenile salmonids through the four lower Snake River dams. That effort resulted in the preparation of the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement (FR/EIS).

The purpose of the FR/EIS is to evaluate and screen structural alternative measures that may increase the survival of juvenile anadromous fish through the Lower Snake River Project and assist in the recovery of Endangered Species Act-listed salmon and steelhead stocks. The FR/EIS examined four alternatives: 1) Existing Conditions; 2) Maximum Transport of Juvenile Salmon; 3) Major System Improvements; and 4) Dam Breaching.

Appendix T evaluates compliance of the recommended plan (preferred alternative), Alternative 3—Major Systems Improvements (Adaptive Migration), with Guidelines established under Section 404(b)(1) of the Clean Water Act (Guidelines). The Guidelines provide for evaluation of the potential short- and long-term effects of the discharges upon the physical, chemical, and biological components of the aquatic environment.

The Section 404(b)(1) evaluation determined the discharges of dredged and fill material associated with Alternative 3—Major Systems Improvements (Adaptive Migration), would comply with the Guidelines, with the inclusion of appropriate and practicable measures to minimize pollution and adverse effects to the affected ecosystem.

1. Introduction

The U.S. Army Corps of Engineers (Corps), Walla Walla District, operates four lock and dam facilities on the lower Snake River. These include the Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dams. In response to the National Marine Fisheries Service (NMFS) 1995 Biological Opinion concerning the operation of the Federal Columbia River Power System, the Corps evaluated structural and operational alternatives to improve the downstream migration of juvenile salmonids through the four lower Snake River dams. That effort resulted in the preparation of the Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement (FR/EIS).

The purpose of the FR/EIS is to evaluate and screen structural alternative measures that may increase the survival of juvenile anadromous fish through the Lower Snake River Project and assist in the recovery of listed salmon and steelhead stocks. The FR/EIS examined four alternatives: 1) Existing Conditions; 2) Maximum Transport of Juvenile Salmon; 3) Major System Improvements; and 4) Dam Breaching.

Multiple appendices to the FR/EIS have been prepared. This appendix evaluates compliance of the recommended plan (preferred alternative), Alternative 3—Major Systems Improvements (Adaptive Migration), with Guidelines established under Section 404(b)(1) of the Clean Water Act (Guidelines).

The Federal Water Pollution Control Act (Clean Water Act) of 1972, as amended, sets national goals and policies to eliminate the discharge of water pollutants into navigable waters. Any discharge of dredged or fill material into navigable waters by the Corps requires a Clean Water Act Section 404(b)(1) evaluation to obtain a state water quality certification under Section 401 of the Federal Water Pollution Control Act. The 404(b)(1) evaluation follows a set of Guidelines developed by the Administrator of the U.S. Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army and published in 40 CFR Part 230. Referred to as the Section 404(b)(1) Guidelines, these guidelines are the substantive criteria used in evaluating discharges of dredged or fill material under Section 404 of the Clean Water Act.

The purpose of the Guidelines is to restore and maintain the chemical, physical, and biological integrity of waters of the United States through the control of discharges of dredged or fill material. Evaluations examine practicable alternatives to the proposed discharge, which would have less adverse impact on the aquatic ecosystem. Evaluations also describe the potential short- and long-term effects of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment.

This Clean Water Act, Section 404(b)(1) evaluation is not intended to function solely as a stand-alone document. Extensive information is contained in the FR/EIS and its numerous technical appendices. Because of the extensive volume of information and data, various information summaries have been included in the Section 404(b)(1) evaluation and references provided for further reading.

2. Project Description

2.1 Purpose

The purpose of the FR/EIS is to evaluate and screen structural alternative measures that may increase the survival of juvenile anadromous fish through the four lowermost dams operated by the Corps on the Snake River and assist in the recovery of Endangered Species Act (ESA)-listed salmon and steelhead stocks. The four dams include Ice Harbor, Lower Monumental, Little Goose, and Lower Granite.

2.2 Location

The four dams that make up the Lower Snake River Project are located along the Snake River in southeast Washington. The Lower Snake River Project extends from near the confluence of the Snake and Columbia Rivers, near Pasco, Washington, to Lewiston, Idaho. Refer to the FR/EIS, Figures 1-1 and 1-2 for Project Vicinity and Regional Base Maps, respectively. Specific descriptions of the locations of the four lower Snake River dams follow:

- Ice Harbor Lock and Dam is located near Pasco, Washington in Franklin County, S.13, T.9N., R.31E., Levy, SW, Washington U.S. Geological Survey (USGS) Quad Map, and in Walla Walla County, S.24, T.9N., R.31E, Humorist, Washington USGS Quad Map.

- Lower Monumental Lock and Dam is located near Kahlotus, Washington in Franklin County, S.34, T.13N., R.34E., and Walla Walla County, S.3, T.12N., R.34E., Lower Monumental Dam, Washington USGS Quad Map.

- Little Goose Lock and Dam is located near Starbuck, Washington in Whitman and Columbia counties, S.27, T.13N., R.38E., Starbuck East, Washington USGS Quad Map.

- Lower Granite Lock and Dam is located near Pomeroy, Washington in Whitman and Garfield counties, Sections 29 and 32, T.14N., R.43E., Almota, Washington USGS Quad Map.

2.3 General Description

Following procedures of the National Environmental Policy Act (NEPA), the Corps identified a range of alternatives for meeting the purpose of evaluating and screening structural alternative measures that may increase the survival of juvenile anadromous fish through the four lowermost dams on the Snake River and assist in the recovery of ESA-listed salmon and steelhead stocks. Four alternatives were carried forward in the FR/EIS for further evaluation. Other alternatives were eliminated from consideration for various reasons. Text from the FR/EIS explaining the four alternatives carried forward, other potential actions outside the scope of the FR/EIS, and those alternatives eliminated from further consideration is reiterated below in Sections 2.4.1.1, 2.4.1.2, and 2.4.1.3, respectively. Refer to Chapters 3 and 6 of the FR/EIS for more complete descriptions of the recommended plan (preferred alternative). Further information may also be found in Section 6 of Appendix E, Existing Systems/Major System Improvements Engineering to the FR/EIS and in Annex B, Surface Bypass and Collection System Combinations to Appendix E of the FR/EIS.

The recommended plan (preferred alternative) proposes incorporation of various aspects of Alternatives 1 and 2, along with construction of new diversions to keep juvenile fish away from turbines. Aspects of Alternative 1 include continuation of project operations and utilization of existing and planned structural configurations.

Appendix T focuses on those aspects of the recommended plan (preferred alternative) that involve discharges of dredged or fill material into navigable waters of the United States. Discharges of dredged and/or fill material associated with new diversions to keep juvenile fish away from turbines would occur in association with construction of removable spillway weirs (RSWs), behavioral guidance structures (BGSs), and surface bypass collectors (SBCs). Planned structural configurations incorporated from Alternative 1 would include discharges of fill material to construct extensions to concrete pier noses, discharges of fill material to add end bay deflectors and modify existing deflectors, and discharges of dredged and fill material to construct additional sheet pile barge moorage cells and a barge access area. Extensive modifications would include discharging of fill material for bank stabilization and constructing support columns for a juvenile bypass outfall. Continued project operations from Alternative 1, which involve discharges, would include maintenance dredging. Operation of juvenile fishways to maximize fish transport from Alternative 2 would also involve discharges of dredged and fill material to construct sheet pile barge moorage cells.

2.3.1 New Diversions to Keep Juvenile Fish Away from Turbines

An RSW is a hinged metal weir attached to the face of a spillbay pier on the forebay side of the dam. The RSW passes water over its top when it is in the raised position. This allows passage of water from a higher elevation in the water column, or closer to the surface, than presently passed from a lower elevation by existing tainter gates. The RSW may be pivoted/lowered below the spillbay, where it rests on landing pads in the substrate of the forebay, or it may be raised in front of the spillbay. A float tank attached to the RSW provides buoyancy to help raise the structure from the bottom. Fish guided by the BGS would be passed directly to the tailrace via the RSW. Two RSWs are proposed to be constructed at each of the four dams, if warranted after prototype testing. A concrete landing pad would be constructed in the substrate for each RSW. The RSW rests on the landing pad while in the lowered position. Landing pad construction may require excavation to form a footing. The excavated material would likely be sidecast. The landing pads would be pre-cast concrete and would be set in place. (See FR/EIS, Appendix E, Annex B, Plate 4.1.4.)

A BGS is a barrier that guides juvenile fish away from particular powerhouse units and towards the SBC or RSW. A BGS consists of a vertical steel curtain suspended by floats. One end of the curtain is attached to the upstream face of the dam. The curtain extends from the dam into the forebay, generally perpendicular to the face of the dam. The curtain also extends vertically from the water surface to near the substrate. The floating BGS is held in position by cables attached to anchors installed in the substrate. BGSs are currently planned for Lower Granite, Lower Monumental, and Ice Harbor Dams. A BGS is not presently planned for Little Goose Dam. Construction of anchors cabled to the BGS to maintain its position may involve the discharge of both dredged and fill material. The substrate would be excavated, if necessary, and likely sidecast to form the footing for the anchor. A pre-cast concrete anchor or similar type device would be placed in the footing for attachment of the anchoring cable. An estimated 28 anchors would be installed in association with each BGS. (See FR/EIS, Appendix E, Annex B, Plates 4.1.1, 4.3.1, and 4.4.1.)

The SBCs direct juvenile fish to collection areas of the juvenile fish facility for transport by truck or barge. A single SBC could be constructed in conjunction with RSWs at each of the four dams if warranted. SBCs are metal structures attached to the upstream face of the dam, in the forebay. Construction of SBCs would likely involve excavation and drilling of rock to form footings for associated cutoff walls. Cutoff walls extend below the SBC and form a barrier that directs juvenile fish located at greater depths away from turbines and toward SBC and BGS structures. Each SBC would have a single cutoff wall. Each cutoff wall would have two footings each. The cutoff wall is described in more detail in the FR/EIS, Appendix E, Section 4.4. Excavated material and rock drill cuttings resulting from footing construction would be sidecast. (See FR/EIS, Appendix E, Annex B, Plate 4.1.3.)

2.3.2 Continuation of Project Operations and Utilization of Existing and Planned Structural Configurations (Elements of Alternative 1)

Maintenance dredging conducted under Alternative 1 would be continued under the recommended plan (preferred alternative). The extent and need for maintenance dredging is currently under evaluation by the Corps in a study entitled *Dredged Material Management Study* (DMMS). The study will produce a report entitled *Dredged Material Management Plan and Environmental Impact Statement* (DMMP/EIS), *McNary Reservoir and Lower Snake River Reservoirs*. The study includes preparation of a Clean Water Act Section 404(b)(1) Evaluation.

The completed DMMP/EIS would be the Corps' programmatic plan for maintenance of the authorized navigation channel in the four lower Snake River reservoirs between Lewiston, Idaho, and the Columbia River, and McNary Reservoir on the Columbia River for 20 years after the Record of Decision is signed. The plan would also address management of dredged material from these reservoirs and maintenance of flow conveyance capacity at the most upstream extent of the Lower Granite Reservoir for the remaining economic life of the project (to year 2074). In accordance with NEPA, consideration and analysis of a broad range of alternatives are being considered, as well as an assessment of cumulative impacts. Completion of the DMMP/EIS is not known at this printing.

Because the short- and long-term impacts of maintenance dredging upon the aquatic environment are being identified and evaluated in the Clean Water Act Section 404(b)(1) Evaluation for the DMMS, no attempt to assess impacts of maintenance dredging is undertaken in this document. The Section 404(b)(1) Evaluation completed for the DMMP/EIS would be incorporated by reference as Annex A to this Appendix T. Maintenance dredging aspects of Annex A that apply to the recommended plan (preferred alternative), including actions identified to minimize impacts, would represent the findings of Appendix T, with regard to maintenance dredging, under Section 404(b)(1) of the Clean Water Act.

Planned extensions of pier noses from Alternative 1 would be implemented as part of the recommended plan (preferred alternative). A pier nose extension is a lengthening of the existing concrete pier noses that exist between adjacent spillbays on the downstream side of the dam. Its purpose is to prevent water from adjacent spillbays from mixing together in the vicinity of the spillway deflectors. Pier nose extensions are currently planned for Lower Granite, Little Goose, and Lower Monumental Dams. There would be an estimation of seven pier nose extensions per dam. Cast-in-place concrete would be placed within a dewatered cofferdam. A temporary bulkhead would be installed that spans across the spillbays. It would be removed when the work is done.

Flow deflectors produce a thin discharge jet of water that skims the water surface of the stilling basin. The skimming jet of water prevents the spillway discharge from plunging and entraining air deep into the stilling basin. Two end-bay deflectors would be added at Lower Monumental and Little Goose Dams. The existing deflectors at Lower Monumental, Little Goose, and Lower Granite Dams were designed to perform within a narrow range of previous tailwater elevations and spill discharges. The length, radius, and elevation of these deflectors would be modified to provide optimal performance during the more typical project operations under the current voluntary spill program.

Extensive modifications refers to proposed modifications to the existing juvenile fish facilities at Lower Granite Lock and Dam. Two aspects of the modifications would include discharges below the ordinary highwater mark of the Snake River. An eroded portion of the riverbank near the existing barge loading dock would be stabilized with grouted riprap, and concrete would be discharged into steel casings to create support columns for a juvenile bypass outfall pipe.

Construction of sheet pile barge moorage cells planned under Alternative 1 would be implemented as part of the recommended plan (preferred alternative). The barge moorage facilities would be necessary to accommodate utilization of additional juvenile fish transportation barges. The sheet pile cells would be located on the downstream side of Lower Granite Dam, adjacent to existing fish barge moorage. See Figure 2-7 of the FR/EIS for the location of the existing fish barge moorage area. Sheet pile cells would be constructed by driving sheet piling into the substrate to bedrock. Pile sections would be driven side-by-side to form a ring-shaped cell. All piling would be driven with a barge-mounted pile driver. The cells average approximately 24.8 feet in diameter. All substrate material overlaying bedrock would be excavated from the footprint of the cells and likely sidecast. The cell would then be filled with gravel. A walkway would connect the cells to the dam. H-piling would be driven to bedrock to provide intermediate support for the walkway. Two cells are currently proposed for construction at Lower Granite Dam. The barge moorage facility would be built only at Lower Granite Dam (see Figure 2-1).

A barge access area would be constructed along the face of the dam at Lower Granite Dam only. The area would allow crane access and facilitate barge maintenance. A sheet pile wall would serve as the interface between the access area and the water. Gravel fill would be placed on the sloping face of the dam and up against the sheet pile wall to form the barge access area (see Figure 2-2).

2.3.3 Maximize Transport of Juvenile Salmon (Elements of Alternative 2)

Operation of juvenile fishways to maximize fish transport for Alternative 2 would include discharges of dredged and fill material to construct sheet pile moorage facilities. The barge moorage facilities would be necessary to accommodate utilization of additional juvenile fish transportation barges. Sheet pile cells are described above under Section 2.3.2.

More complete descriptions of the above actions may be found in the FR/EIS, Appendix E, Existing Systems and Major System Improvements Engineering and Appendix J, Plan Formulation to the FR/EIS.

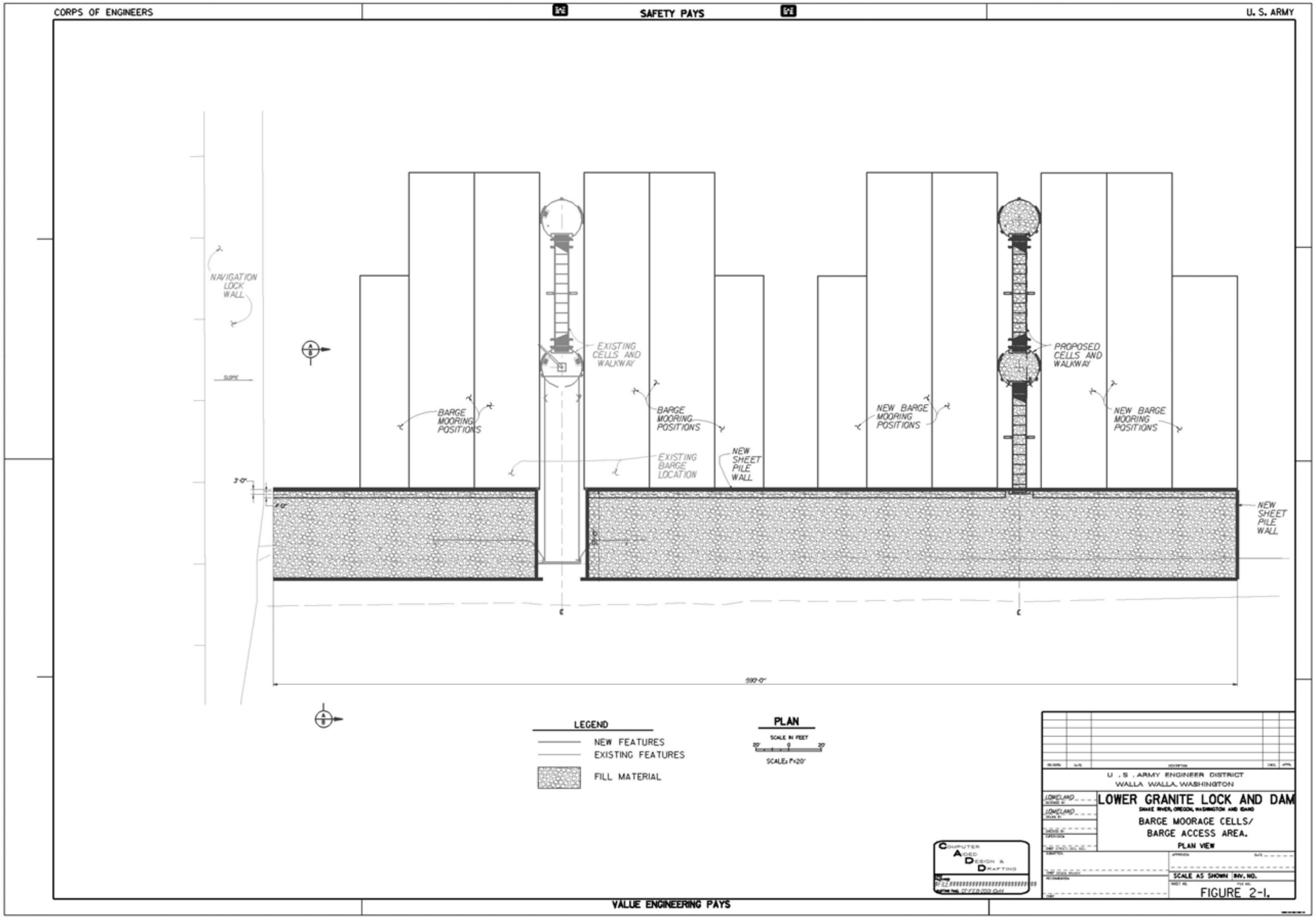

Figure 2-1. Lower Granite Dam Barge Moorage Cells/Barge Access Area

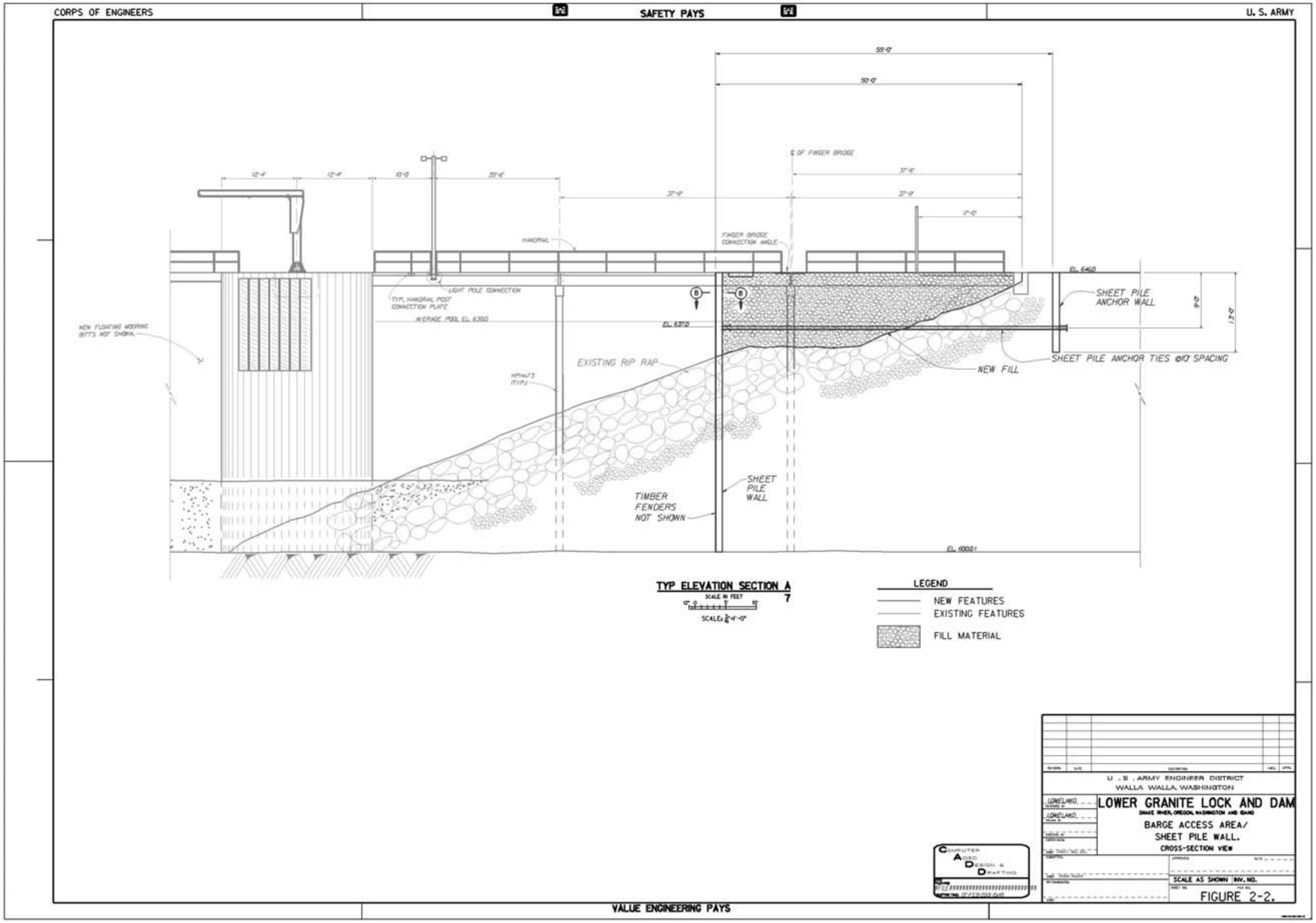

Figure 2-2. Lower Granite Dam Barge Access Area/Sheet Pile Wall

2.4 Analysis of Alternatives to the Recommended Plan (Preferred Alternative)

The 404(b)(1) Guidelines (40 CFR Part 230) are the substantive criteria used in evaluating discharges of dredged or fill material under Section 404 of the Clean Water Act. The Guidelines provide for consideration of alternatives to a proposed project. Because the NEPA process extensively examined alternatives through preparation of the FR/EIS and its numerous appendices, the 404(b)(1) evaluation focuses on practicable alternatives to the recommended plan (preferred alternative). Section 2.4.1 below presents a summary of alternatives examined through the NEPA process. Section 2.4.2 discusses the procedures used for identification of practicable alternatives to the recommended plan (preferred alternative) and presents a summary of the practicable alternatives analysis and findings.

2.4.1 Alternatives Identified through NEPA

2.4.1.1 Alternatives Carried Forward

Alternative 1—Existing Conditions

Existing conditions consists of continuing the operation of the fish passage facilities and project operations that were in place or under development at the time that this FR/EIS was initiated. They would continue to meet the authorized uses of the Lower Snake River Project. (See FR/EIS, Section 1.2, Purpose and Need; Figure 3-1, which summarizes the activities that would continue with the existing operations and activities for other alternatives; and Section 2, Affected Projects and Programs, which describes these operations in detail.) This alternative is the base case or "no action" alternative considered in the NEPA process.

Project operations would remain the same, unless modified through future actions. These would include all ancillary facilities such as fish hatcheries and Habitat Management Units (HMUs) under the Lower Snake River Fish and Wildlife Compensation Plan (Comp Plan) (see FR/EIS, Section 2.1.8, Lower Snake River Fish and Wildlife Compensation Plan); recreation facilities; power generation; and irrigation.

Adult and juvenile fish passage facilities would continue to operate. Similarly, testing of SBCs at Lower Granite Dam would continue through 2001. Information gained from this testing could be used as applicable for other projects on the Columbia River System.

Existing operations include several other measures. Detailed discussions of these measures may be found in the FR/EIS, Section 3.1. Other measures include:

- Install new turbine cams
- Install new turbine runners
- Upgrade Lower Granite juvenile fish facilities
- Upgrade fish barges
- Modify adult fish attraction
- Install trash boom at Little Goose Dam

- Modify fish separators
- Install cylindrical dewatering screens
- Install spillway flow deflectors/pier extensions
- Improve extended submerged bar screens (ESBSs).

Alternative 2—Maximum Transport of Juvenile Salmon

All of the existing or planned structural configurations from the existing conditions would be included in this alternative. Project operations would remain the same, unless modified through future actions. These would include all ancillary facilities such as fish hatcheries and HMUs under the Comp Plan, recreation facilities, power generation, navigation, and irrigation. However, this alternative assumes that the juvenile fishway systems would be operated to maximize fish transport and that voluntary spill would not be used to bypass fish through the spillways (except at Ice Harbor Dam).

To accommodate Alternative 2—Maximum Transport of Juvenile Salmon, measures would be used to maintain, upgrade, and significantly improve fish facilities (Alternative 1—Existing Conditions) that would focus on limiting in-river migration. Also, there would be no need to modify spillway flow deflectors or pier extensions with this alternative because voluntary spill would be eliminated.

Alternative 3—Major System Improvements (Adaptive Migration)

The migration strategy allows for either fish-friendly transportation or in-river migration. At Lower Granite and Lower Monumental Dams, a two-unit powerhouse surface collection channel with two RSWs would be installed if warranted after prototype testing. Surface collectors could then be used to collect fish at these two dams for downstream transportation. Lower Granite is a logical location for collecting fish for transport because it is the furthest upstream dam. It was decided to use a surface collector at Lower Monumental to allow collection of 1) fish not collected at Lower Granite, 2) fish entering the Snake River from the Tucannon River, and 3) fish released from the Lyons Ferry Hatchery.

When in transport mode, the surface collectors in front of Turbine Units 5 and 6 at Lower Granite and Lower Monumental would collect downstream migrating fish and pass them through a dewatering section in the surface collector, delivering them to the existing juvenile fish collection channel within each dam. To guide fish away from Units 1 through 4, a BGS would be constructed in the forebay.

When it is desired to keep the fish in the river, the surface collector would be shut off and the fish would be guided by the BGS past the surface collector to two RSWs. The RSWs would provide a surface attraction flow and a less stressful method of bypassing fish than what is used now for spillway passage.

As with the other system options, ESBS intake diversion systems would be used in conjunction with these two-unit SBC channels. At Lower Granite Dam, the existing ESBS would be used, whereas at Lower Monumental Dam there would be a new ESBS to replace the existing submerged traveling screens (STS). ESBSs would be located in the turbine intakes of all six units of both powerhouses to offer a bypass for fish that pass around or under the BGS.

At Little Goose Dam, a full-length powerhouse occlusion would be installed. The occlusion structure is expected to improve the performance of the ESBS and to increase the guidance of fish away from the turbine intakes and towards the spillway. An RSW would be placed in spillbays 1 and 3 to bypass fish. The goal is to provide an effective bypass for juvenile fish. Also, each turbine unit at Little Goose Dam would have an existing ESBS in place. Fish diverted by the ESBS would be directed to the juvenile fish facilities where they would be collected for transport or returned to the river.

Two RSWs would be constructed at Ice Harbor. One RSW would be constructed on spillbay 1 and the other on spillbay 3. A BGS would extend upstream from the interface of the powerhouse and spillway. Two removable raised spillway weirs would be installed. The RSWs would provide attraction flow to the spillways and would provide a less stressful method of bypassing fish over the spillway than the current method. New ESBSs would replace the existing STS at Ice Harbor. They would be installed in the turbine intakes to offer a bypass for fish passing around or under the BGS.

Alternative 4—Dam Breaching

The dam breaching scenario differs from all other drawdown scenarios. Structural modifications would be undertaken at the dams, allowing reservoirs to be drained, and resulting in a free-flowing river that would remain unimpounded. Breaching of only one, two, or three dams was not considered in the FR/EIS because the removal of only one dam would eliminate major navigation in the lower Snake River and would curtail options for collecting and transporting juvenile fish.

With Alternative 4—Dam Breaching, the navigation locks would no longer be operational and navigation for larger vessels would be curtailed. Similarly, recreation opportunities, operation and maintenance of hatcheries and HMUs, and other activities associated with the modification from a reservoir environment to an unimpounded river in the lower Snake River would entail important changes in these activities. (See FR/EIS, Sections 5.5.2, 5.10.2, and 5.12 for details on specific changes.) No hydropower would be produced at the four dams under this alternative.

For dam breaching, the primary reason for leaving portions of the dam in place is that it meets the operational criteria at the lowest practical cost. However, modifications to structures would be done in such a manner that the structures could be restored to operating conditions with later modifications (see FR/EIS, Figure 3-3). With this alternative, reservoirs behind the four lower Snake River dams would be eliminated, which would result in a 140-mile, near-natural river. This requires the protection of structures from natural river flows and the decommissioning of equipment and structures. Secondly, construction operations would be phased so that power production, navigation, and fish migration could continue until the last possible period.

Dam breaching would involve removal of the earthen embankment section and abutment at Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dams. Once the embankment is removed, the river would flow around the remaining structures (powerhouses, spillways, and navigation locks). Levees would be used to "shape" the river into a channel around these structures. Long-term maintenance or preservation of these powerhouses, spillways, and navigation locks would be minimal.

2.4.1.2 Other Potential Actions outside the Scope of the FR/EIS

Numerous other studies by the Corps, other Federal agencies, states, and tribes are also being conducted in the Snake River System and elsewhere in the Columbia River Basin to address salmonid species that are either at risk or listed under ESA. This FR/EIS addresses, in detail, alternatives that could be implemented at the four lower Snake River dams. This FR/EIS does not directly address all other actions being considered in the Columbia River System to conserve and restore ESA-listed salmon runs;

however, it does consider these other actions as part of the cumulative impacts analysis, discussed in the main text of the FR/EIS in resource subsections throughout Section 5, and in Section 5.16, Cumulative Effects.

Measures are also being considered at McNary, John Day, The Dalles, and Bonneville Dams to improve the effectiveness of juvenile salmon migration. These measures include additional transportation, flow deflectors, collection facilities, and spill modifications. All of these measures are in the feasibility testing phase, are under study, or have been proposed; therefore, they are not addressed in detail in this FR/EIS. They are, however, addressed in the main text of the FR/EIS in discussions of cumulative effects in resource subsections throughout Section 5, and in Section 5.16, Cumulative Effects. The actions at these lower Columbia River dams will or have been specifically addressed in detail in other NEPA documents.

2.4.1.3 Alternative Actions Eliminated from Further Consideration

A wide variety of actions and options were identified, examined, and discussed in Phases I and II of the Corps System Configuration Study (Corps, 1994). Many of these were eliminated for a number of reasons, such as: 1) significant biological and uncertainty concerns, 2) benefits of the action were less than other proposed actions, 3) potentially adverse effects to both adult and juvenile fish, 4) unacceptable impacts to turbines or other fish bypass components, and 5) potentially detrimental impacts to other resources, such as cultural.

Alternative actions that were not eliminated during the System Configuration Study received further preliminary detailed evaluation and analysis for this Feasibility Study (see Appendix J, Plan Formulation). These actions were specifically addressed and evaluated in the Interim Status Report (Corps, 1996). As part of this evaluation process, the four alternatives (Sections 3.1 to 3.4 in the main text of the FR/EIS) were selected for full evaluation while the others were eliminated for one or more of the following reasons: 1) not meeting the purpose and need of this FR/EIS; 2) the probability of success of implementation of the action was considered low or unlikely, or 3) the action would be addressed in other forums or through other NEPA analyses. The following provides general descriptions of the actions eliminated from detailed analysis. As specifically noted, the descriptions generally coincide with those alternatives evaluated in Appendix E, Existing Systems/Major System Improvements Engineering and Section 6 in the main text of the FR/EIS.

- **In-river Migration Option with Voluntary Spill under Existing Conditions (this option was evaluated by the Corps as Option A-1a—see Appendix E, Existing Systems/Major System Improvements Engineering)**

  This option assumes that the existing or currently planned juvenile fishway systems would be operated to maximize in-river fish passage and that voluntary spill would be used to bypass fish through the spillways. Because juvenile fish would remain in the river, and voluntary spill would be used to attract the fish to the spillway, additional structures to implement dissolved gas abatement would be needed (see Appendix E, Existing Systems/Major System Improvements Engineering for details).

  This option does not follow an adaptive migration strategy because no fish would be transported. Therefore, it would not meet the objectives of the NMFS 1995, 1998, or 2000 Biological Opinions. In addition, in-river migration would result in a lower direct survival of juveniles through the lower Snake River and the entire migratory corridor than a combination of in-river migration and transportation measures. For this reason, this option was eliminated from further consideration.

- **Maximized Transport at the Four Lower Snake River Facilities Without Voluntary Spill (with major SBC development at all four lower Snake River dams; this action was not specifically evaluated by Plan for Analyzing and Testing Hypotheses [PATH], but is the Corps' Option A-2b—see Appendix E, Existing Systems/Major System Improvements Engineering)**

  Under this alternative, the number of fish collected and delivered to the existing or upgraded transportation facilities located at each project would be maximized. Full-length powerhouse SBCs would be provided at Lower Granite, Little Goose, and Lower Monumental. These would be used in conjunction with ESBSs located in the turbine intakes. Fish collected by both bypass structures would be combined and delivered to the transportation facilities and either trucked or barged downstream.

  The upper two dams (Lower Granite and Little Goose) currently have ESBSs installed in the turbine intakes. These would continue to be used; however, the intakes at Lower Monumental are currently outfitted with STSs. These would be removed and replaced with ESBSs to increase the screen diversion efficiency and further reduce the number of fish passing through the turbines.

  The turbine intakes are also currently outfitted with STSs at Ice Harbor. As at Lower Monumental, these would be removed and replaced with ESBSs to increase the diversion efficiency of the screening system. No SBCs would be installed at Ice Harbor.

  If the combination of the SBC and the ESBS systems function as anticipated at Lower Granite (the major system improvements alternative), there should be very few migrating fish left in the river at the lower three dams (see Section 3.3, Alternative 3—Major System Improvements in the main text of the FR/EIS). In addition, few fish enter the Snake River between Lower Monumental and Ice Harbor; therefore, construction of SBCs at all dams would not appear to be justified. This option was eliminated from further consideration. In addition, the intent of this option is to maximize transport, which does not incorporate an adaptive migration strategy. Therefore, it does not meet the objectives of the 1995, 1998, and 2000 NMFS Biological Opinions.

- **Maximized Transport at the Four Lower Snake River Facilities with Voluntary Spill at Ice Harbor (this is similar to the Corps' Option A-2c—see Appendix E, Existing Systems/Major System Improvements Engineering)**

  This option assumes the juvenile fishway systems would be operated to maximize fish transportation and voluntary spill would only be needed at Ice Harbor to aid in bypassing fish over the spillways.

  The juvenile fish passage strategies for this option are the same as under the previous option; however, there are significant differences in designs and project operations between the two. Also, the costs for this option are considerably lower than for the previous one. The primary difference is an SBC would only be developed at Lower Granite. Only ESBSs would be used at the other three dams. This option does not incorporate an adaptive migration strategy and does not meet the objectives of the 1995, 1998, and 2000 NMFS Biological Opinions. Therefore, it was eliminated from further consideration.

- **In-river Migration Option (no transportation, no drawdown, SBCs at all dams, and flow augmentation under the 1995 Biological Opinion) Plus an Additional 1.0 MAF Flow Augmentation (this action was evaluated by the Corps as Alternative A-6a)**

  With this action, spill would be maximized to the extent possible to bypass additional fish over the spillways. There would be no transportation of juvenile fish, and in-river migration would be maximized. Augmentation flows would be increased by an additional 1.0 MAF. Therefore, the total augmentation flow would be 1,427 MAF.

  Juvenile fish would be passed directly downstream to the tailrace. To maximize diversion away from the turbines, ESBS intake diversion systems would be used in conjunction with the SBCs at all four dams to divert fish that might pass under the SBC and into the turbine intakes. Lower Granite and Little Goose already have ESBS systems. These ESBS systems would continue to be used in conjunction with the new SBCs. The STS systems at Lower Monumental and Ice Harbor would be removed and replaced with new ESBS systems.

  The Corps has an interest in flow augmentation from upstream sources and how it would affect operations and juvenile fish passage in the lower Snake River. As a result, the Corps asked BOR for assistance in developing further information on flow augmentation, particularly regarding the feasibility and potential impacts of providing the 1.0 MAF additional flow augmentation. The current findings of BOR's studies are presented in the *Snake River Flow Augmentation Impact Analysis* (BOR, 1999). The report concludes additional flow augmentation would involve high costs and multiple implementation issues. Section 7 consultation with the BOR and Idaho Power on the flow issue is continuing under a separate review process.

  Additionally, PATH did a preliminary screening analysis of this alternative, designated as Alternative A-6, which found with "most realistic" assumptions that it performed at only 80 to 100 percent of the survival and recovery criteria that PATH Alternative A-2 did. Therefore, it was unlikely this alternative would perform any better than alternatives considered fully and was not included for detailed assessment.

- **In-river Migration with No Flow Augmentation (this is the same as Corps Option 6b—see Appendix E, Existing Systems/Major System Improvements Engineering)**

  This alternative was eliminated from detailed analysis because it was not recommended in the 1995 and 1998 Biological Opinions and no flow augmentation would occur. In addition, adaptive migration would not be an objective of this option and, therefore, flexibility for implementing passage options would be limited.

  PATH performed a preliminary screening analysis alternative (designated as Alternative A-6') with very similar characteristics to this alternative but with the inclusion of SBCs at all Snake River dams to bypass fish. Even with the addition of SBCs, which should enhance dam passage survival relative to current bypass systems, the PATH preliminary analysis found that this alternative performed worse than PATH Alternative A-2 relative to the NMFS survival and recovery criteria. Therefore, considering its poor performance and NMFS' lack of recommendation in its 1995 and 1998 Biological Opinions to study this alternative, this alternative was not carried forward to full alternative analysis.

- **In-river Migration (major system improvements and flow augmentation under the 1995 Biological Opinion; this is similar to the Corps' Option A-6d—see Appendix E, Existing Systems/Major System Improvements Engineering)**

  This option assumes that juvenile fishway systems would be operated to maximize in-river fish passage. This option is similar to the previous option, except it assumes 427 KAF from upstream storage and not 1,427 KAF. It also includes different SBC components to pass fish (see Appendix E, Existing Systems/Major System Improvements Engineering). It includes, for example, the use of a BGS and RSW in lieu of a SBC at each dam, except Little Goose. A full-powerhouse, bypass-only surface collector would be used for Little Goose.

  This option also assumes that there would be no voluntary spill except at Little Goose. Adaptive migration would not be an objective of this option and, therefore, flexibility for implementing passage options would be limited.

- **Dam Removal (for PATH analysis, this action is equivalent to A-3)**

  Dam removal would include the same actions as described for dam breaching but would also include removal of all structures (e.g., spillways, powerhouses, navigation locks) at each facility. In addition, long-term maintenance of site structures or preservation of equipment would be eliminated. This alternative was not considered in detail because dam breaching would achieve the same results at a lower cost. In addition, the option of re-establishing the function of the dams in the future would be eliminated. Dam removal as an alternative would result in no increase in fish survival or recovery compared to the dam breaching without removal. Therefore, this alternative was eliminated from further consideration.

2.4.2 Alternatives Analysis Under the 404(b)(1) Guidelines

This analysis evaluates the recommended plan, identified and selected through earlier NEPA processes, for compliance with the 404(b)(1) Guidelines. The analysis does not attempt to reiterate or duplicate processes that were conducted through NEPA to identify an array of alternatives that would satisfy the purpose and need of the project, or revisit selection of the recommended plan (preferred alternative). The analysis focuses on identification of practicable alternatives to the preferred/selected alternative.

2.4.2.1 Practicable Alternatives

Practicable alternatives are defined in the Guidelines at 40 CFR Part 230.10. For clarification, the Guidelines express two clear and automatic presumptions that relate to the "water dependency" provisions of the regulations. The first presumption is that there are practicable alternatives to non-water dependent discharges proposed for special aquatic sites. "Non-water dependent discharges" are those associated with activities that do not require access or proximity to or siting within the special aquatic site to achieve their basic purpose. The second presumption is that alternatives to discharges in special aquatic sites (meaning discharges in uplands) are less damaging to the aquatic ecosystem and are environmentally preferable.

The goal of these presumptions is to verify the existence or non-existence of practicable alternative(s) to the proposed discharge by forcing a hard look at the feasibility of using environmentally preferable sites. Consequently, the Guidelines state that these presumptions are to be rebutted in order to pass the alternatives portion of the Guidelines.

The Guidelines state "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." The Guidelines emphasize that the only alternatives, which must be considered, are practicable alternatives. An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. For the purpose of this requirement, practicable alternatives include, but are not limited to:

- Activities that do not involve a discharge of dredged or fill material into the waters of the United States
- Discharges of dredged or fill material at other locations in waters of the United States.

Where the activity associated with a discharge that is proposed for a special aquatic site does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not water dependent), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise. In addition, where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge that do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise.

2.4.2.2 Summary of Findings

As stated in 2.4.2.1, the Guidance expresses two important presumptions that are to be rebutted in order for a project to pass the alternatives portion of the guidance. Both presumptions deal with the water dependency provisions of the Guidelines. The first presumption is simply that practicable alternatives are presumed to exist for projects that do not require siting within a water of the United States (i.e., non-water dependent). The second presumption is actions that do not involve discharges into special aquatic sites are environmentally preferable. Rebuttal of the presumptions requires the following, respectively: 1) Demonstration that the recommended plan (preferred alternative) is water dependent and, therefore, cannot be accomplished without discharges into waters of the United States; and 2) Demonstration that practicable alternatives that would avoid discharges are not available.

The four alternatives, identified through the NEPA process and carried forward in the FR/EIS, would each accomplish the identified purpose, however, to varying extents. The FR/EIS, Appendix J, Plan Formulation identifies Alternative 3—Major System Improvements as the recommended plan for increasing survival of juvenile anadromous fish through the four dams and assisting in the recovery of ESA-listed salmon and steelhead stocks. Alternative 3, as well as the three other alternatives carried forward in the FR/EIS, would involve the discharge of dredged or fill material in the Snake River at each of the dams.

Because the discharges associated with the recommended plan (preferred alternative) must occur in the Snake River at the site of the four dams in order to accomplish the overall project purpose, the proposed action is determined to be water dependent. Because the action is water dependent, the recommended plan (preferred alternative) cannot be accomplished without discharges into the Snake River and cannot be conducted at alternate locations that would avoid discharges in the Snake River at the four proposed sites. Based on this, the two presumptions are effectively rebutted.

Because the two presumptions are effectively rebutted, no practicable alternatives to the recommended plan (preferred alternative) are considered available. This analysis was performed in accordance with the Guidelines for alternatives analysis identified in 40 CFR Section 230.10(a)(1-5) and satisfies the requirement of Section 403(c) of the Clean Water Act that states that alternatives be considered.

2.5 Description of Method for Dredging and Placement of Materials

2.5.1 Removable Spillway Weirs

Excavation of footings for RSW landing pads and BGS anchor footings would be conducted using a barge-mounted clamshell dredge with a 10-cubic yard (cy) bucket, or similar type equipment. Excavated material would likely be disposed in the water adjacent to the excavation site. The bucket would be lowered into the excavation site, loaded, and raised sufficient to clear the substrate. The dredge arm would then be swiveled to a position adjacent to the excavation site, and the bucket would be lowered vertically to the substrate. The bucket would then be opened and allowed to empty. The empty bucket would then be raised above the substrate, and the dredge arm would be swiveled back over the excavation site where the process would be repeated.

Landing pads would likely consist of a single section of pre-cast concrete. The landing pad would be lowered to the excavated footing using a barge-mounted crane. A diver would confirm positioning of the landing pad.

2.5.2 Behavioral Guidance System

Excavation of footings for cabled BGS anchors would be performed following the same excavation procedures described above for the RSW. Excavated material would likely be disposed in the water adjacent to the excavation site.

Each BGS anchor would likely consist of a single piece of pre-cast concrete, a ships anchor, or another similar, suitable anchor. The anchor would be placed using a barge-mounted crane. Crane cables attached to the anchors would lower the anchors to the excavation site. A diver would confirm positioning of the anchors.

2.5.3 Surface Bypass Collector

Excavation of primarily silt and clay to construct footings for SBC cutoff walls would be performed following the same excavation procedures described above for the RSW. Excavated material would likely be disposed in the water adjacent to the excavation site.

Following excavation of silt and clay, borings would be made into the bedrock or gravels and cobbles in the bottom of the footings to allow anchoring of the footings to the bedrock. Borings would be performed using an underwater pneumatic drill. The drill cuttings would likely be sidecast immediately adjacent to the footing.

Steel rods would be inserted into the boreholes and anchored using cementitious grout. The remainder of the footing would be filled with a single piece of pre-cast concrete.

2.5.4 Pier Nose Extensions

Dredging would not be required to construct pier nose extensions. Formwork would be placed on the spillway piers, and concrete would be placed in the forms. This would all be done in the area dewatered by a bulkhead. The cofferdam is a removable steel bulkhead.

2.5.4.1 Add End Bay Deflectors

A steel plate/form would be placed across the spillbay to form a tightly sealed area between the steel form and existing concrete of the spillbay. The interior of the form would be dewatered. A small amount of concrete on existing deflectors would be removed to create a bench for the new spillway deflectors. Holes would be core drilled into the existing spillbay and reinforcing steel bars would be grouted into the holes. Concrete cores would be disposed in uplands. The bars would extend above the spillbay into the location of the new deflector. Concrete would be placed between the spillbay and the steel form. Concrete would be discharged from trucks staged at the top of the dam, through a chute, to the deflector site. After the concrete has attained adequate strength, the steel form would be removed.

2.5.4.2 Modify Existing Deflectors

A steel plate/form would be placed in the same fashion as described for the addition of end bay deflectors. The interior of the form would be dewatered. The existing deflector would be removed from within the formed area by saw-cutting, jack-hammering, and drilling and splitting the concrete. Concrete sections would be removed for upland disposal using a barge mounted crane. Concrete would be discharged in a similar fashion to that described for addition of the end bay deflectors.

2.5.4.3 Bank Stabilization

Excavation of materials from below the Ordinary High Water Mark (OHWM) is not anticipated. Riprap would be placed along the bank using a backhoe sitting at the tip of the bank. Grout would be delivered to the site by a concrete mixer truck and placed using a concrete pumper truck sitting at the top of the bank.

2.5.4.4 Bypass Outfall Support Columns

Four, 30-inch diameter steel casings would be driven into the overburden and seated into the bedrock. Overburden would be removed from the interior of the casings and disposed in uplands. A 24-inch diameter hole would be drilled 10-feet into the bedrock beneath each casing. Drill cuttings would be removed and disposed in uplands. A wide flange pile would be inserted into the casing and hole. The casing and hole would be filled with concrete.

2.5.5 Sheet Pile Barge Moorage Cells and Barge Access Area

Silt and other material overlying bedrock would be excavated from the footprint of the cell and likely sidecast. Excavation would be conducted similarly to what was described in Section 2.5.1. Gravel would then be used to fill the cells. The gravel would likely be taken from a barge and placed into the cells using a 10-cy bucket lowered from a barge-mounted crane, or similar equipment.

Riprap excavated to construct the barge access area would be excavated using a barge-mounted crane. Excavated riprap would be disposed in uplands.

Gravel placed to construct the barge access area would likely be placed with a 10-cy bucket lowered from a crane stationed at the top of the dam, or similar equipment and methods.

2.6 Description of the Proposed Discharge Site

2.6.1 Removable Spillway Weirs

2.6.1.1 Location

Two landing pads would be constructed in the forebay at each of the four dams. Landing pads would be constructed approximately 88 feet upstream of existing piers. The RSW landing pads would be constructed in spillbays 3 and 5 at Lower Granite and Lower Monumental Dams and in spillbays 1 and 4 at Little Goose and Ice Harbor Dams.

2.6.1.2 Type of Site and Habitat

The Snake River at the site of the four lowermost dams is classified as a Lacustrine System, consisting of deep, open water that is permanently flooded due to impounding (Cowardin et al., 1979). The reservoir pool behind each of these four dams is approximately 30 meters (100 feet) deep at each damsite. (See FR/EIS, Appendix C, Water Quality.)

The Corps conducted sediment sampling in or near the forebay of each of the four dams in 1997. Summarized results of the in-depth particle analysis are contained in Table 2-1. The cross-section of samples at each survey site was averaged. Overall, silt and clay represent the highest concentration of sediments at all four sample sites.

2.6.1.3 Timing and Duration of Discharge

All discharges associated with construction of RSWs would occur during the standard in-water work window of December 15 through March 1, except as modified following coordination with appropriate resource agencies. The work would occur over an estimated 60-day period.

Sidecast dredged and fill material associated with construction of RSWs would be permanently discharged. The actual excavation and discharge of dredged material would occur over an estimated 24-hour period (three, 8-hour days) at each RSW landing pad site. The actual placement of pre-cast concrete into excavated footings would occur during an estimated 16-hour period (two, 8-hour days) at each RSW landing pad site. Work times within the standard in-water work window would vary based on on-site conditions.

2.6.2 Behavioral Guidance Structures

2.6.2.1 Location

A single BGS would be constructed in the forebay at each of Lower Granite, Lower Monumental, and Ice Harbor Dams. The floating BGSs would extend perpendicular to the upstream face of the dam, originating at the SBC entrance and extending 1,000-plus feet upstream, into the forebay. Paired anchors would be cabled to the structure approximately every 100 feet. (See FR/EIS, Appendix E, Annex B, Plates 4.1.1, 4.3.1, and 4.4.1.)

2.6.2.2 Type of Site and Habitat

Refer to Section 2.6.1.2 for a description of the type of site and habitat.

Table 2-1. Sediment Sampling in/near the Forebay of the Four Lower Snake River Dams

Location	Corps Sample ID#	Gravel (%)	Very Fine Gravel (%)	Very Coarse Sand (%)	Medium Sand (%)	Fine Sand (%)	Very Fine Sand (%)	Silt and Clay (%)	Total (%)
Ice Harbor	IHR9.8-1 through 9.8-6	0	0	0	2	9	24	65	**100**
Lower Monumental	LMN41.8-1 through 41.8-7	0	0	0	2	3	10	84	**99**
Little Goose	LGS70.7-1 through 70.7-9	0.6	1	1	1	3	11	81	**99**
Lower Granite	LGR107.7-1 through 107.7-11	.2	.3	.3	1	1	11	84	**98**

Source: CH2M HILL, 1997

2.6.2.3 Timing and Duration of Discharge

All discharges associated with construction of BGSs would occur during the standard in-water work window of December 15 through March 1, except as modified following coordination with appropriate resource agencies. The work would occur over an estimated 60-day period. Sidecast dredged and fill material associated with construction of BGSs would be permanently discharged. The excavation and discharge of dredged material would occur during an estimated 30, 4-hour periods for all of the footings for the BGS. The placement of anchors into the excavated footings would occur during an estimated 8-hour period at each BGS site. Work times within the standard in-water work window would vary based on on-site conditions.

2.6.3 Surface Bypass Collectors

2.6.3.1 Location

A single SBC would be constructed on the upstream face of each of Lower Granite, Little Goose, and Lower Monumental Dams. A cutoff wall, extending from the bottom of the SBC downward to the substrate, would sit atop two footings. (See FR/EIS, Appendix E, Annex B, Plate 4.1.3.)

2.6.3.2 Type of Site and Habitat

Refer to Section 2.6.1.2 for a description of the type of site and habitat.

2.6.3.3 Timing and Duration of Discharge

All discharges associated with construction of SBCs would occur during the standard in-water work window of December 15 through March 1, except as modified following coordination with appropriate resource agencies. The work would occur over an estimated 45-day period. Sidecast dredged and fill material associated with construction of SBCs would be permanently discharged. The excavation and discharge of dredged material would occur during an estimated 24 hours (three, 8-hour periods) at each SBC installation site. The placement of concrete into the excavated footings would occur during an estimated 8-hour period at each SBC installation site. Work times within the standard in-water work window would vary based on on-site conditions.

2.6.4 Pier Nose Extensions

2.6.4.1 Location

Pier nose extensions are currently proposed for construction at Lower Monumental, Little Goose, and Lower Granite Dams.

2.6.4.2 Type of Site and Habitat

The Snake River at the site of the four lowermost dams is classified as a Lacustrine System, consisting of deep, open water that is permanently flooded due to impounding (Cowardin et al., 1979).

The pier nose extensions would be constructed upon existing concrete sitting atop the substrate.

2.6.4.3 Timing and Duration of Discharge

Construction of pier nose extensions would occur during the in-water work window of December 15 through March 1, except as modified following coordination with appropriate resource agencies. The cast-in-place concrete would be permanently discharged.

2.6.5 Add End Bay Deflectors

2.6.5.1 Location

Two end bay deflectors would be installed in spillbays 1 and 8 at each of Lower Monumental and Little Goose Dams. The deflectors would be installed on the downstream portion of the spillway ogees (downstream side of the dams). See Figure 2-2 in Annex C of Appendix E for a typical spillway deflector.

2.6.5.2 Type of Site and Habitat

The Snake River at the site of the four lowermost dams is classified as a Lacustrine System, consisting of deep, open water that is permanently flooded due to impounding (Cowardin et al., 1979). The concrete would be placed over existing concrete.

2.6.5.3 Timing and Duration of Discharge

The concrete would be permanently discharged.

2.6.6 Modify Existing Deflectors

2.6.6.1 Location

All existing deflectors at Lower Monumental (six each), Little Goose (six each), and Lower Granite (eight each) Dams would be modified.

2.6.6.2 Type of Site and Habitat

The Snake River at the site of the four lowermost dams is classified as a Lacustrine System, consisting of deep, open water that is permanently flooded due to impounding (Cowardin et al., 1979). The concrete would be placed over existing concrete.

2.6.6.3 Timing and Duration of Discharge

All discharges associated with modification of existing deflectors would occur during the standard in-water work window of December 15 through March 1, except as modified following coordination with appropriate resource agencies. The concrete would be permanently discharged.

2.6.7 Bank Stabilization

2.6.7.1 Location

Bank stabilization would be constructed along approximately 150 linear feet of the left bank approximately 1,300 feet downstream of the downstream face of the Lower Granite Dam.

2.6.7.2 Type of Site and Habitat

The Snake River at the site of the four lowermost dams is classified as a Lacustrine System, consisting of deep, open water that is permanently flooded due to impounding (Cowardin et al., 1979). Riprap and grout would be placed below the OHWM upon existing riprap and grout.

2.6.7.3 Timing and Duration of Discharge

Construction would occur during the in-water work window of December 15 through March 1, except as modified following coordination with appropriate resource agencies. The riprap and grout would be permanently discharged.

2.6.8 Bypass Outfall Pipe Support Columns

2.6.8.1 Location

Supports for the bypass pipe would be constructed perpendicular to the left bank alignment approximately 1,200 feet downstream of the downstream face of Lower Granite Dam. The first pair of supports would be situated approximately 50 feet waterward from the OHWM and the second pair approximately 130 feet waterward from the OHWM.

2.6.8.2 Type of Site and Habitat

The Snake River at the site of the four lowermost dams is classified as a Lacustrine System, consisting of deep, open water that is permanently flooded due to impounding (Cowardin et al., 1979). Support columns would be placed through the substrate and into bedrock. The substrate generally consists of the same constituents identified in Table 2-1.

2.6.8.3 Timing and Duration of Discharge

Construction would occur during the in-water work window of December 15 through March 1, except as modified following coordination with appropriate resource agencies. The concrete would be permanently discharged.

2.6.9 Sheet Pile Barge Moorage Cells and Barge Access Area

2.6.9.1 Location

Sheet pile barge moorage cells and a barge access area would be constructed at Lower Granite Dam only. The new moorage cells and barge access area would be situated on the downstream side of the earthen portion of the dam (see Figures 2-1 and 2-2).

2.6.9.2 Type of Site and Habitat

The Snake River at Lower Granite Dam is classified as a Lacustrine System, consisting of deep, open water that is permanently flooded due to impounding (Cowardin et al., 1979).

No sediment sampling data is available for the site of the barge moorage cells and barge access area. Portions of the substrate are covered with riprap (see Figure 2-2). The specific site of the moorage cells and barge access area may be more generally described as low velocity backwater habitat, of which portions of the substrate are covered with riprap.

2.6.9.3 Timing and Duration of Discharge

All discharges associated with construction of moorage cells and the barge access area would occur during the standard in-water work window of December 15 through March 1, except as modified following coordination with appropriate resource agencies. The work would occur over an estimated 75-day period. Sidecast dredged material and fill material associated with construction of moorage cells would be permanently discharged. The excavation and discharge of dredged material associated with construction of the moorage cells would occur during an estimated three, 8-hour periods. Fill material associated with construction of the barge access area would also be permanently discharged. The placement of fill material to construct the barge access area would occur during an estimated eight, 8-hour periods. Work times within the standard in-water work window would vary based on on-site conditions. No discharges of dredged material would occur in association with construction of the barge access area.

2.7 General Description of Dredged or Fill Material

2.7.1 General Characteristics of Material

2.7.1.1 Dredged Material

Dredged material discharged in association with construction of RSWs, BGSs, and SBCs would generally consist of the same constituents identified in Table 2-1. In addition, the substrate is likely underlain by cobbles ranging in diameter from 1 to 6 inches and coarse gravels ranging in diameter from 1/16 inch to 1 inch.

No excavation would occur in association with the bank stabilization.

Overburden and bedrock drilled from the interior of the bypass outfall support column casings would be disposed in uplands.

No sediment sampling data are available to identify material that would be dredged from the interior of barge moorage cells. Sediment sampling is discussed in Section 3.2.1.4 of this appendix. Some riprap exists at the site; therefore, excavated material may include riprap where the footprint of the cell overlies existing riprap (see Figure 2-2). Riprap would also be excavated to construct the barge access area, but it would be disposed of in uplands.

Existing, cured concrete would be removed to facilitate modification of existing deflectors and addition of new deflectors.

2.7.1.2 Fill Material

Fill material for RSW landing pads, BGS cutoff wall footings, and SBC anchors would consist of pre-cast concrete or other similar type material. Pier nose extensions, added and modified deflectors, bank stabilization, and bypass outfall support columns would consist of cast-in-place concrete. Fill material used to construct sheet pile barge moorage cells and barge access area would consist of gravel.

2.7.2 Quantity of Material and Size of Excavation and Discharge Areas

2.7.2.1 Removable Spillway Weirs

Two RSWs would be constructed at each of the four dams, if warranted after prototype testing. The RSWs would be constructed on the upstream face of the dams. Each RSW would have a single landing pad upon which the weir would rest in the down position. Landing pads would be constructed in the substrate. All quantities are only estimates and would vary depending upon site-specific conditions.

An estimated 150 cy at Lower Granite Dam and 30 cy at Little Goose, Lower Monumental, and Ice Harbor Dams of primarily silt and clay would be excavated to form a single footing for each landing pad and would likely be sidecast as a permanent discharge of dredged material. Dimensions of the discharged dredged material would be approximately 40 feet in diameter (0.028 acre) at Lower Granite Dam and 24 feet in diameter (0.010 acre) at Little Goose, Lower Monumental, and Ice Harbor Dams, per excavated landing pad. Approximately 300 cy (0.056 acre) at Lower Granite Dam and 60 cy (0.020 acre) at Little Goose, Lower Monumental, and Ice Harbor Dams of substrate material would be permanently discharged as dredged material at each of the four dams. Total permanent discharge of dredged material for all four dams (eight landing pads) would be approximately 480 cy (0.116 acre).

An estimated 142 cy of pre-cast concrete or similar type material would be permanently discharged as fill material for each landing pad. The permanently discharged fill material would encompass approximately 0.018 acre per pad. Approximately 284 cy (0.036 acre) of pre-cast concrete would be permanently discharged as fill material at each of the four dams. Total permanent discharge of fill material for all four dams (eight landing pads) would be approximately 1,136 cy (0.144 acre) (see Table 2-2).

2.7.2.2 Behavioral Guidance Structures

A single BGS would be constructed at each of Lower Granite, Lower Monumental, and Ice Harbor Dams. A BGS would not be installed at Little Goose Dam. Anchors cabled to the BGS would be placed in the substrate. An average of 28 anchors would be installed in association with each of the three BGSs for an estimated total of 84 anchors. All quantities are only estimates and would vary depending upon site-specific conditions.

An estimated 67 cy at Lower Granite Dam and 15 cy at Lower Monumental and Ice Harbor Dams of substrate material would be excavated to form a single footing for each anchor and would likely be sidecast as a permanent discharge of dredged material. Dimensions of the discharged dredged material would be approximately 30 feet in diameter (0.016 acre) at Lower Granite Dam and 18 feet in diameter (0.0060 acre) at Lower Monumental and Ice Harbor Dams, per anchor. Approximately 1,876 cy (0.45 acre) at Lower Granite Dam and 420 cy (0.168 acre) at Lower Monumental and Ice Harbor Dams of

Table 2-2. Excavation and Discharge Quantity and Area Totals for Removable Spillway Weir

Location	Work Item Description	Excavation	Dredged Material Discharge (Permanent)	Fill Material Discharge (Permanent)
Lower Granite	Landing Pad (2 total)	300 cy total (150 cy/pad) 0.036 acre total (0.018 acre/pad)	300 cy total (150 cy/pad) 0.056 acre 0.028 acre/pad	284 cy total (142 cy/pad) 0.036 acre total (0.018 acre/pad)
Little Goose	Landing Pad (2 total)	60 cy total 30 cy/pad 0.036 acre total (0.018 acre/pad)	60 cy total (30 cy/pad) 0.020 acre 0.010 acre/pad	284 cy total (142 cy/pad) 0.036 acre total (0.018 acre/pad)
Lower Monumental	Landing Pad (2 total)	60 cy total (30 cy/pad) 0.036 acre total (0.018 acre/pad)	60 cy total (30 cy/pad) 0.020 acre 0.010 acre/pad	284 cy total (142 cy/pad) 0.036 acre total (0.018 acre/pad)
Ice Harbor	Landing Pad (2 total)	60 cy total (30 cy/pad) 0.036 acre total (0.018 acre/pad)	60 cy total (30 cy/pad) 0.020 acre 0.010 acre/pad	284 cy total (142 cy/pad) 0.036 acre total (0.018 acre/pad)
Totals		**480 cy total** **0.14 acre total**	**480 cy total** **0.116 acre total**	**1,136 cy total** **0.144 acre total**

Source: Corps, 2001

substrate material would be permanently discharged as dredged material. Total discharge of dredged material for all three dams (84 anchors) would be approximately 2,716 cy (0.786 acre).

Approximately 128 cy of pre-cast concrete would be permanently discharged as fill material for each anchor. Dimensions of each anchor would be approximately 20 feet by 20 feet (0.0092 acre). Approximately 3,584 cy (0.257 acre) of pre-cast concrete would be permanently discharged as fill material at each of the three dams. Total discharge of fill material for all three dams (84 anchors) would be approximately 11,000 cy (0.77 acre) (see Table 2-3).

2.7.2.3 Surface Bypass Collectors

An SBC would be constructed at Lower Granite, Little Goose, and Ice Harbor Dams. Each SBC would have a single cutoff wall. Each cutoff wall would have two footings resulting in eight total footings. Cutoff walls would be embedded/anchored in footings in the substrate. All quantities are estimates only and would vary depending upon site-specific conditions.

An estimated 88 cy at Lower Granite Dam and 20 cy at Little Goose and Lower Monumental Dams of primarily silt and clay with an incidental quantity of rock drill cuttings would be excavated to form a

Table 2-3. Excavation and Discharge Quantity and Area Totals for Behavioral Guidance Structure

Location	Work Item Description	Excavation	Dredged Material Discharge (Permanent)	Fill Material Discharge (Permanent)
Lower Granite	Anchors (28 total)	1,876 cy total (67 cy/anchor) 0.26 acre total (0.0092 acre/anchor)	1,876 cy total (67 cy/anchor) 0.45 acre total 0.016 acre/pad	3,584 cy total (128 cy/anchor) 0.2576 acre total (0.0092 acre/anchor)
Lower Monumental	Anchors (28 total)	420 cy total (15 cy/anchor) 0.26 acre total (0.0092 acre/anchor)	420 cy total (15 cy/anchor) 0.168 acre total 0.0060 acre/pad	3,584 cy total (128 cy/anchor) 0.2576 acre total (0.0092 acre/anchor)
Ice Harbor	Anchors (28 total)	420 cy total (15 cy/anchor) 0.26 acre total (0.0092 acre/anchor)	420 cy total (15 cy/anchor) 0.168 acre total 0.0060 acre/pad	3,584 cy total (128 cy/anchor) 0.2576 acre total (0.0092 acre/anchor)
Totals		**2,716 cy total** **0.78 acre total**	**2,716 cy total** **0.786 acre total**	**11,000 cy total** **0.77 acre total**

single footing and likely sidecast as a permanent discharge of dredged material. Dimensions of the discharged dredged material would be approximately 33 feet in diameter (0.020 acre) at Lower Granite Dam and 20 feet in diameter (0.007 acre) at Little Goose and Lower Monumental Dams, per footing. Approximately 176 cy (0.040 acre) at Lower Granite Dam and 40 cy (0.014 acre) at Little Goose and Lower Monumental Dams of substrate material and rock drill cuttings would be permanently discharged as dredged material at each of the three dams. Total permanent discharge of dredged material for all three dams (six footings) would be approximately 256 cy (0.068 acre).

Approximately 15 cy of pre-cast concrete would be permanently discharged as fill material for each footing. Dimensions of the permanently discharged fill material would be approximately 10 feet by 10 feet (0.0023 acre), per footing. Approximately 30 cy (0.0046 acre) of pre-cast concrete would be permanently discharged as fill material at each of the three dams. Total discharge of fill material for all three dams (six footings) would be approximately 90 cy (0.0138 acre) (see Table 2-4).

2.7.2.4 Pier Nose Extensions

An estimated seven pier nose extensions would be constructed at each of the three dams identified in Table 2-5. Each extension would consist of approximately 60 cy of cast-in-place concrete and would encompass an estimated 0.002 acre (see Table 2-5). All quantities are estimates only and would vary depending upon site-specific conditions.

2.7.2.5 Add End Bay Deflectors

A total of two end bay deflectors would be added at each of Little Goose and Lower Monumental Dams. Approximately 10 cy of existing concrete would be removed to facilitate construction of each deflector (40 cy total). Approximately 240 cy of concrete would be discharged as fill material for each deflector (960 cy total). See Table 2-6.

Table 2-4. Excavation and Discharge Quantity and Area Totals for Surface Bypass Collectors

Location	Work Item Description	Excavation	Dredged Material Discharge (Permanent)	Fill Material Discharge (Permanent)
Lower Granite	Cutoff Wall Footings (2 total)	176 cy total (88 cy/footing) 0.036 acre total (0.018 acre/footing)	176 cy total (88 cy/footing) 0.040 acre total 0.020 acre/footing	30 cy total (15 cy/footing) 0.0046 acre total (0.0023 acre/pad)
Little Goose	Cutoff Wall Footings (2 total)	40 cy total (20 cy/footing) 0.0088 acre total (0.0044 acre/footing)	40 cy total (20 cy/footing) 0.014 acre total 0.007 acre/footing	30 cy total (15 cy/footing) 0.0046 acre total (0.0023 acre/pad)
Lower Monumental	Cutoff Wall Footings (2 total)	40 cy total (20 cy/footing) 0.0088 acre total (0.0044 acre/footing)	40 cy total (20 cy/footing) 0.014 acre total 0.007 acre/footing	30 cy total (15 cy/footing) 0.0046 acre total (0.0023 acre/pad)
Totals		**128 cy total** **0.054 acre total**	**256 cy total** **0.068 acre total**	**90 cy total** **0.0138 acre total**

Table 2-5. Excavation and Discharge Quantity and Area Totals for Pier Nose Extensions

Location	Work Item Description	Excavation	Dredged Material Discharge	Fill Material Discharge (Permanent)
Lower Granite	Pier Nose Extension (7 total)	0.0 cy total 0.0 acre total	0.0 cy total 0.0 acre total	420 cy total (60 cy/extension) 0.014 acre total (0.002 acre/extension)
Little Goose	Pier Nose Extension (7 total)	0.0 cy total 0.0 acre total	0.0 cy total 0.0 acre total	420 cy total (60 cy/extension) 0.014 acre total (0.002 acre/extension)
Lower Monumental	Pier Nose Extension (7 total)	0.0 cy total 0.0 acre total	0.0 cy total 0.0 acre total	420 cy total (60 cy/extension) 0.014 acre total (0.002 acre/extension)
Totals		**0.0 cy total** **0.0 acre total**	**0.0 cy total** **0.0 acre total**	**1,260 cy total** **0.042 acre total**

Table 2-6. Excavation and Discharge Quantity and Area Totals for Add End Bay Deflectors

Location	Work Item Description	Excavation	Dredged Material Discharge	Fill Material Discharge (Permanent)
Little Goose	Add Deflectors (2 total)	20 cy total 10 cy/deflector 0.012 acre total (0.006 acre/ deflector)	0 cy total (0 cy/deflector) 0 acre	480 cy total (240 cy/deflector) 0.052 acre total (0.026 acre/deflector)
Lower Monumental	Add Deflectors (2 total)	20 cy total (10 cy/deflector) 0.012 acre total (0.006 acre/ deflector)	0 cy total (0 cy/deflector) 0 acre	480 cy total (240 cy/deflector) 0.052 acre total (0.026 acre/deflector)
Totals		**40 cy total** **0.024 acre total**	**0 cy total** **0 acre total**	**960 cy total** **0.104 acre total**

2.7.2.6 Modify Existing Deflectors

A total of eight deflectors at Lower Granite and six deflectors at each of Little Goose and Lower Monumental would be modified. Existing concrete deflectors would be removed and disposed in uplands. Existing deflectors would consist of approximately 250 cy per deflector (5,000 cy total). An estimated 240 cy of concrete would be discharged per deflector as fill material (5,955 cy total). See Table 2-7.

2.7.2.7 Bank Stabilization

Approximately 12.8 cy of fill material (riprap and cement grout) would be discharged below the OHWM. See Table 2-8.

2.7.2.8 Bypass Outfall Support Columns

An estimated 17.7 cy of sand, gravel, and fractured basalt would be excavated from the interior of the steel casings. This material would be disposed in uplands. A total of approximately 40.7 cy of concrete would be discharged as fill material into the interior of the support columns. See Table 2-9.

2.7.2.9 Sheet Pile Barge Moorage Cells and Barge Access Area

Moorage cells would be constructed at Lower Granite Dam only. An estimated two cells total would be constructed. Cells would be formed by driving sheet piling into the river bottom. Each cell would be approximately 24.8 feet in diameter. There are 2,950 square feet of sheet pile below the water line for each cell; a total of 5,900 square feet. After driving the piling, substrate material in the interior of the cell (about 5 feet thick) would be excavated using a barge-mounted crane and bucket. The volume of excavated soil would be about 88 cy per cell. The material would likely be sidecast and cover an area of about 0.020 acre per cell. The total amount of excavated material would be about 176 cy and the total disposal area would be about 0.040 acre. Approximately 670 cy of gravel would be placed in each cell below the water line for a total of 1,340 cy of gravel placed in both cells below the water line. All quantities are only estimates and would vary depending upon site-specific conditions.

Table 2-7. Excavation and Discharge Quantity and Area Totals for Modifying Deflectors

Location	Work Item Description	Excavation	Dredged Material Discharge (Permanent)	Fill Material Discharge (Permanent)
Lower Granite	Modify Deflectors (8)	2,000 cy total for deflectors (250 cy/ deflector) 0.28 acre total for deflectors (0.026 acre/ deflector)	0 cy total (0 cy/deflector) 0 acre	1,920 cy total for deflectors (240 cy/deflector) 0.208 acre total for deflectors (0.026 acre/deflector)
Little Goose	Modify Deflectors (6)	1,500 cy total for deflectors 250 cy/defector 0.156 acre total for deflectors (0.026 acre/ deflector)	0 cy total (0 cy/deflector) 0 acre	1,440 cy total for deflectors (240 cy/deflector) 0.156 acre total for deflectors (0.026 acre/deflector)
Lower Monumental	Modify Deflectors (6)	1,500 cy total for deflectors (250 cy/ deflector) 0.156 acre total for deflectors (0.026 acre/ deflector)	0 cy total (0 cy/deflector) 0 acre	1,440 cy total for deflectors (240 cy/deflector) 0.156 acre total for deflectors (0.026 acre/deflector)
Totals		**5,000 cy total** **0.52 acre total**	**0 cy total** **0 acre total**	**5,955 cy total** **0.63 acre total**

Table 2-8. Excavation and Discharge Quantity and Area Totals for Bank Stabilization

Location	Work Item Description	Excavation	Dredged Material Discharge (Permanent)	Fill Material Discharge (Permanent)
Lower Granite	Bank Stabilization	0 cy 0 acre	0 cy 0 acre	12.8 cy total 0.015 acre
Totals		**0 cy total** **0 acre total**	**0 cy total** **0 acre total**	**12.8 cy total** **0.015 acre total**

Table 2-9. Excavation and Discharge Quantity and Area Totals for Outfall Support Columns

Location	Work Item Description	Excavation	Dredged Material Discharge (Permanent)	Fill Material Discharge (Permanent)
Lower Granite	Bypass Outfall Support Columns (4)	17.7 cy total for 4 columns (4.4 cy/column) 0.0004 acre total (0.0001 acre/column)	0 cy (0 cy/column) 0 acre	40.7 cy total for 4 columns (10.2 cy/column) 0.0004 acre total (0.0001 acre/column)
Totals		**17.7 cy total** **0.0004 acre total**	**0 cy total** **0 acre total**	**10.7 cy total** **0.0004 acre total**

An access to the moorage cells and moored barges would be constructed along the face of the dam to allow crane access and facilitate barge maintenance. A sheet pile wall would serve as the interface between the access area and the water. The sheet pile wall along the face of the dam would be 570 feet long and have 21,660 square feet of wall below water. There would be about 1,900 cy of riprap excavation covering approximately 0.40 acre from the face of the dam below the waterline and behind the new sheet pile wall. All excavated riprap would be disposed in uplands. Approximately 2,100 cy of gravel fill would then be placed behind the wall below the waterline (see Table 2-10). All quantities are only estimates and would vary depending upon site-specific conditions.

2.7.3 Source of Material

2.7.3.1 Removable Spillway Weirs

Dredged material discharged in association with construction of the RSW landing pads would originate from excavation of the landing pad footings in the forebay. The source for pre-cast concrete landing pads would likely be a local commercial concrete production plant.

2.7.3.2 Behavioral Guidance System

Dredged material discharged in association with construction of the BGS anchor footings would originate on site from excavation of the footings in the forebay. The source for the pre-cast concrete footing would likely be a local commercial concrete production plant.

2.7.3.3 Surface Bypass Collector

Dredged material discharged in association with construction of the SBC cutoff wall footings would originate on site from excavation of the footings in the forebay. The source for the pre-cast concrete anchors would likely be a local commercial concrete production plant.

2.7.3.4 Pier Nose Extensions

Cast-in-place concrete fill material discharged to construct pier nose extensions would be obtained from a local commercial concrete production plant.

Table 2-10. Excavation and Discharge Quantity and Area Totals for Sheet Pile Barge Moorage Cells and Barge Access Area

Location	Work Item Description	Excavation	Dredged Material Discharge (Permanent)	Fill Material Discharge (Permanent)
Lower Granite	Sheet Pile Moorage Cell (2 Total)	176 cy total (88 cy/cell) 0.022 acre total (0.011 acre/cell)	176 cy total (88 cy/cell) 0.040 acre total	1,340 cy total (670 cy/cell) 0.022 acre total (0.011 acre/cell)
	Barge Access Area	1,900 cy total 0.40 acre total	0 cy total 0.0 acre total	2,100 cy total 0.45 acre total
Totals		**2,076 cy total** **(0.42 acre total)**	**176 cy** **0.04 acre**	**3,440 cy total** **0.47 acre**

2.7.3.5 Add End Bay Deflectors

Cast-in-place concrete fill material discharged to add end bay deflectors would be obtained from a local commercial concrete production plant.

2.7.3.6 Modify Existing Deflectors

Cast-in-place concrete fill material discharged to modify existing deflectors would be obtained from a local commercial concrete production plant.

2.7.3.7 Bank Stabilization

Riprap and concrete would be obtained from local commercial sources.

2.7.3.8 Bypass Outfall Support Columns

Concrete would be obtained from a local commercial source.

2.7.3.9 Sheet Pile Barge Moorage Cells and Barge Access Area

Dredged material discharged in association with construction of the moorage cells at Lower Granite Dam would originate on site, downstream of the earthen embankment portion of the dam. The source for the rock and gravel fill material discharged into the moorage cells and behind the sheet pile wall for the barge access area would be a local commercial source.

3. Factual Determinations

3.1 Physical Substrate Determinations

3.1.1 Dredged Material

Dredged material would likely be discharged in association with construction of the RSW landing pads, BGS anchor sites, SBC cutoff wall support footings, and barge moorage cells.

Sidecasting of silt and clay, sand, and gravel excavated to form footings for the RSW landing pads, BGS anchor sites, SBC cutoff wall support footings, and construction of moorage cells, would permanently elevate the existing substrate at the discharge site. Actual changes in the substrate elevation and slope are predicted to be negligible due to the limited quantity of material and anticipated settling of the material at the discharge site. Immobile bottom-dwelling organisms would likely be smothered by the discharge. Some mobile organisms would also likely be smothered; however, most would temporarily migrate from the discharge site. Colonization of the newly elevated substrate to concentrations similar to pre-discharge conditions should occur in the short term due to consistency in particle size. The dredged material would originate on site; therefore, there would be no change in the chemical constituents of the materials.

Sidecast dredged material would be confined to areas immediately adjacent to the excavation site to minimize transport distance of the material and minimize the footprint of the discharge. Negligible movement of discharged dredged material is predicted due to the depth of the water at the discharge site and tendency for clay and silt to settle out in this area of slow-moving water.

Sections 3.4.1, 3.4.2, and 3.4.3 discuss effects on turbidity, contaminants, and biota, respectively.

3.1.2 Fill Material

Placement of pre-cast concrete for RSW landing pads, BGS anchors, and SBC cutoff wall support footings would permanently replace the clay and silt, sand, and gravel substrate excavated to form the footings. Negligible changes in the substrate elevation and slope would result from existence of the RSW landing pads and BGS anchors due to their profile. No movement of the concrete landing pads or anchors is anticipated. Little or no impact would occur upon benthics directly from the placement of the landing pads or anchors, due to prior disturbance of the site through excavation. The exposed concrete landing pads and anchors would not be conducive to benthic re-colonization in the short term. In the long term, however, following natural deposition of clay and silt over the concrete, recolonization should occur. Some future short-term disturbance of benthics would occur when the RSW is lowered to rest on the landing pad. The SBC cutoff wall support footings would cause minimal change in substrate elevation and slope. The concrete footings, with the cutoff wall sitting atop it, would permanently change the substrate elevation and slope and would permanently eliminate the substrate within the footprint of the concrete footings. Minimal disturbance of benthics would result from placement of the footings due to prior disturbance of the site through excavation. Re-colonization of the concrete footings would be marginal due to the concrete cutoff wall sitting atop the footings.

Cast-in-place concrete used to construct pier nose extensions and end bay deflectors and to modify existing deflectors would be placed upon existing concrete that covers the substrate. Riprap and cement grout discharged to construct the bank stabilization would be placed upon existing riprap. Concrete discharged into the interior of the bypass outfall support columns would permanently eliminate the substrate within the interior of the columns. Gravel discharged in the interior of the barge moorage cells and barge access area would replace the substrate at the discharge site, including substrate areas covered with riprap, for the cells with footprints on existing riprap. The gravel fill in the barge access area would be placed atop existing riprap. The gravel fill would permanently eliminate the substrate within the interior of the moorage cells and beneath the barge access fill. Gravel discharged in the interior of the barge moorage cells would have negligible short-term effects on benthics due to prior disturbance of the site through excavation. Long-term effects would occur upon benthics through the permanent elimination of the substrate within the footprint of the cells. Long-term permanent effects upon benthics would result from the barge access fill.

3.1.3 Actions Taken to Minimize Impacts

The following actions would be taken to minimize impacts:

- Sidecast dredged material would be confined to areas immediately adjacent to the excavation site to minimize transport distance of the material and minimize the footprint of the discharge.
- Excavation would be held to the minimum necessary to lessen impacts to the substrate.
- Pre-cast concrete would be adequately cured before placement in the water.
- Materials excavated from the interior of the bypass outfall support columns would be disposed in uplands.
- Cast-in-place concrete would be placed within an area dewatered by a cofferdam/bulkhead.

3.2 Chemical Description of Materials

The materials to be dredged are mostly sedimentary in nature. As the runoff from adjacent land and from upper river contributions travels with the freshets, fine particulate matter is carried with the current until the velocities slow enough to allow for settling in the calmer portions of the reservoir. This discussion focuses on the materials referred to as “fines.” These materials tend to be rich in organic materials and, thus, have the best potential to harbor deleterious or beneficial constituents. In terms of concentration, nutrients such as ammonia, organic nitrogen, phosphorus, and sulfate make up the bulk of sediment constituents. A portion of these sediments harbor pesticide and herbicide compounds and their degradation products.

A variety of elements and organic compounds have entered the environment as a result of human activities. Such substances find their way into the aquatic environment through runoff, direct discharges, and settled airborne particulate matter. Some of these chemicals are known to harm aquatic life by direct toxicity, reducing viability, or limiting reproductive success (Bonn, 1999). The sediment history of the lower Snake River is as much a part of the agricultural history as it is a history of chemical usage. In the 20th century, the primary use of land adjacent to the lower Snake River was agricultural (Drawdown Regional Economic Workgroup [DREW], 1999). Therefore, the sediment chemistry in the Snake River is likely to be a legacy of the agricultural chemicals used in the 20th century.

3.2.1 Dredged Material

3.2.1.1 Removable Spillway Weirs

Ice Harbor Forebay

Sediment quality determinations are taken from the 1997 sediment investigation of the lower Snake River (Anatek Labs, 1997). Constituent values of organic compounds were as follows: 3.83 micrograms per kilogram (µg/kg) of 4,4-dichloro-diphenyl-dichloro-ethylene (DDE); 1.1 µg/kg glyphosate; and 61 milligrams per kilogram (mg/kg) total petroleum hydrocarbons (TPH). Tests were conducted for other organic constituents, but none were detected (Anatek Labs, 1997). The concentration values of metals in the forebay were as follows: 0.68 mg/kg beryllium (Be); 53.5 mg/kg vanadium (V); 20.8 mg/kg chromium (Cr); 1,041 mg/kg manganese (Mn); 11.6 mg/kg cobalt (Co); 14.9 mg/kg nickel (Ni); 21.9 mg/kg copper (Cu); 57.2 mg/kg zinc (Zn); 8.09 mg/kg arsenic (As); 1.89 mg/kg selenium (Se); 0.44 mg/kg molybdenum (Mo); 178 mg/kg barium (Ba); 0.23 mg/kg thallium (Tl); and 13.1 mg/kg lead (Pb). The mean inorganic nutrient concentration of the Ice Harbor forebay was 81.4 mg/kg ammonia; 1,317.1 mg/kg total Kjeldahl nitrogen; 0.7 mg/kg nitrite/nitrate; 2.5 percent organic carbon; 37.7 mg/kg phosphorus; and 7.7 mg/kg sulfate. The mean parts hydronium (pH) of the soil was 6.9 units.

Lower Monumental Forebay

Sediment quality determinations are taken from the 1997 sediment investigation of the lower Snake River (Anatek Labs, 1997). Constituent values of organic compounds were as follows: 6.99 µg/kg 4,4-DDE and 58.91 mg/kg TPH. The concentration values of metals in the forebay were as follows: 0.74 mg/kg Be; 47.3 mg/kg V; 25.4 mg/kg Cr; 829 mg/kg Mn; 11.8 mg/kg Co; 15.5 mg/kg Ni; 23.3 mg/kg Cu; 54.8 mg/kg Zn; 8.09 mg/kg As; 2.04 mg/kg Se; 0.51 mg/kg Mo; 202 mg/kg Ba; 0.15 mg/kg Mercury (Hg); 0.23 mg/kg Tl; and 13.1 mg/kg Pb. The mean inorganic nutrient concentration of the Lower Monumental forebay was 81.4 mg/kg ammonia; 1,146.1 mg/kg total Kjeldahl nitrogen; 0.6 mg/kg nitrite/nitrate; 2.2 percent organic carbon; 38.2 mg/kg phosphorus; and 8.4 mg/kg sulfate. The mean soil pH was 6.9 units.

Little Goose Forebay

Sediment quality determinations are taken from the 1997 sediment investigation of the lower Snake River (Anatek Labs, 1997). Constituent values of organic compounds were as follows: 8.96 µg/kg 4,4-DDE; 3.0 µg/kg glyphosate; and 45.18 mg/kg TPH. The concentration values of metals in the forebay were as follows: 0.77 mg/kg Be; 53.5 mg/kg V; 25.6 mg/kg Cr; 848 mg/kg Mn; 13.2 mg/kg Co; 17.4 mg/kg Ni; 29.77 mg/kg Cu; 65.0 mg/kg Zn; 6.70 mg/kg As; 1.68 mg/kg Se; 0.32 mg/kg Mo; 212 mg/kg Ba; 0.12 mg/kg Hg; 0.24 mg/kg Tl; and 14.37 mg/kg Pb. The mean inorganic nutrient concentration of the Little Goose forebay was 64.3 mg/kg ammonia; 1,344.1 mg/kg total Kjeldahl nitrogen; 0.7 mg/kg nitrite/nitrate; 3.3 percent organic carbon; 35 mg/kg of phosphorus; and 10.5 mg/kg sulfate. The mean soil pH was 7.1 units.

Lower Granite Forebay

Sediment quality determinations are taken from the 1997 sediment investigation of the lower Snake River (Anatek Labs, 1997). Constituent values of organic compounds were as follows: 10.17 µg/kg 4,4-DDE;

6.76 µg/kg 4,4- dichloro-diphenyl-dichloro-ethane (DDD); 3.0 µg/kg glyphosate; and 82.25 mg/kg TPH. The concentration values of metals in the forebay were as follows: 0.77 mg/kg Be; 84.0 mg/kg V; 24.4 mg/kg Cr; 517.5 mg/kg Mn; 13.28 mg/kg Co; 16.98 mg/kg Ni; 32.81 mg/kg Cu; 68.3 mg/kg Zn; 6.78 mg/kg As; 1.68 mg/kg Se; 0.33 mg/kg Mo; 198 mg/kg Ba; 0.15 mg/kg Hg; 0.23 mg/kg Tl; and 15.75 mg/kg Pb. The mean inorganic nutrient concentration of the Lower Granite forebay was 75.7 mg/kg ammonia; 1,746.5 mg/kg total Kjeldahl nitrogen; 1.4 mg/kg nitrite/nitrate; 5.2 percent organic carbon; 34.1 mg/kg of phosphorus; and 17.9 mg/kg sulfate. The mean soil pH was 6.8 units.

3.2.1.2 Behavioral Guidance Structures

The chemical quality of the sediment is the same as described in Section 3.2.1.1.

3.2.1.3 Surface Bypass Collectors

The chemical quality of the sediment is the same as described in Section 3.2.1.1.

3.2.1.4 Sheet Pile Barge Moorage Cells

Dredged material would primarily consist of basalt or igneous rock with intermixed silt and sand. Some riprap may be excavated and discharged as dredged material. No chemical data are available for the silt material. Prior to construction, sediment samples would be obtained and analyzed for chemical constituents, including particle size.

3.2.1.5 Barge Access Area

No discharges of dredged material would occur in association with construction of the barge access area.

3.2.1.6 Pier Nose Extensions

Construction of pier nose extensions would not require excavation or discharges of dredged material.

3.2.1.7 Add End Bay Deflectors

No discharge of dredged material is anticipated.

3.2.1.8 Modify Existing Deflectors

No discharge of dredged material is anticipated.

3.2.1.9 Bank Stabilization

No discharge of dredged material is anticipated.

3.2.1.10 Bypass Outfall Support Column

No discharge of dredged material is anticipated.

3.2.2 Fill Material

3.2.2.1 Removable Spillway Weirs

The RSWs are bolted to the upstream concrete face of the dam. Drill cuttings, similar in texture to coarse sand, would not have a measurable effect to the water column and would not exceed one half of a cubic foot in total material. Landing pads would be constructed of washed gravel and sand mixed with Portland cement in accordance with the specification for American Society for Testing and Materials (ASTM) C150, Type I or II.

3.2.2.2 Behavioral Guidance Structure

The series of concrete anchors used to secure the BGS would likely consist of washed gravel and sand mixed with Portland cement in accordance with specification ASTM C150, Type I or II.

3.2.2.3 Surface Bypass Collectors

SBC structures would be bolted directly to the upstream concrete face of the dam. Concrete drill cuttings, similar in texture to coarse sand, would not exceed one half of a cubic foot in total material. The concrete footings would consist of washed gravel and sand mixed with Portland cement in accordance with specification for ASTM C150, Type I or II.

3.2.2.4 Sheet Pile Barge Moorage Cells

The cells would be filled with gravel that would be washed of any silts and soils prior to placement.

3.2.2.5 Barge Access Area

The barge access area would be filled with gravel that would be washed of any silts and soils prior to placement.

3.2.2.6 Pier Nose Extensions

The pier nose extensions would be cast-in-place concrete consisting of washed gravel and sand mixed with Portland cement in accordance with specification for ASTM C150, Type I or II.

3.2.2.7 Add End Bay Deflectors

The end bay deflectors would be cast-in-place concrete generally consisting of washed gravel and sand mixed with Portland cement in accordance with specification for ASTM C150, Type I or II.

3.2.2.8 Modify Existing Deflectors

The modifications would be cast-in-place concrete generally consisting of washed gravel and sand mixed with Portland cement in accordance with specification for ASTM C150, Type I or II.

3.2.2.9 Bank Stabilization

Riprap would consist of angular rock. Cement grout would consist of washed gravel and sand mixed with Portland cement in accordance with specification for ASTM C150, Type I or II.

3.2.2.10 Bypass Outfall Support Column

Concrete discharged into the interior of the support columns would consist of washed gravel and sand mixed with Portland cement in accordance with specification for ASTM C150, Type I or II.

3.3 Water Salinity, Circulation, and Fluctuation Determinations

3.3.1 Water

The Washington State classification of the lower Snake River from the confluence with the Clearwater River, Idaho, to the confluence of the Columbia River is “Class A,” meaning it is of such quality as to qualify for an “Excellent” status [Washington Administrative Code (WAC) 173-201A-030]. Waters of this class meet or exceed certain requirements for multiple uses. Class A requirements include the following:

- water shall not exceed a geometric mean of 100 fecal coliform per 100 milliliters and 10 percent of all samples shall not exceed 200 fecal coliform
- dissolved oxygen shall exceed 8 milligrams per liter (mg/L)
- temperature shall not exceed 20 degrees Celsius (°C)
- pH shall range from 6.5 to 8.5 with a human-caused variation of less than 0.5 units
- turbidity shall not exceed 5 Nephelometric Turbidity Units (NTUs) over background when less than 50 NTUs background or have no more than 10 percent increase over background when the background is higher than 50 NTUs
- concentration of toxic or deleterious material shall not be introduced into the water that has a potential to impair a characteristic use or adversely impact the most sensitive biota dependent upon these waters.

Even though Washington Department of Ecology (Ecology) has classified the water quality of the lower Snake River as excellent, they have placed it on the 303(d) list for temperature and dissolved oxygen (Ecology, 1997).

3.3.1.1 Salinity

At the simplest level, salinity is the amount of dissolved material in grams per one kilogram. This is usually a measurement of metallic or alkaline earth salts of chloride in the water. Natural seawater ranges from 3,460 ppm to 3,480 ppm of dissolved ions. The proportions of the anion (negatively charged ion) and cations (positively charged ion) remain relatively constant. Complex equations have been developed to convert the electrical information into a practical salinity scale that can then be calculated to the mass of salts in seawater. Freshwater concentration of dissolved ions and cations is generally between 100 to 200 ppm of which only about 10 percent is of chloride ion. The ionic composition of freshwaters is dominated by dilute solutions of alkalis and alkaline earth compounds, particularly bicarbonates, sulfates, and chlorides. The amount of silica acid, which occurs largely in un-disassociated form, is usually small, but occasionally they are significant in hard to very hard water.

The salinity of freshwater is best expressed as a sum of the ionic composition of the seven major cations and anions in mass or milliequivalents per liter (Clarke, 1924; Gorham, 1955). This paragraph and later paragraphs discuss specific conductivity because this entire action occurs in freshwater only. Conductivity cannot be a direct relationship to salinity in freshwater because it is not the appropriate unit of measure for the physical characteristic of salinity. Conductivity measures the ability of a compound in an aqueous solution to exhibit electrical resistance or current conductance as measured by a conductivity bridge cell that is composed of noble metal (usually platinum). In practice, Walla Walla District commonly uses YSI 6600 ugp® sondes to measure conductivity. This instrument is configured to measure many water quality parameters plus depth simultaneously. Therefore, this instrument is the primary workhorse for dredge monitoring activities.

In 1997, the average conductivity in the lower Snake River from River Mile (RM) 6 to RM 129 ranged from 68 microhms to 363 microhms (Appendix C, Water Quality). Re-suspension of sediments can put more of the major ion and cation salts into solution. This action causes an increase in salinity. Other factors such as the release of pollutants, stormwater runoff, and windblown dusts can increase salinity of a body of water. When compared to the ocean, these small changes in salinity, induced by the addition of salts, will result in minute differences when compared on the practical salinity scale. Freshwater biota not accustomed to changes in dissolved salt concentration could be negatively affected by such changes because they lack the capacity to regulate the pressure change associated with osmosis with even small increases of salinity. The Corps has some ion and cation balance data, but that data does not always include temperature, conductivity, or pH data to complement the essential analysis. Identification of baseline salinity and estimation of potential change is difficult in the absence of adequate data. Effects of the discharge of dredged and fill material upon salinity are predicted to be localized, short term, and minimal overall (low).

One YSI 6600 upg® sonde would be placed in the forebay and one YSI 6600 upg® sonde would be placed at the turbine exit of the dam to assess the accuracy of the prediction for RSWs and SBCs, as it relates to salinity. An estimated two sondes would be placed downstream, four sondes alongside, and two sondes upstream of BGSs to assess the accuracy of the prediction as it relates to salinity and the BGSs. One sonde would be placed in the forebay and 12 sondes would be placed in a grid array downstream of the pier nose extensions to assess the accuracy of the prediction as it relates to pier nose extensions. One sonde would be placed in the forebay and 12 sondes would be placed in a grid array downstream of the moorage cells and barge access area to assess the accuracy of the prediction as it relates to salinity, moorage cells, and barge access area.

Sondes would collect pH, conductivity, and depth. Backup instrumentation would be on standby at all times. Alkalinity, hardness, and calcium ion analysis would be conducted by titration (a process for determining concentration) before, during, and after construction. Flame photometry or ISE electrodes would be used to measure sodium and potassium. Sulfate ion would be measured by turbidimetric analysis and fluoride ion concentration would be measured by ISE to determine their contribution to salinity changes.

Salinity Gradients

The Practical Salinity Scale is a system for comparing the salinity strength of seawater and brackish with full-strength seawater. However, the Practical Salinity Scale is an inappropriate scale of measure in freshwater systems. The proposed actions would take place in freshwater.

In the absence of a freshwater salinity scale, analysis of ion/cation balance and specific conductivity are generally acceptable for describing quantities of dissolved salts. Unlike seawater, concentrations of salts vary between bodies of freshwater. If sufficient data are collected on individual ion/cation concentration, a correlation to conductivity may be calculated. This correlation would provide a reasonable estimate of salinity for monitoring purposes.

Dredged Material

Removable Spillway Weirs

During construction of the Lower Granite Dam prototype RSW, dredging accounted for only a few microhms of conductivity change. The change in conductivity from background to observable (ΔC) measurement was insignificant in terms of measurable environmental effect upon conductivity. Based on this, any change in conductivity resulting from the discharge of dredged material is also expected to be insignificant.

Behavioral Guidance Structures

A prototype BGS has been constructed at Lower Granite Dam. No field data on the effects of discharges associated with BGSs are available. The effects of the discharge of dredged material associated with BGSs upon salinity and conductivity are expected to be comparable to that identified above for RSWs.

Surface Bypass Collectors

No field data on the effects of discharges associated with SBCs are available. However, the effects of the discharge of dredged material associated with SBCs upon salinity and conductivity are expected to be comparable to that identified above for RSWs.

Sheet Pile Barge Moorage Cells

No field data on the effects of discharges associated with moorage cell construction are available. The effects of the discharge of dredged material associated with moorage cells upon salinity and conductivity are expected to be comparable to that identified above for RSWs. Water samples would be collected and analyzed for ions and cations before, during, and after construction to assess the accuracy of the prediction.

Barge Access Area

No field data on the effects of discharges associated with barge access area construction are available. The effects of the discharge of dredged material associated with construction of the access area upon salinity and conductivity are expected to be comparable to that identified above for RSWs. Water samples would be collected and analyzed for anions and cations before, during, and after construction to assess the accuracy of the prediction.

Pier Nose Extensions

No excavation or discharge of dredged material is anticipated.

Add End Bay Deflectors

No discharge of dredged material is anticipated.

Modify Existing Deflectors

No discharge of dredged material is anticipated.

Bank Stabilization

No excavation or discharge of dredged material is anticipated.

Bypass Outfall Support Column

Materials excavated from the interior of the tightly sealed bypass outfall support columns would be disposed in uplands.

Fill Material

Removable Spillway Weirs

Fill material would likely be pre-cast concrete. No known studies have been conducted to show measurable short-term or long-term changes to conductance in freshwater ecosystems. During construction of the Lower Granite Dam prototype RSW, no ΔC was detected in relation to significant number and instrument error or measurement bias during the short-term monitoring. Based on the results of this short-term monitoring, discharges of fill material associated with RSWs are not expected to affect conductivity.

Behavioral Guidance Structures

The effects of the discharge of fill material associated with BGSs upon conductivity are expected to be comparable to that identified above for RSWs.

Surface Bypass Collectors

The effects of the discharge of fill material associated with SBCs upon conductivity are expected to be comparable to that identified above for RSWs.

Sheet Pile Barge Moorage Cells

The fill material associated with moorage cell construction may contribute to localized short-term impacts on salinity or conductivity. The extent of the effect would be dependent upon the level of salts in the source gravel. Use of washed gravel from a local gravel source would reduce the potential for incorporation of materials having elevated levels of salts. Water samples would be collected and analyzed for anions and cations before, during, and after construction to assess the accuracy of the prediction.

Barge Access Area

The fill material associated with barge access construction may contribute to localized short-term moderate impacts on salinity or conductivity. The extent of the effect would depend on the level of salts in the source gravel. Use of local gravel sources would reduce the potential for incorporation of materials having elevated levels of salts. Water samples would be collected and analyzed for anions and cations before, during, and after construction to assess the accuracy of the prediction.

Pier Nose Extensions
The discharge of cast-in-place concrete fill material would impact salinity if wet concrete comes in contact with or is released into the water. No specific testing of the effects of wet concrete on regional water types has been conducted. Because of the chemical composition of the concrete, significant amounts of anions and cations could be released into the water. In terms of uncertainty and risk, there would be no impact if there were no release. The work would occur in an area dewatered by a temporary bulkhead. This design would minimize the risk of releasing wet concrete into the water. Water samples would be collected and analyzed for ions and conductivity before, during, and after construction to identify effects of accidental releases of wet concrete into the water column and to identify remedial actions.

Add End Bay Deflectors
The effects of the discharge of fill material upon salinity and conductivity are expected to be comparable to that identified above for pier nose extensions.

Modify Existing Deflectors
The effects of the discharge of fill material upon salinity and conductivity are expected to be comparable to that identified above for pier nose extensions.

Bank Stabilization
The effects of the discharge of fill material upon salinity and conductivity are expected to be comparable to that identified above for pier nose extensions.

Bypass Outfall Support Column
The effects of the discharge of fill material upon salinity and conductivity are expected to be comparable to that identified above for pier nose extensions.

3.3.1.2 Water Chemistry
Some of the best data available on Snake River water chemistry are from the USGS in Pasco, Washington. The USGS collected the data near Burbank, Washington, but this station was discontinued in the mid 1990s. Tables 3-1 through 3-7 contain water quality information from the USGS, Station No. 13353200, Snake River at Burbank, Washington and demonstrate previous water chemistries through mid-1990. Little changes in water chemistry are expected to result from construction of RSWs, BGSs, and SBCs. Water chemistry analysis was previously conducted in association with construction of the prototype RSW at Lower Granite. The analysis revealed no measurable change in water chemistry. Possible changes in water chemistry are expected for the pier nose extensions. Measurable water chemistry changes would likely occur in association with construction of the moorage cells and barge access area. Changes are expected to be localized and of short duration. In order to minimize impacts to water chemistry, efforts would be made to control the amount and duration of discharge, minimize discharges, and perform work in the winter months. Water samples would be collected and analyzed for changes in water chemistry before, during, and after construction of the RSWs, BGSs, SBCs, pier nose extensions, moorage cells, and barge access area to assess accuracy of the associated predictions.

3.3.1.3 Clarity

In 1997, Secchi disks and underwater irradiameters were used to determine the transparency of the water and the photic zone. From river mile 6 to river mile 140, the average Secchi transparency ranged from 1.1 to 2.5 meters and the photic zones ranged 3.3 to 5.5 meters (FR/EIS, Appendix C, Water Quality). Some correlation was suggested based on concentrations of total suspended solids (TSS); however, water clarity is frequently useless as a measurement to determine effects to the environment during and after dredge or fill actions. The Secchi disk, while useful during limnological sampling between March and October, only provides a gross estimate of photic zone that could later be loosely correlated to clarity. In freshwaters, clarity is generally important to the study of algal community structure. Eutrophication effects can be related somewhat to water clarity, but effects from this parameter are most commonly measurable as a secondary effect many months later.

For the purpose of the proposed actions, it is expected that initial effects upon clarity would be minor. Water samples would be collected and analyzed for clarity before, during, and after construction of RSWs, BGSs, pier nose extensions, barge moorage cells, and barge access area to assess accuracy of the prediction.

3.3.1.4 Color

Color in water may result from the presence of natural metallic ions (iron and manganese are the most common colorants in natural water), humus (decaying organic material), plankton, weeds, and wastes. Excessive color affects both domestic and commercial uses and may require removal. Water color means the true and apparent color by a chroma analysis and is measured only after all turbidity is removed. A high resolution (upper end) scanning spectrophotometer or tintometer is required to measure true and apparent color. Color values and subsequent changes due to human activities may suggest changes to aesthetic qualities of the surface waters and should not be totally discounted.

Actual true and apparent color is poorly understood in the Snake River Basin. Potential impacts upon color are expected to be minimal. Water samples would be collected and analyzed for color before, during, and after construction of RSWs, BGSs, pier nose extensions, barge moorage cells, and barge access area to assess the accuracy of the prediction.

Appendix T

Table 3-1. Physical Parameters for USGS Water Quality Data, Station No. 13353200, Snake River at Burbank, Washington (Water Year October 1997 to September 1998)

Date	Specific Conductance (µs/cm) (00095)	pH Water Whole Field (Standard Units) (00400)	Temperature Water (°C) (00010)	Turbidity (NTU) (00076)	Oxygen, Dissolved (mg/L) (00300)	Oxygen, Dissolved (% Saturation) (00301)	Hardness Total (mg/L as $CaCO_3$) (00900)	Hardness Noncarb Dissolved Fld as $CaCO_3$ (mg/L) (00904)	Calcium, Dissolved (mg/L as Ca) (00915)	Magnesium, Dissolved (mg/L as Mg) (00925)
Oct. 29, 1997	350	8.1	14.0	1.4	11.4	112	120	3	31	10.0
Dec. 10, 1997	267	8.0	7.0	2.1	11.4	92	89	–	23	7.6
Jan. 28, 1998	339	8.1	4.0	12.0	12.5	96	110	–	29	10.0
Mar. 4, 1998	340	8.2	5.5	2.6	12.8	102	120	8	31	10.0
Apr. 8, 1998	204	8.1	9.0	6.7	12.4	107	72	3	19	6.1
May 7, 1998	156	7.9	14.0	2.9	11.2	110	54	3	15	4.4
May 27, 1998	154	7.8	12.5	7.4	12.6	120	54	–	14	4.5
May 19, 1998	154	7.8	12.5	21.0	12.8	122	53	–	14	4.4
June 22, 1998	146	8.0	17.0	4.1	10.8	113	53	0	15	4.1
July 6, 1998	127	7.8	18.0	4.6	10.2	109	45	–	13	3.3
Aug. 12, 1998	151	7.9	22.5	2.4	9.4	109	53	–	14	4.2
Sept. 3, 1998	174	7.8	22.0	2.4	7.9	92	60	–	16	4.9
Sept. 28, 1998	258	8.0	20.5	1.4	7.7	87	82	–	21	7.0

µs/cm = microsiemens per centimeter
°C = degrees celcius
NTU = Nephelometric Turbidity Unit
mg/L = milligram per liter
$CaCO_3$ = calcium carbonate
Mg = magnesium
Source: USGS, Water Resources Data, Washington. 1998. Report No. WA-98-1.

Appendix T

Table 3-2. Anions and Cations for USGS Water Quality Data, Station No. 13353200, Snake River at Burbank, Washington (Water Year October 1997 to September 1998)

Date	Sodium, Dissolved (mg/L as Na) (00930)	Potassium, Dissolved (mg/L as K) (00935)	Bicarbonate Water Dissolved IT Field mg/L as HCO_3 (00453)	Carbonate Water Dissolved IT Field mg/L as CO_3 (00452)	Alkalinity Water Dissolved Total IT Field mg/L as $CaCO_3$ (39086)	Sulfate Dissolved (mg/L as SO_4) (00945)	Chloride, Dissolved (mg/L as Cl) (00940)	Fluoride, Dissolved (mg/L as F) (00950)	Silica, Dissolved (mg/L as SiO_2) (00955)	Solids, Residue at 180°C Dissolved (mg/L) (70300)
Oct. 29, 1997	21.0	2.9	145	0	119	31.0	12.0	.5	17	211
Dec. 10, 1997	15.0	2.3	109	0	89	21.0	8.8	.4	16	163
Jan. 28, 1998	19.0	2.9	140	0	115	29.0	13.0	.4	19	214
Mar. 4, 1998	20.0	2.7	135	0	111	28.0	12.0	.5	21	199
Apr. 8, 1998	12.0	1.9	84	0	69	15.0	6.8	.3	19	130
May 7, 1998	8.2	1.3	63	0	52	11.0	4.8	.3	15	102
May 27, 1998	8.9	1.7	70	0	57	11.0	4.7	.2	15	101
May 29, 1998	8.8	1.7	67	0	55	11.0	4.6	.2	17	105
June 22, 1998	7.8	1.4	65	0	53	10.0	3.8	.2	13	98
July 6, 1998	6.4	1.3	57	0	47	8.3	3.2	.2	12	88
Aug. 12, 1998	8.6	1.8	66	0	54	11.0	4.4	.3	12	86
Sept. 3, 1998	11.0	1.9	78	0	64	14.0	5.0	.3	13	112
Sept. 28, 1998	18.0	2.8	105	0	86	22.0	8.2	.3	13	161

mg/L = milligrams per liter
NA = sodium
K = potassium
HCO_3 = hydrogen carbonate
CO_3 = carbonate
Ca CO_3 = calcium carbonate
F = fluoride
SiO_2 = silica oxide
°C = degrees celsius
Source: USGS, Water Resources Data, Washington. 1998. Report No. WA-98-1.

Appendix T

Table 3-3. Nutrients for USGS Water Quality Data, Station No. 13353200, Snake River at Burbank, Washington (Water Year October 1997 to September 1998)

Date	Nitrogen, Nitrite Dissolved (mg/L as N) (00613)	Nitrogen, $NO_2 + NO_3$ Dissolved (mg/L as N) (00631)	Nitrogen, Ammonia Dissolved (mg/L as N) (00608)	Nitrogen, Ammonia + Organic Total (mg/L as N) (00625)	Nitrogen, Ammonia + Organic Dissolved (mg/L as N) (00623)	Phosphorus Total (mg/L as P) (00665)	Phosphorus, Dissolved (mg/L as P) (00666)	Phosphorus Ortho, Dissolved (mg/L as P) (00671)	Aluminum, Dissolved (µg/L as Al) (01106)
Oct. 29, 1997	.005	.69	.011	.2	.2	.07	.04	.049	1
Dec. 10, 1997	.004	.58	.010	.1	.1	.03	.02	.034	2
Jan. 28, 1998	.008	1.0	.027	.3	.1	.07	.04	.038	4
Mar. 4, 1998	.005	.99	<.002	.2	.1	.04	.03	.036	3
Apr. 8, 1998	.005	.39	.017	.3	.1	.07	.04	.030	4
May 7, 1998	.004	.22	.006	.2	.1	.03	.01	.015	4
May 27, 1998	.010	.26	.023	.2	.1	.06	.04	.023	5
May 29, 1998	.015	.32	.018	.2	.1	.10	.03	.035	10
June 22, 1998	.003	.14	<.002	.2	<.1	.03	.02	.016	6
July 6, 1998	.002	.11	<.002	.2	<.1	.04	<.01	.016	16
Aug. 12, 1998	.006	.10	.008	.2	.1	.02	.01	.012	2
Sept. 3, 1998	.007	.17	.004	.1	.1	.03	.02	.016	2
Sept. 28, 1998	.005	.28	.003	.2	.2	.05	.06	.028	2

Note: < Actual value is known to be less than the value shown.
mg/L = milligram per liter
N = nitrogen
NO_2 = nitrogen dioxide
NO_3 = nitrate
P = phosphorus
Al = aluminum
µg/L = microgram per liter
Source: USGS, Water Resources Data, Washington. 1998. Report No. WA-98-1.

Appendix T

Table 3-4. Metals for USGS Water Quality Data, Station No. 13353200, Snake River at Burbank, Washington (Water Year October 1997 to September 1998)

Date	Arsenic, Dissolved (µg/L as As) (01000)	Barium, Dissolved (µg/L as Ba) (01005)	Boron, Dissolved (µg/L as B) (01020)	Chromium, Dissolved (µg/L as Cr) (01030)	Copper, Dissolved (µg/L as Cu) (01040)	Iron, Dissolved (µg/L as Fe) (01046)	Lithium, Dissolved (µg/L as Li) (01130)
Oct. 29, 1997	4	31	50.4	2	1	<3	17
Dec. 10, 1997	2	25	36.2	<1	2	<10	10
Jan. 28, 1998	3	33	45.3	3	5	<10	15
Mar. 4, 1998	3	32	46.5	3	7	<10	18
Apr. 8, 1998	2	20	29.7	<1	2	15	10
May 7, 1998	2	17	22.0	<1	1	11	8
May 27, 1998	1	17	24.0	<1	2	<10	7
May 29, 1998	1	17	<16.0	1	2	18	6
June 22, 1998	1	15	18.2	<1	5	<10	6
July 6, 1998	<1	15	<16.0	<1	2	22	7
Aug. 12, 1998	<1	18	<16.0	<1	<1	<10	8
Sept. 3, 1998	2	20	23.3	<1	<1	<10	7
Sept. 28, 1998	3	26	36.5	<1	<1	<10	11

Note: < Actual value is known to be less than the value shown.
µg/L = microgram per liter
As = arsenic
Ba = barium
B = boron
Cr = chromium
Cu = copper
Fe = iron
Li = lithium
Source: USGS, Water Resources Data, Washington. 1998. Report No. WA-98-1.

Table 3-5. Metals and Organic Carbon for USGS Water Quality Data, Station No. 13353200, Snake River at Burbank, Washington (Water Year October 1997 to September 1998)

Date	Molybdenum, Dissolved (µg/L as Mo) (01060)	Strontium, Dissolved (µg/L as Sr) (01080)	Vanadium, Dissolved (µg/L as V) (01085)	Uranium, Natural Dissolved (µg/L as U) (22703)	Carbon, Organic Dissolved (mg/L as C) (00681)	Alachlor, Water, Dissolved (µg/L) (46342)
Oct. 29, 1997	2	180	7	3	2.1	<.002
Dec. 10, 1997	1	140	<6	2	3.2	<.002
Jan. 28, 1998	2	170	<10	2	2.0	<.002
Mar. 4, 1998	2	170	<10	2	1.9	<.002
Mar. 8, 1998	1	110	<10	1	2.7	<.002
May 7, 1998	<1	86	<10	<1	2.4	<.002
May 27, 1998	1	90	<10	<1	2.5	.005
May 29, 1998	1	87	<10	<1	2.9	.005
June 22, 1998	<1	92	<10	<1	2.2	<.002
July 6, 1998	<1	78	<10	<1	2.4	<.002
Aug. 12, 1998	1	92	<10	<1	1.6	<.002
Sept. 3, 1998	1	100	<10	<1	1.9	<.002
Sept. 28, 1998	2	140	<10	2	1.9	<.002

Note: < Actual value is known to be less than the value shown.
µg/L = microgram per liter
Mo = molybdenum
Sr = strontium
V = vanadium
U = uranium
C = carbon
Source: USGS, Water Resources Data, Washington. 1998. Report No. WA-98-1.

Table 3-6. Pesticides for USGS Water Quality Data, Station No. 13353200, Snake River at Burbank, Washington (Water Year October 1997 to September 1998)

Date	Diethyl Atrazine Water Dissolved (µg/L) (04040)	Atrazine Water Dissolved (µg/L) (39632)	DCPA Water Filtered 0.7 µ GF (µg/L) (82682)	P,P' DDE Dissolved (µg/L) (34653)	EPTC Water Filtered 0.7 µ GF (µg/L) (82668)	Metolachlor Water Dissolved (µg/L) (39415)	Metribuzin Sencor Water Dissolved (µg/L) (82630)
Oct. 29, 1997	E.008	.008	E.001	<.006	<.002	.005	<.004
Dec. 10, 1997	E.005	.006	<.002	<.006	<.002	<.002	<.004
Jan. 28, 1998	E.006	<.008	<.002	<.006	<.002	<.002	<.004
Mar. 4, 1998	E.005	.005	<.002	<.006	<.002	<.002	<.004
Apr. 8, 1998	E.002	<.001	<.002	<.006	<.002	<.002	<.004
May 7, 1998	E.002	E.003	<.002	<.006	E.003	<.002	<.004
May 27, 1998	E.003	.007	E.002	<.006	.010	.006	.010
May 29, 1998	<.002	.004	E.002	E.0003	.006	.005	.009
June 22, 1998	<.002	<.001	E.002	<.006	.006	.008	<.004
July 6, 1998	<.002	<.001	<.002	<.006	.010	.004	<.004
Aug. 12, 1998	<.002	<.005	<.002	<.006	<.002	.005	<.004
Sept. 3, 1998	E.004	.006	<.002	<.006	E.003	.007	<.004
Sept. 28, 1998	E.004	.005	E.001	<.006	<.002	.007	<.004

Note: < Actual value is known to be less than the value shown.
E = Estimated
µg/L = microgram per liter
GF = glass filter
Source: USGS, Water Resources Data, Washington. 1998. Report No. WA-98-1.

Table 3-7. Pesticides and Sediment Load for USGS Water Quality Data. Station No. 13353200, Snake River at Burbank, Washington (Water Year October 1997 to September 1998)

Date	Simazine Water Dissolved (µg/L) (04035)	Terbacil Water Filtered 0.7 µ GF (µg/L) (82665)	Triallate Water Filtered 0.7 µ GF (µg/L) (82678)	Sediment, Suspended (mg/L) (80154)
Oct. 29, 1997	<.005	E.006	<.001	4
Dec. 10, 1998	<.005	<.007	E.002	4
Jan. 28, 1998	<.005	<.007	.008	24
Mar. 4, 1998	<.005	<.007	<.001	4
Apr. 8, 1998	<.005	<.007	<.001	10
May 7, 1998	<.005	<.007	<.001	11
May 27, 1998	E.003	E.005	E.004	27
May 29, 1998	<.005	<.007	.010	45
June 22, 1998	<.005	<.007	<.001	13
July 6, 1998	<.005	<.007	<.001	12
Aug. 12, 1998	<.005	<.007	<.001	5
Sept. 3, 1998	<.005	<.007	<.001	4
Sept. 28, 1998	<.005	<.007	<.001	6

Note: < Actual value is known to be less than the value shown.
E = Estimated
µg/L = microgram per liter
GF = glass filter
mg/L = milligram per liter
Source: USGS, Water Resources Data, Washington. 1998. Report No. WA-98-1.

3.3.1.5 Odor

Both the Standard Methods Committee and the American Society for Testing and Materials (ASTM) have controlled odor threshold tests. The Corps has not previously conducted any standardized odor tests on the Snake River; therefore, no prior data is available. During installation of the prototype RSW at Lower Granite Dam in Fiscal Year 2001, no detectable odor was present in water sampled for turbidity.

No changes in odor are anticipated in association with the project. Any unusual odors detected during construction would be investigated.

3.3.1.6 Taste

No ASTM or Standard Method approved taste test data is available. Any potential changes in taste would likely occur as a result of re-suspension of metals. Due to the limited discharge of dredged and fill material, any change in taste would likely be very localized and of short duration.

3.3.1.7 Dissolved Gas Levels

Dissolved gas supersaturation has been one of the major water quality concerns in the Snake River and Columbia River Basins since the late 1960s. Dissolved gas supersaturation is caused when water passing through a dam's spillway carries trapped air deep into the waters of the plunge pool, increasing pressure and causing the air to dissolve into the water. Most spillway discharges affecting dissolved gas levels occur during spring runoff between the months of March and June. The proposed dredged and fill material discharges would occur during the in-water work window of December 15 through March 1. None of the proposed dredged or fill material discharge activities would require the spilling of water; therefore, the discharges would not produce increased levels of total dissolved gas (TDG).

3.3.1.8 Temperature

Based on gas monitoring temperature data collected during 1998 through 2000, the median temperature in the months of December to March ranges from 2°C (35.6°F) to 7°C (44.6°F). Most of the construction would take place when water temperatures are around 4°C (39.2°F) or 5°C (41°F). The proposed actions are not expected to directly or indirectly cause any water temperature change.

3.3.1.9 Nutrients

Nitrogen

Based on 1997 limnological data used in the FR/EIS, the dominant species of nitrogen in the Snake River System are soluble nitrate and nitrite (the measurement is combined when analyzed by cadmium reduction methodology). The portion of nitrite is small because of the well-oxygenated waters. Nitrite is an intermediate oxidation state of nitrogen, both in the oxidation of ammonia to nitrate and in the reduction of nitrate. In the sediments, denitrification occurs as a result of bacterial decomposition of the nitrate ion. This occurs in a state of anoxia.

The nitrification and denitrification process in the Snake River sediments is not well understood. The sediments contain high amounts of ammonia (60 to 80 ppm), but it is not fully understood how the nitrogen cycle works in the Snake River forebays. No information is available concerning sediment oxygen demand. The lower Snake River had average water nitrate/nitrite levels from 0.13 to 0.35 mg/L of (NO_2 + NO_3). Total water nitrogen levels in the lower Snake River ranged from 0.31 to 0.65 mg/L (total-N). The water ammonia levels were near instrument detection limits in some cases or below detection limit (0.007 mg/L N as NH_3). These readings generally indicate nutrients levels are below those typically associated with eutrophic conditions. Water quality data have not been collected during storm events or periods of high flow (spring runoff). It is possible the introduction of large amounts of nitrogen containing nutrients occurs during high flow events. The discharge of dredged material has the potential to increase nutrient levels, which could lead to eutrophic conditions. However, because the discharges would be conducted during winter months and during months of low productivity, any impacts resulting from increased nutrient levels are expected to be localized and of short duration. Water samples would be collected and analyzed for organic nitrogen before, during, and after construction of RSWs, BGSs, pier nose extensions, barge moorage cells, and barge access area to assess accuracy of the prediction.

Phosphorus

The 1997 limnological data identified total phosphorus (TP) as the dominant species. The TP values in the lower Snake River ranged from 0.036 mg /L to 0.067 mg/L TP as phosphate. The ortho-phosphate (ortho-P) in the lower Snake River ranged from 0.013 mg/L to 0.023 mg/L ortho-P as phosphate. Phosphate is essential for plant growth and, when present with other nutrients in abundance, leads to substantial increases in algae growth. When this occurs, deleterious effects from nuisance blooms of blue-green algae increase. Large mats of floating biological material characterize these blooms of blue-green algae. The lower Snake River water quality has degraded significantly by increased nutrient loading since 1974 (Greene, 1995). Greene (1995) determined growth potentials in 1995 Snake River samples were so large that test algae could not reach nitrogen or phosphorus limitation without the assistance of ethylendiamine tetraacetic acid disodium salt (EDTA). No samples from high-flow periods during spring runoff have been analyzed. It is possible that a majority of the phosphorus loading occurs during this time. Concentrations of phosphorus in lower Snake River sediments range from 34 to 38 ppm. Very little is understood about the phosphorus budget of the lower Snake River reservoirs. The discharge of dredged material has the potential to release phosphorus into the water column. Any impacts resulting from increased phosphorus levels are expected to be localized and of short duration because the discharges would be conducted during winter months and during months of low productivity. Small releases of phosphorus should not pose a problem. Water samples would be collected and analyzed for phosphorus parameters before, during, and after construction of RSWs, BGSs, pier nose extensions, barge moorage cells, and barge access area to assess the accuracy of the predictions. Results would be compared and a determination of actual impacts upon phosphorous concentrations would be documented.

Anions and Cations

The most recent ion data for the lower Snake River are 3 years old. The effects of the discharge of dredged and fill material upon anions and cations are expected to be minor and would not deplete concentrations of anions and cations necessary for healthy biota. Water samples would be collected and analyzed for ions before, during, and after construction of RSWs, BGSs, pier nose extensions, barge moorage cells, and barge access area to assess the accuracy of the prediction.

3.3.1.10 Eutrophication

Eutrophic conditions occur when high levels of nutrients occur in conjunction with long photoperiods, greater retention time, and optimal algae growing conditions. These conditions result in massive blooms of algae sometimes considered a nuisance. During these conditions, oxygen is depleted in the lower portions of the water column and releases of undesirable chemical constituents affect aesthetics and quality of the aquatic habitat.

During the winter months, when this action would take place, eutrophic conditions would not be produced due to insufficient light energy and heat budget.

3.3.1.11 Other Effects

There would be some effects caused by re-suspension of nutrient-laden sediment. This is especially a problem in the case of ammonium because of the ammonia-rich sediments and alkaline pH of the water. No data have been collected from the Snake River on ammonia concentrations in the water column in association with the discharge of dredged material. Elutriate tests conducted in 1997 for the FR/EIS revealed an average of 3 ppm of ammonia due to re-suspension of sediment (Appendix C, Water Quality). This generally indicates re-suspension of ammonia is a year-round concern.

Ammonia would likely be dissolved into the water column with re-suspension of sediments. Effects typically occur less frequently during the winter months; therefore, impacts would likely be minimal. Sediment samples would be collected and analyzed for ammonia before, during, and after construction of RSWs, BGSs, barge moorage cells, and barge access areas to assess accuracy of the prediction. If unionized ammonia exceeds state and Federal limits, work suspension or other actions would be taken to minimize the impacts.

3.3.2 Current Patterns and Circulation

3.3.2.1 Current Pattern and Flow

Removable Spillway Weirs

An RSW passes water through the spillway from a higher elevation in the water column or closer to the surface than the water currently passed from a lower elevation by existing tainter gates. Construction of the RSW is intended to direct the movement of juvenile fish and improve their passage through the lower Snake River dams. Minor changes in flow patterns would occur in the immediate vicinity of an RSW. Overall, no more than a negligible localized effect is expected to occur upon current pattern and flow of the Snake River.

Behavioral Guidance Structures

Changes in flow and current pattern have the potential to affect use of the affected area by aquatic invertebrates and lower food chain organisms. BGSs are expected to have the potential for measurable changes in flow and current. No data on flow and current changes resulting from a BGS are currently available. Flow and current pattern changes resulting from a BGS are expected to be minor and localized. Effects of using the affected area are expected to be minor for both aquatic invertebrates and lower food chain organisms.

Surface Bypass Collectors

SBCs are designed to produce noticeable and desirable changes in flow and current patterns. The changed flow and current patterns attract target species for surface bypass. The effects of these currents have been extensively measured at Lower Granite Dam. The effects to fish from the prototype surface collection system installed at Lower Granite Dam are addressed by Normandeau (2000), and detailed current and flow patterns are described in the Lower Granite Hydroacoustic Evaluation of the Prototype SBC (Corps, 2000). In summary, alterations of flows were found to be very minor, yet beneficial to attracting anadromous fish. Future installations of SBCs would have similar effects upon current pattern and flow.

Sheet Pile Barge Moorage Cells

Moorage cells would be constructed in a low-velocity backwater eddy. This slough-like area is an effect of the pool and is not considered an area that has a large-scale effect upon current and flow patterns of the

Snake River. Placement of individual cells would likely have small-scale effects upon flow patterns and would likely produce measurable changes to flow and current regimes. Effects of small-scale changes in flow and current regimes upon habitat are also expected to be small.

Pier Nose Extensions

Pier nose extensions produce measurable changes in current pattern and flow. An extended pier nose minimizes mixing of water from adjacent spillbays in the vicinity of spillway deflectors. The resulting desired changes in flow and current patterns are locally significant, providing beneficial effects through a reduced potential for elevated TDG levels.

Add End Bay Deflectors

Deflectors cause measurable changes in current pattern and flow by producing a thin discharge jet of water that skims the water surface of the stilling basin. The skimming jet of water prevents the spillway discharge from plunging and entraining air deep into the stilling basin. The resulting desired changes in current pattern and flow are locally significant, providing beneficial effects through a reduced potential for elevated TDG levels.

Modify Existing Deflectors

The existing deflectors would be modified to provide optimal performance based on tailwater elevations and spill discharge parameters of the current voluntary spill program. Effects upon current pattern and flow would be comparable to those identified immediately above for the addition of end bay deflectors.

Bank Stabilization

Placement of riprap and grout would have no more than a negligible effect upon current patterns and circulation.

Bypass Outfall Support Columns

Placement of support columns would likely have small-scale effects upon flow patterns and produce measurable changes to flow and current regimes. Effects of small-scale changes in flow and current regimes upon habitat are expected to be small.

3.3.2.2 Velocity

The discharges of dredged and fill material associated with the recommended plan (preferred alternative) are expected to have no more than a negligible effect upon velocity.

Removable Spillway Weirs

A prototype RSW is currently under construction at Lower Granite Dam. Field data on velocity change resulting from an RSW is not available. Absent an analysis of field data, effects from an RSW upon velocity are expected to be minor and localized.

Behavioral Guidance Structures

A prototype BGS has been constructed at Lower Granite Dam. No field data on the effects of a BGS upon velocity have been collected. Effects of the discharge of fill material are expected to have no more than a negligible effect upon velocity.

Surface Bypass Collectors

No field data on the effects of the prototype SBC at Lower Granite Dam upon velocity have been collected. SBCs are designed to produce noticeable and desirable changes in flow and current patterns within the immediate vicinity of the installation site; however, SBCs are not designed to produce noticeable changes in velocity. Any such changes in the overall velocity of the Snake River are expected to be insignificant and non-measurable.

Sheet Pile Barge Moorage Cells

There is very little measurable current under most conditions in this slackwater area. Acquisition of velocity readings would be difficult due to the slackwater nature of the site. Effects of moorage cells upon velocity are expected to be negligible.

Pier Nose Extensions

The pier nose extensions would produce localized measurable changes in current pattern, but it probably would not affect velocity. Changes in velocity are not expected to be measurable outside of the localized area.

Add End Bay Deflectors

Deflectors would likely produce measurable changes in current pattern, but it probably would not affect velocity. Changes in velocity are not expected to be measurable outside of the localized area.

Modify Existing Deflectors

As previously indicated, the deflectors would be modified to perform optimally under tailwater elevations and spill discharge parameters of the current voluntary spill program. The modified deflectors would continue to produce a skimming flow similar to that produced by the deflectors prior to modification. Changes in current pattern would likely be more prominent than changes in velocity. Resulting changes in velocity are expected to be minor and localized.

Bank Stabilization

Placement of riprap and cement grout should have no recognizable effect upon velocity.

Bypass Outfall Support Columns

Effects of bypass outfall support columns upon velocity are expected to be negligible.

3.3.2.3 Gradient

Stratification in the lower Snake River does not occur because the Lower Snake River Project features run-of-river dams. However, the gradient, in regards to classic eutrophication, is directly caused by a reduction in flow, an increase in retention time, and an increase in ambient temperature. The nutrient-rich sediments release the constituents that are required for plant development, stimulating phytoplankton growth. This growth enhances oxygen depletion and thermal gradient. Conditions are not expected to be conducive to development of eutrophic conditions during construction.

3.3.2.4 Hydrologic Regime

The discharges of dredged and fill material associated with construction of the RSWs, BGSs, SBCs, moorage cells, barge access area, and pier nose extensions would not alter the hydrologic regime. Changes in hydrologic regime are most likely to occur in response to changing weather patterns or changes in the overall management of flows within the lower Snake River System.

3.3.3 Normal Water Fluctuations

The discharges of dredged and fill material associated with the RSWs, BGSs, SBCs, moorage cells, barge access area, and pier nose extensions are expected to have no measurable effect upon normal water fluctuations.

3.3.4 Actions that Would Be Taken to Minimize Impacts

One YSI 6600 upg® sonde would be placed in the forebay, and one YSI 6600 upg® would be placed at the turbine exit of the dam to assess the accuracy of the predicted impacts regarding salinity for RSWs and SBCs. An estimated two sondes would be placed downstream, four sondes alongside, and two sondes upstream of the BGSs to assess the accuracy of the prediction as it relates to salinity and the BGSs. One sonde would be placed in the forebay and 12 sondes would be placed in a grid array downstream of the pier nose extensions to assess the accuracy of the prediction as it relates to pier nose extensions. One sonde would be placed in the forebay, and 12 sondes would be placed in a grid array downstream of the moorage cells and the barge access area to assess the accuracy of the prediction as it relates to salinity, the moorage cells, and the barge access area. Sondes would collect pH, conductivity, and depth. Backup instrumentation would be on standby at all times. Alkalinity, hardness, and calcium ion analyses would be conducted by titration before, during, and after construction. Flame photometry or ISE electrodes would be used to measure sodium and potassium. Sulfate ion would be measured by turbidimetric analysis and fluoride ion concentration would be measured by ISE to determine their contribution to salinity changes.

Water samples would be collected and analyzed for ions and cations before, during, and after construction of moorage cells and the barge access area to assess the accuracy of the predicted impact upon salinity.

Washed gravel, used as fill material in construction of moorage cells and the barge access area, would be obtained from a local gravel source to reduce the potential for incorporation of materials with elevated levels of salts. This approach would minimize potential impacts to salinity and conductivity.

Water samples would be collected and analyzed for ions and conductivity before, during, and after construction of pier nose extensions, and deflector additions and modifications to identify effects of accidental releases of wet concrete into the water column and to identify remedial actions.

Controlling the amount and duration of discharge, minimizing discharges, and performing work in the winter months would help minimize impacts to water chemistry. Water samples would be collected and analyzed for changes in water chemistry before, during, and after construction of the RSWs, BGSs, SBCs, pier nose extensions, deflector additions and modifications, moorage cells, and barge access area to assess accuracy of the associated predicted impacts.

Water samples would be collected and analyzed for clarity, color, organic nitrogen, phosphorus parameters, and ions before, during, and after construction of RSWs, BGSs, pier nose extensions, deflector additions and modifications, barge moorage cells, and barge access area to assess accuracy of the predicted impact.

Sediment samples would be collected and analyzed for ammonia before, during, and after construction of RSWs, BGSs, SBCs, pier nose extensions, barge moorage cells, and barge access area to assess accuracy of the predicted impact.

3.4 Suspended Particulate/Turbidity Determinations

A colloidal or suspended matter composition of very fine organic and inorganic matter, clays, microorganisms, and plankton causes turbidity in water. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted with no change or flux level through the sample. The standard unit of measurement is the NTU, which references the instrument calibrated to measure the property using a standardized hydrazine sulfate/hexamethylenetetramine suspension (APHA, 1998). Correlation of turbidity with the mass or particle number concentration of suspended matter is problematic due to differences in size, shape, and refractive indices affecting the light scattering of a suspension. The cause-and-effect relationship to the aquatic environment is a direct effect of suspended sediment loads blocking light and, in some cases, altering the specific gravity of the water when the total dissolved solids fraction increases.

The non-scientist often confuses turbidity with the particle mass density measurement called TSS. Suspended particle or sediment load is composed of fine particles consisting primarily of inorganic materials of sufficient size and mass to settle quickly when kinetic energy (flow) decreases enough for the mass of the particle to fall out of suspension. The literature suggests there are direct correlations between suspended sediment load and fish feeding. Lloyd (1985) lists several studies spanning three decades where increased sediment load resulted in decreases of salmonid feeding. Noggle (1978) looked at the physiological effects to gill tissue in salmon exposed to high loads of suspended sediment. Most of the conclusions were that the fish only had damaged gills when extreme quantities of sediment were suspended in test waters. He also concluded that feeding was most affected in the moderate and lower levels of suspended particles and turbidity.

The use of mixing zones in monitoring and enforcement of sediment and turbidity standards seeks to accommodate the temporal suspension effects of larger size particles. While a single relationship between turbidity measurements and suspended sediment concentration may not be extremely accurate for the wide diversity of streams and rivers, the impacts caused by levels of the suspended particles can often occur with an increase in turbidity. The practicality of rapid measurement of suspended sediment quantity by drying at constant temperature followed by precision weighing is difficult at best. The ease and accuracy for which turbidity can be measured in the field has prompted many regulators to develop turbidity criteria instead of suspended sediment criteria.

Turbidity measurements collected after installation of a prototype RSW at Lower Granite Dam demonstrated little measurable effect to the river system. The mean turbidity for this project was within the parameters of the 401 Certification during the construction activities. The particle size determinations, as mentioned earlier, showed most of this area to be primarily silt.

3.4.1 Expected Changes in Suspended Particulate and Turbidity Levels in the Vicinity of the Site

A short-term increase in turbidity would likely occur in the immediate area of the proposed actions. For the RSWs, BGSs, and SBCs, there would likely be very small increases in turbidity caused from the dredged material discharge and the placement of the pre-cast concrete fill material. These three actions would require a small dilution zone. Once the water from these upstream actions enters the powerhouse turbines, the mixing of the powerhouse flow would likely only produce minor turbidity increases downstream.

One YSI 6600 upg® sonde would be placed in the forebay and one YSI 6600 upg® sonde would be placed at the turbine exit of the dam to assess the accuracy of the prediction for RSWs and SBCs, as it relates to turbidity. An estimated two sondes would be placed downstream, four sondes alongside, and two sondes upstream of BGSs to assess the accuracy of the prediction as it relates to turbidity and the BGSs. One sonde would be placed in the forebay and 12 sondes would be placed in a grid array downstream of the pier nose extensions to assess the accuracy of the prediction as it relates to pier nose extensions. One sonde would be placed in the forebay, and 12 sondes would be placed in a grid array downstream of the moorage cells and barge access area to assess the accuracy of the prediction as it relates to turbidity, moorage cells, and barge access area.

Sondes would collect turbidity and depth 24 hours per day, 7 days per week. Backup instrumentation would be on standby at all times. Secondary readings would be taken using a Hach 2100 P nephelometer for quality assurance/quality control (QA/QC). The data would be provided to Ecology, if requested.

Provided there is no release of wet concrete into the water outside of the tightly sealed forms, no measurable turbidity is expected to be produced by the installation of the spillway pier nose extensions, the additions and modifications of the deflectors, and the bypass outfall support columns. The tightly sealed forms would be dewatered prior to the discharge of concrete by pumping the water out and into the Snake River. Minor releases of wet concrete into the water located within the area dewatered by the bulkhead may occur incidentally. During and following the discharge of concrete, the area behind the bulkhead would be dewatered by pumping the water out for upland disposal. Effects of the potential incidental releases are predicted to be negligible. Turbidity would be monitored during construction of pier nose extensions to assess the accuracy of this prediction. Monitors would be placed downstream of bulkheads used to dewater pier nose extension construction sites. Readings would be routinely collected for use in assessing impacts and identifying work methods for minimizing potential impacts. If, during discharge activity, turbidity levels at the monitoring site exceed 5 NTUs over background turbidity when the background turbidity is 50 NTUs or less; or, if turbidity levels at the monitoring site increase by more than 10 percent when the background turbidity is more than 50 NTUs, discharge activity would temporarily cease until turbidity levels at the monitoring site returned to levels within these limits.

The discharge of substrate material excavated from within the interior of the moorage cells into the water would increase turbidity levels above background. This discharge of dredged material has the potential to cause minor to major turbidity increases. Washed gravel would be discharged into the constructed moorage cell. This discharge of gravel fill material would not directly introduce sediments or increase turbidity outside the cell; however, some turbid water would likely be forced out of the cell as the gravel fill displaces it.

The introduction of the turbid water into the water column of the Snake River would increase turbidity beyond background. The increase in turbidity resulting from introduction of the turbid water is predicted to be minimal.

Monitoring would be conducted to assess the accuracy of this prediction. If, during in-water excavation and discharge activity, turbidity levels at the monitoring site exceed 5 NTUs over background turbidity when the background turbidity is 50 NTUs or less; or, if turbidity levels at the monitoring site increase by more than 10 percent when the background turbidity is more than 50 NTUs, in-water excavation and discharge activity would temporarily cease until turbidity levels at the monitoring site returned to levels within these limits.

The excavation of riprap to facilitate construction of the bulkhead for the barge access area would likely increase turbidity levels beyond background. The excavated riprap would be disposed in uplands. Washed gravel would be discharged behind the constructed bulkhead. This discharge of gravel fill material would not introduce sediments or increase turbidity outside the bulkhead; however, some turbid water may be forced out of the area behind the bulkhead as it is displaced by the gravel fill. The introduction of the displaced turbid water into the water column would increase turbidity levels beyond background. The increase in turbidity resulting from introduction of the turbid water is expected to be minimal.

Monitoring would be conducted to assess the accuracy of this prediction. If, during in-water excavation and discharge activity, turbidity levels at the monitoring site exceed 5 NTUs over background turbidity when the background turbidity is 50 NTUs or less, or if turbidity levels at the monitoring site increase by more than 10 percent when the background turbidity is more than 50 NTUs, in-water excavation and discharge activity would temporarily cease until turbidity levels at the monitoring site returned to levels within these limits.

3.4.2 Effects (Degree and Duration) on Chemical and Physical Properties of the Water Column

The latest information from the 1997 sediment evaluation in the Snake River (Anatek Labs, 1997) describes sediments that are relatively clear of pesticides and herbicides. There are some metal concentrations in these forebay areas above the background levels. These include barium, manganese, zinc, and sometimes mercury. Copper is a concern because of its use as an agricultural chemical and its synergistic effect of toxicity to aquatic life with zinc. The metals themselves are transient (just as the sediments are) and must be re-tested every 5 years to assess the impacts they could pose.

3.4.2.1 Ammonia

Potential risk of impacts of actions involving excavation and in-water disposal upon ammonia in the Lower Granite Lake are judged to be extremely high because the elutriate ammonia average (3.6 mg/L at 8.5 pH) could exceed the early life stage criterion three-fold. The elutriate ammonia average could also exceed both acute criterions (2.14 mg/L and 3.20 mg/L). Potential impacts upon ammonia in the Little Goose, Lower Monumental, and Ice Harbor reservoirs are judged to be moderate because the elutriate ammonia average could exceed the chronic early life stage criterion. Duration of localized effects would be short because of diffusion of the dissolved ammonia. Dissolved ammonia would remain in solution for a considerable amount of time because of temperature and inactivity of microbes that reduce the ammonia to nitrogen gas.

3.4.2.2 Manganese

As indicated in Section 3.2 above, manganese is present in each of the four lower Snake River reservoirs. Because a small quantity is released over a short period, there is a good chance there would be a very minor localized effect of lower dissolved oxygen in the immediate area.

3.4.2.3 Mercury

Excavation and sidecasting of sediments could liberate mercury from the sediments allowing it to elutriate into the water column. Data in the FR/EIS and in Appendix C, Water Quality on the amount of mercury in the sediment and the amount of mercury elutriated suggests 100 percent of mercury found in sediments would be dissolved and any localized effects of mercury would be short term. Any long-term effects would be cumulative in nature because of mercury's propensity to bio-accumulate.

3.4.2.4 Zinc

Localized acute effects of zinc would be short term due to the effects of diffusion and water hardness. The degree of effect could range from minor to major, depending upon the amount of exposure. Juvenile salmonids have the lowest resistance to acute and chronic exposure to zinc (EPA, 1976). Any long-term effects would be cumulative in nature because of zinc's propensity to bio-accumulate.

3.4.2.5 Copper

Localized acute effects of copper would be short term due to the effects of diffusion and alkalinity. The degree of effect could be major, depending upon the amount of exposure. Copper is more toxic at lower concentrations than zinc and is reported to have a synergistic effect with zinc (EPA, 1976).

3.4.2.6 Tetrachlorodibenzo-p-dioxin and Tetrachlorinated Dibenzo Furans

The potential of disturbing sediment containing tetrachlorodibenzo-p-dioxin (TCDDs) and tetrachlorinated dibenzo furans (TCDFs) is expected to be minimal. If, however, sediments containing 2378-TCDD and 2378 TCDF were encountered, the effects could be major and long term.

3.4.2.7 Turbidity

Discharges of dredged and fill material associated with the proposed action would increase turbidity levels above background. The effects of the discharges and actions to minimize their impacts are presented in Section 3.4 above.

3.4.3 Effects on Biota

3.4.3.1 Primary Production, Photosynthesis

In temperate lakes, both biomass and productivity of phytoplankton is usually low (Wetzel, 1983). Where nutrients are adequate, the growth is still limited to species that are adapted to low temperatures and low irradiance. In Indiana, a very significant portion of the total annual primary productivity occurs in some lakes during the winter months (Wetzel, 1966). Similar values have been found in other temperate lakes, emphasizing the widely held assumption that winter productivity is insignificant. This assumption is not universally valid. No data exist about chlorophyll *a* concentrations during the winter months or algal populations of the lower Snake River.

Significant activities that increase turbidity can seriously affect winter primary productivity. There may be little margin for unaffected loss of irradiance with winter-adapted species of phytoplankton. This could have some secondary effects to primary productivity. Although turbidity could impact primary productivity, no more than negligible impacts are expected due to planned actions to minimize impacts.

3.4.3.2 Suspension/Filter Feeders

Rotifers

The cycle of rotifers is characterized by large numbers of generations in which reproduction is parthenogenic. The amictic females produce eggs that are all diploid. The diploid egg production is broken once or twice per year by the production of mictic females. These haploid females produce haploid eggs that, if fertilized by a male, become resting eggs that over-winter. These eggs are usually hatched as a result of temperature and chemical changes in the water. These resting eggs are resistant to harsh environmental conditions.

Aside from resuspending, these eggs would probably survive most construction impacts. Some eggs may be entrained into the structures. This construction effort entails less than 1/100th of a percent of the available area in the pool. Given existing technology, measurable effect to the rotifer population is expected to be insignificant.

Cladocera

In many ways, the cladocera produce parthenogenic offspring until environmental conditions require sexual versions to be produced. In cladocera, the changes are linked to food quality as much as they are to light and temperature. Some of the resting eggs of cladocera tend to float in the proposed construction areas. Movements of large floating plant equipment could trap and destroy some of the resting eggs. Effects upon cladocera as well as the overall population are expected to be negligible.

Copepods

Little is known about copepods and their seasonal fluctuations in the lower Snake River System. Copepods are not studied as widely as cladocera because of the importance of cladocera as food for planktivorous fish. Copepods are an important link in the ecosystem because of their abundance and diversity.

During the construction work window of December 15 through March 1, copepods exist primarily in a resting stage. During this stage, copepods are more resilient. The proposed action is expected to have no more than a minimal effect upon copepods.

3.4.3.3 Sight Feeders

Salmon and centrarchid fish are known to feed on zooplankton by sight. The dynamics of wintering zooplankton and the interactions of fish are poorly understood in the Snake River System. Typically in freshwater systems, primary productivity decreases during the winter months because of decreases in periods of sunlight and in temperature. As a result, zooplankton decreases, causing sight feeders to alter feeding habits to more benthic-oriented prey items (e.g., snails, worms, etc.). In addition, the activity and metabolism of poikilothermic organisms (including sight feeders) tends to slow with decreases in temperature, resulting in lower feeding rates.

Because the disposal of dredged and fill material would occur during the in-water work window of December 15 through March 1, when water temperature is low and feeding rates reduced, the potential impact upon sight feeders is expected to be negligible. Also, all salmonids should have migrated out of the lower Snake River during the in-water work window except for a small percent of remnant holdover juvenile spring/summer chinook salmon, fall chinook salmon, or over-wintering juvenile steelhead. In addition, the dredging and disposal process may benefit sight feeders by exposing and redistributing benthic prey items from below the substrate to where fish may have access to them.

3.4.4 Actions Taken to Minimize Impacts

One YSI 6600 upg® sonde would be placed in the forebay and one YSI 6600 upg® sonde would be at the turbine exit of the dam to assess the accuracy of the prediction for RSWs and SBCs, as it relates to turbidity. An estimated two sondes would be placed downstream, four sondes alongside, and two sondes upstream of the BGSs to assess the accuracy of the prediction as it relates to turbidity and the BGSs. One sonde would be placed in the forebay and 12 sondes would be placed in a grid array downstream of the pier nose extensions to assess the accuracy of the prediction as it relates to pier nose extensions. One sonde would be placed in the forebay and 12 sondes would be placed in a grid array downstream of the moorage cells and barge access area to assess the accuracy of the prediction as it relates to turbidity, the moorage cells, and barge access area.

Sondes would collect turbidity and depth 24 hours per day, 7 days per week. Backup instrumentation would be on standby at all times. Secondary readings would be taken using a Hach 2100 P nephelometer for QA/QC.

Turbidity would be monitored 300 feet downstream of the dam during in-water excavation and discharge activities associated with construction of RSWs, BGSs, SBCs, sheet pile barge moorage cells, and the barge access area. In accordance with WAC 173 201A-030, if, during in-water excavation and discharge activity, turbidity levels at the monitoring site exceed 5 NTUs over background turbidity when the background turbidity is 50 NTUs or less; or, if turbidity levels at the monitoring site increase by more than 10 percent when the background turbidity is more than 50 NTUs, in-water excavation and discharge activity would temporarily cease until turbidity levels at the monitoring site returned to levels within these limits.

3.5 Contaminant Determinations

The purpose of contaminant determinations is to determine the degree to which the proposed discharges would introduce, relocate, or increase contaminants. Under the general framework of Section 404 of the Clean Water Act, testing of excavated material is conducted to assist in making factual determinations regarding the effect of the discharge on the aquatic ecosystem and in determining whether the discharge will comply with the 404(b)(1) Guidelines (40 CFR 230.10 and 230.11). The 404(b)(1) Guidelines provide for testing under certain circumstances. Suggested protocols for testing, when determined appropriate under 40 CFR 230.60 and 230.61, are outlined in the Inland Testing Manual, February 1998, developed jointly by the Corps and the EPA. The Inland Testing Manual facilitates testing in conjunction with proposed dredged material discharges resulting from navigation dredging.

The chemicals of concern (CoC) for the proposed activity are identified in the FR/EIS, Appendix C, Water Quality. The following discussion addresses CoCs and other contaminants. Each of the four lower Snake River reservoirs are discussed because there are slight variations for each pool. CoCs identified in Appendix C are ammonia, manganese, dioxin toxicity equivalents (dioxin TEQ), and total dichloro-diphenyl-trichloro-ethane (DDT). Other possible contaminants discussed below include: mercury, zinc, copper, turbidity, wet concrete, rinse water from gravel fill, and the congeners TCDD and TCDF.

3.5.1 Dredged Material

In all cases except one, the excavated material would be sidecast immediately adjacent to the extraction site. The exception is that riprap excavated to construct the barge access area would be disposed in uplands.

3.5.1.1 Effects from Ammonia

Ammonium (NH_4+) itself is generally only toxic in large concentrations. It is the un-ionized portion of ammonia (NH_3) that is toxic to aquatic life (Downing and Merkens, 1955). Un-ionized ammonia is more toxic because it is a neutral molecule and, thus, has the ability to diffuse across the epithelial membranes of aquatic organisms far more readily than a charged ion. Ammonia is a byproduct of the organism's biological processes and must be excreted. High external un-ionized ammonia concentrations reduce or reverse diffusive gradient and cause the buildup of ammonia in gill tissue (EPA, 1999). Tabata (1962) and Armstrong et al. (1978) postulated that, assuming ammonia and un-ionized ammonia have different partial toxicity, the un-ionized ammonia was 100 times more toxic than ionized ammonia. In studies done by Tabata (1962) and Armstrong et al. (1972), they found that un-ionized ammonia toxicity had a measurable correlation to pH. Nimmo et al. (1989) conducted studies with Johnny darters in river water and juvenile fathead minnows that resulted in LC 50s in terms of un-ionized ammonia increasing from factors of 3.5 to 6.2 with increasing temperatures. Johnson (1995) investigated the effect of pH on chronic toxicity of ammonia on *Ceriodaphnia dubia* in test waters of three different ionic compositions. In all three waters, LC 50s expressed in terms of un-ionized ammonia increased with increasing pH; however, unlike Ankley et al. (1995), the pH dependence was greater in waters with higher rather than lower hardness.

As indicated in Section 3.2 above, ammonia is present in each of the four pools of the lower Snake River. The potential for impacts due to ammonia is likely to occur when sediments associated with ammonia are resuspended. The concentration of ammonia in the sediments, when compared to the potential amount of dissolved ammonia, makes excavation of sediments in the summer undesirable because the amount of un-ionized ammonia increases as water temperature increases. Un-ionized ammonia also increases dramatically when levels exceed 7.5 pH.

Table 3-8 presents an evaluation of pH-induced impacts upon ammonia levels using existing data. Waters of the Snake River are typically between pH 7.8 and 8.5, and therefore are high in alkalinity. Sediments excavated and sidecast would contain levels of ammonia considered to be relatively high. Elutriation tests were previously conducted to obtain estimates of ammonia dissolved in the water (FR/EIS, Appendix C, Water Quality). Table 3-8 compares elutriation data to average concentrations of sediment ammonia for each pool, to average pool pH, and to the National Criterion for Ammonia in Fresh Water (EPA, 1999). The elutriate ammonia averages in mg/L for Lower Granite, Little Goose, Lower Monumental, and Ice Harbor are 3.6 mg/L, 2.6 mg/L, 2.5 mg/L and 3.6 mg/L, respectively (Anatek Labs, 1997). An assessment, based on chronic and acute criterion for fish (EPA, 1999), was then conducted.

Potential impacts of actions involving excavation and in-water disposal upon ammonia in the Lower Granite reservoir are judged to be extremely high because the elutriate ammonia average (3.6 mg/L at 8.5 pH) could exceed the early life stage chronic criterion three-fold. The elutriate and ammonia average could also exceed both acute criterions (2.14 mg/L and 3.20 mg/L). Potential impacts upon ammonia in the Little Goose, Lower Monumental, and Ice Harbor reservoirs were judged to be moderate because the elutriate ammonia average could exceed the early life stage chronic criterion.

Table 3-8. Potential Ammonia Levels of Resuspended Sediment upon Fish

	Lower Granite	Little Goose	Lower Monumental	Ice Harbor
Elutriate ammonia average (mg/L)	3.6	2.6	2.5	3.6
Dissolved elutriate percentage (%)	4.7	4.0	4.2	4.4
Average forebay concentration of ammonia (mg/kg)	75.7	64.3	59.6	81.3
Average pH in winter	8.5[1/]	8.3[2/]	8.1[3/]	8.0[4/]
Early life stage chronic criterion (mg/L)	1.09	1.52	2.10	2.43
Acute criterion with salmon present (mg/L)	2.14	3.15	4.64	5.62
Acute criterion with salmon absent (mg/L)	3.20	4.71	6.95	8.40
Predicted risk of impact	Extremely High	Moderate	Moderate	Moderate

1/ Data source: Prototype BGS Installation at Lower Granite
2/ Data source: Estimated pH from previous unpublished data
3/ Data source: Corps. 1998 LSRF Data
4/ Data source: Anatek Labs, 1997

Monitoring of ammonia concentrations would be conducted during construction to assess the accuracy of the predictions. If, during discharge activities, ammonia levels at monitoring sites exceed state and Federal limits, discharge activities would temporarily cease until ammonia levels at monitoring sites returned to levels within state and Federal limits.

3.5.1.2 Effects from Manganese

The literature suggests that excessive dissolved manganese is only a concern for commercial and domestic water supplies. With the exception of the lower Snake River, most natural waters are usually well below 1,000 µg/L (Thurston et al., 1979). Actual toxicity of manganese to aquatic life is not well documented. Some documentation exists suggesting that the 1997 eluate may be tolerated by most freshwater organisms (McKee and Wolf, 1963). Morgan (1967) described how different compounds of manganese use differing concentrations of oxygen based on the alkalinity (measured by sodium hydroxide). He showed there was a rapid consumption of oxygen within 10 to 20 minutes followed by an extended period of very slow oxygen uptake. This demonstrates the potential for anaerobic sediment, suddenly released in the alkaline water column with manganeous salts, to rapidly scrub dissolved oxygen in the solids suspension. While the manganese has no direct effect on the environment, the loss of dissolved oxygen does provide a potential secondary effect.

As indicated in Section 3.2 above, manganese is present in each of the four lower Snake River reservoirs. Because a small quantity is released over a short period, there is a good chance there would be a minor localized effect of lower dissolved oxygen in the immediate area.

3.5.1.3 Effects from Dioxin TEQ

A thorough understanding of the relevant toxicity of 2,3,7,8- tetrachlorodibenzo-p-dioxin (2378-TCDD) is necessary to assess toxicity equivalence quantity (TEQ). There are 210 dioxin and furan congeners. Seventeen of these congeners are toxic. The isomer 2378-TCDD is the most toxic of the 17 toxic congeners of dioxin and furans. Dioxin TEQ refers to the mathematical operation of converting the toxicity of a congener to the toxicity of TCDD. There are 75 different TCDD congeners, or forms, of which 2378-TCDD (commonly referred to as dioxin) is the most toxic and widely studied. TCDFs are chemically similar to TCDDs and occur in 135 forms.

The TCDDs and TCDFs with chlorine atoms located at the 2,3,7, and 8 positions are considered to be the most toxic. There are 7 TCDDs and 10 TCDFs with this substitution pattern. To assess the toxicity of TCDD/TCDF mixtures in fish, a set of toxicity equivalence factors (TEFs) are used to convert toxicity of each congener to that of 2378-TCDD, called toxicity equivalents, or TEQs (Barned et al., 1989). Calculation of TEQ for a hypothetical fish sample containing 5 parts per trillion (ppt) TCDD and 23 ppt TCDF (considered to be 1/10 as toxic as TCDD, giving it a TEF of 0.1) is as follows: [5 + (0.1 x 23)] = 7.3 ppt TEQ.

The U.S. Food and Drug Administration (Hall, 1981) has advised that TCDD concentrations less than 25 ppt are little cause for human health concern. Ecology, on the other hand, uses a criterion of 0.07 ppt TCDD in fish tissue to assess violations of state surface water quality standards. This value is based on an increased lifetime cancer risk of 1 in 1 million and is derived from the EPA health criterion for TCDD of 0.013 parts per quadrillion in water and a bioconcentration factor of 5,000 (EPA, 1986).

TCDDs and TCDFs are relatively insoluble (less than one part per billion in water) and have a high octanol/water partition coefficient, defined as the ratio of a compound's concentration in n-octanol to water in an equal mixture of the two solvents (Crummett and Stehl, 1973; Smith et al., 1988). These characteristics cause it to be sequestered in the fatty tissues of organisms and adsorbed to carbon-containing sediment in the aquatic environment (Maybee et al., 1991; EPA, 1984; Opperhuizen and Sijm, 1990). Decomposition of TCDDs and TCDFs in the aquatic environment may be a very slow process. Half-lives of these compounds in sediments are probably greater than 1 year, and may be 10 years or more for TCDD (Eisler, 1986; Environment Canada/Health and Welfare Canada, 1990).

Effects from 2378-TCDD and TCDF

TCDD and TCDF are persistent toxic substances that enter the environment as unintended byproducts of several industrial processes. They represent a hazard to aquatic life and human health because of their toxicity at low levels, persistence, and bioaccumulation factors (National Resources Council Canada [NRCC], 1981; Eisler, 1986). The most significant sources are pulp mills, municipal waste incinerators, and fires involving polychlorinated biphenyl (PCB)-contaminated oil (EPA, 1984; Palmer et al., 1988). Other potential sources of deposition include open burning of household waste in barrels (Lemieux et al., 2000). The EPA (1993) considers dioxin-like compounds to be carcinogens.

TCDD and TCDF have low solubility in water; less than 1 parts per billion (ppb) (Crummet and Stehl, 1973). When discharged to aquatic environments, their primary fate is sorption to the sediments and accumulation in biota (Johnson et al., 1991). Concentrations in fish can exceed environmental concentrations by factors as high as more than 5,000 because of this solubility by lipid tissue (Maybee et al., 1991; EPA, 1984; Opperhuizen and Sijm, 1990).

Since the 1980s, there have been concerns about dioxin/furan contamination of the Washington portion of the Snake River. These concerns arose when 2378-TCDD was found in the effluent of bleached Kraft pulp mills in the United States. In 1999, there was no 2378-TCDD detected in the Lower Granite sediment sample sites (CH2M HILL, 1999). In 1991, in response to the dwindling salmon stocks on the Snake River, the Corps initiated a sediment quality study to attempt identification of potential sediment/contaminant factors that could be associated with mortality. Five of 19 sediment composite samples analyzed for dioxin/furan compounds averaged 0.43 ppt 2378-TCDD and 2.72 ppt 2378-TCDF (Pinza et al., 1992).

In 1994, the Corps conducted sediment and water quality studies to determine the extent of contamination from various non-point sources (particularly storm water runoff). Results from dioxin furan analysis yielded 0.68 ppt 2378-TCDD and 1.34 ppt 2378-TCDF in the Corps' east pond. An inlet stream into the east pump pond yielded 4.56 ppt 2378-TCDD and 68.6 ppt 2378-TCDF (MRI, 1994).

In 1998, prior to confluence dredging, the Corps initiated a sediment study in which nine samples were collected in the confluence area of the Snake and Clearwater Rivers. Only two of the nine samples yielded a result with 1.3 and 1.7 ppt 2378-TCDF and no detect for 2378-TCDD.

CH2M HILL conducted dioxin tests in the Lower Granite reservoir and in the Clearwater arm of the reservoir. Seven sites were selected and individual sub-sets were combined into a composite sample for analysis. All of the in-river site sample results showed no detects and below detection limits for 2378-TCDD and 2378-TCDF. The only sample that contained detectable levels of contamination was the Corps' east pond (CH2M HILL, 1999). The contamination results for 2378-TCDD and 2378-TCDF were very low (2.8 ppt and 34 ppt, respectively). The east pond receives storm runoff from multiple sources. CH2M HILL again repeated the study in 1999 and discovered the only detection was for 2378-TCDF in the amount of 23 ppt.

Potential impacts of disturbing sediment containing TCDDs and TCDFs are expected to be minimal. As indicated in the text above, concentrations of TCDDs and TCDFs primarily occur above Lower Granite Dam. Sampling conducted in 1999 (CH2M HILL, 1999) above and below Lower Granite Dam resulted in "no detect" or "below detection limits" for 2378-TCDD and 2378 TCDF.

3.5.1.4 Total DDT

DDT is an organochlorine pesticide. Several organochlorine pesticides were detected in the sediment samples collected from the lower Snake River. Three principal organochlorine pesticide compounds detected in the sediments are related; DDT being the parent compound and DDD-DDE being daughter products generated by the transformation of DDT in the environment (Callahan et al., 1979).

The military developed and produced DDT during World War II to control mosquitoes and, thereby, the spread of malaria and other diseases. Released into civilian markets in 1945, DDT was used heavily over the next 2 decades to control agricultural and forest insects as well as disease vectors. By 1961, 1,200 formulations of DDT were available for use on 334 crops (EPA, 1992). The DDT was also used to control fishes, bats, and other wildlife. After World War II, additional organochlorine pesticides including methoxychlor, aldrin, dieldrin, and chlordane became available. These were followed in the

1950s and 1960s by endosulfan, endrin, mirex, kepone, toxaphene, and others (Smith, 1991). In addition to being highly toxic, organochlorine pesticides are relatively insoluble in water, adhere strongly to soil particles, and are resistant to physical, chemical, and biological degradation. These properties were viewed as desirable, and negative consequences from bioaccumulation and toxicity to nontarget organisms were not foreseen.

The ecological consequences of organochlorine pesticides were extensive, and some remain evident. Many organochlorine compounds bioaccumulate because of their insolubility in water and resistance to complete metabolic degradation. Upon accumulation by vertebrates, DDT is metabolized to DDE, which is stable and toxic; it impairs calcium metabolism in the shell gland of adult female birds. At sufficiently high concentrations, eggshell thickness can be reduced to the extent that eggs cannot support the weight of the incubating parents. As thickness decreases, the shell can break and death of the developing embryo can result. Susceptibility varies, but predatory birds are most vulnerable for two reasons; 1) physiologically and 2) their position at the apex of aquatic food chains (Cooke, 1973).

It was expected that no organochlorine pesticide would be present in the sediments tested during the special sediment study of 1997 for the Feasibility Study. In response to the dramatic decline in use of the organochlorine pesticides, other researchers reported sharp drops in the detection of these compounds (Mineau and Peakall, 1987; Prouty and Bunck, 1986; Bunck et al., 1987; Baumann and Whittle, 1988; Schmitt et al., 1990; Wiemeyer et al., 1993; Weseloh et al., 1994; Mora, 1995). Therefore, no contamination was expected because of the length of time since the use of these products. This study was considered to be a benchmark of 20 years after phase-out of these compounds. To the contrary, organochlorine pesticide residues were detected in the sediments of all the four lower Snake River reservoirs.

The predominant organochlorine compound detected was DDE, which ranged in average concentration from 2.68 in Ice Harbor to 6.48 in the Lower Granite reach, with an arithmetic mean concentration of 4.89 ppb. DDD was detected in 11 sediment samples, with an average maximum concentration of 6.48 ppb in Lower Granite reach and an arithmetic mean of 2.07 ppb. DDT was detected in only five samples, with a mean arithmetic concentration of 1.62 ppb.

Total DDT (DDD, DDE, and DDT) concentrations ranged from nondetect to 32.8 ppb with an average concentration of 8.23 ppb. The highest mean reach concentration for total DDT was 11.3 ppb for Lower Granite Lake. The average reach concentration of total DDT decreased steadily from Lower Granite Lake down to 5.7 ppb as recorded in Lake Sacajawea. The maximum and average total DDT concentrations in the lower Snake River sediments exceed the guidance levels set forth in the Puget Sound Dredged Disposal Analysis Guidance Manual: Data Quality Evaluation for Proposed Dredged Material Disposal Projects (PTI Environmental Services, 1989) or recommended screening concentration (6.9 ppb), but are lower than the bioaccumulation trigger concentration of 50 ppb as established in the Portland District Dredged Material Evaluation Framework (DMEF) (Corps, 1998). Concentration levels above the screening level prompt biological testing to ascertain health risks to aquatic organisms using the DMEF (Corps, 1998).

The pesticides aldrin, dieldrin, endrin, heptachlor, and lindane were all detected in five or fewer of the 1994 dredge material sediment evaluation samples. The concentrations range was as follows: aldrin ranged from nondetect to 3.5 ppb, dieldrin ranged from nondetect to 8 ppb, endrin ranged from nondetect to 9.4 ppb, heptachlor ranged from nondetect to 4.9 ppb, and lindane ranged from nondetect to 5.5 ppb. The maximum concentrations of aldrin, dieldrin, heptachlor, and lindane in the Snake River sediment are lower than their screening level concentration of 10 ppb. No screening level has been established for endrin in the DMEF (Corps, 1998).

The greatest risk associated with DDT and other organophosphorus pesticides and herbicides is bioaccumulation. Bioaccumulation of DDT from consumption of fish tissue is possible because humans are the apex of the food chain. The highest concentrations of DDT are expected to be associated with the finer sediments deposited from stream run-off. Potential impacts from re-suspending sediments containing DDT and its daughter products are possible. Sediment samples would be collected and analyzed for DDT before construction of RSWs, BGSs, barge moorage cells, and the barge access area to determine the presence of DDT. Where DDT is found above the screening level or elutriate value, the specific material would be taken to an approved upland disposal site.

3.5.1.5 Effects of Mercury

The latest sampling for mercury took place about a mile below Silcott Island in the Lower Granite reservoir (CH2M HILL, 1999). Mercury was detected in two of four samples from that location at 230 μg/kg and 670 μg/kg. In 1997, mercury was measured about 1,700 μg/kg in this location (Anatek Labs, 1997). In 1985, (Crecelius and Gurtisen, 1985) sediment upstream of this location near the Port of Lewiston, Idaho, averaged only 30 μg/kg. In the Lower Granite reservoir, mercury seems to appear and reappear throughout the various sampling events. Although there was dispersion between samplings and the hydrologic cycles influenced sediment deposition, mercury still seems to be quite mobile in this portion of the lower Snake River.

Some organisms have the ability to convert the inorganic and organic forms of mercury to the highly toxic methyl mercury (Jensen and Jernolov, 1969). Methyl mercury and dimethyl mercury are concentrated many fold in fish because there is relatively no way for them to excrete methyl mercury (Train, 1979). The EPA Freshwater Criteria as of 1985 is 0.012 μg/L for 4 days with a 2.4 μg/L per 1 hour maximum average. Sediment samples referenced above contained well in excess of these levels and averaged eluate tests (0.1 μg/L) suggest a potential for a problem.

Excavation and sidecasting of sediments could liberate mercury from the sediments allowing it to elutriate into the water column. Data in FR/EIS, Appendix C, Water Quality on the amount of mercury in the sediment and the amount of mercury elutriated suggests 100 percent of any mercury found in sediments would be dissolved. However, mercury levels detected were near instrument lower detection limits.

Prior to the start of construction, sediment would be analyzed for mercury and elutriation. If mercury is found to be present, elutriated sediments and dissolved mercury in water would be monitored. If mercury levels exceed the Freshwater Criteria (EPA, 1985a) of 0.012 μg/L for 4 days with a 2.4 μg/L per 1 hour maximum average, work would be halted and consultation would be conducted with appropriate state and Federal agencies.

3.5.1.6 Effects from Zinc

Skidmore (1964) reviewed the toxicity of zinc to fish and reported that both an increase in temperature and a decrease of dissolved oxygen increased the toxicity of zinc. Toxic concentrations of zinc cause adverse changes in the morphology and physiology of fish. Acute concentrations induce cellular breakdown of the gills and clogs them with mucus (Train, 1979). Chronic concentrations of zinc cause general enfeeblement and widespread histological changes to many organs, but not to the gills (EPA, 1980). The level of toxicity is also dependant upon water hardness. Zinc is more toxic in soft water than it is in hard water (EPA, 1980). Other metals, such as copper, can be synergistic with zinc depending on water hardness (Anderson and Weber, 1976).

In the Lower Granite reservoir, the average concentration of zinc in the sediments was 61,400 μg/kg (Anatek Labs, 1997). The eluate tests conducted in 1997 averaged 54,050 μg/L for the four lower Snake River reservoirs. The eluate test averaged 21.3 μg/L of zinc. Based on the equation developed for zinc by the EPA (EPA, 1985b), the acute criterion for the protection of aquatic life should not exceed certain limits because of the relative hardness of the water. Zinc is found in the sediments of the lower Snake River in abundant quantities.

Excavation and sidecasting of sediments could liberate zinc from the sediments allowing it to elutriate into the water column. Data in FR/EIS, Appendix C, Water Quality Appendix on the amount of zinc in the sediment and the amount of zinc elutriated suggest 31 percent, 29 percent, 40 percent, and 72 percent, of elutriated zinc at Lower Granite, Little Goose, Lower Monumental, and Ice Harbor, respectively, would be dissolved into the water column. Based on existing concentrations of zinc (Appendix C, Water Quality) and high degree of variability in the effects of zinc upon fish, the proposed action has the potential to surpass the acute condition criteria for rainbow trout (EPA, 1976) and pose a moderate or higher risk to fish.

Prior to the start of construction, sediment would be analyzed for zinc and elutriation and water would be analyzed for hardness. Elutriate would be analyzed to determine if an acute or chronic condition is created for specific species of fish that may be present during construction. If a chronic or acute condition is identified, additional bioassay analysis would be required.

3.5.1.7 Effects from Copper

In most cases, copper is not considered a potential contaminant. It is an essential element for the propagation of plants and is required for animals because it is an important constituent of insect blood chemistry (Train, 1979). Copper in excess of what is needed for health and vitality can be very detrimental to the primary producer level of the food chain. Ibragim and Patin (1975) demonstrated that copper concentration of 10 μg/L to 100 μg/L inhibited phytoplankton growth. Copper toxicity is very similar to zinc in relation to its interactions with water hardness and the temperature/alkalinity complex (EPA, 1985b).

Acute toxicity data are available for 41 genera (EPA, 1985b). At a water hardness of 50 mg/L as $CaCo_3$, the genera ranged in sensitivity to copper between 16.74 μg/L and 10,240 μg/L. The lowest acute toxicity concentration for a single test was 6.5 μg/L for exposure of the cladocera (*Daphnia magna*) in hard water. The values ranged 3.87 μg/L in an early life stage test with *Salvelinus fontinalis* to 60.36 μg/L in an early life stage test with *Esox lucius*. In the 1997 study (Anatek Labs, 1997), the average value for zinc in the eluate test was 21.3 μg/L.

No factual determinations have been made regarding the effects on resident genera and species in the lower Snake River. Information in the literature is sparse and no comparisons have been made at this time. Because copper sulfate is used frequently as a fungicide in this area, copper can be a contaminant based on possible deposition in areas potentially enriched with zinc and because of its potential for synergistic toxicity.

Excavation and sidecasting of sediments could liberate copper from the sediments, allowing it to elutriate into the water column. Data in FR/EIS, Appendix C, Water Quality on the amount of copper in the sediment and the amount of copper elutriated suggest 13 percent, 13 percent, 19 percent, and 14 percent of elutriated copper at Lower Granite, Little Goose, Lower Monumental, and Ice Harbor, respectively, would be dissolved into the water column.

Prior to the start of construction, sediment would be analyzed for copper and elutriation and water would be analyzed for hardness. Elutriate would be analyzed to determine if an acute or chronic condition is created for specific species of fish that may be present during construction. If a chronic or acute condition is identified, additional bioassay analysis would be required.

3.5.1.8 Effects from Turbidity

Discharges of dredged and fill material associated with the proposed action would increase turbidity levels above background. The effects of the discharges and actions to minimize their impacts are presented in Section 3.4 above.

3.5.2 Fill Material

Contaminants could be introduced into the aquatic environment through the accidental discharge of wet concrete directly into the water, and through use of contaminated gravel to construct the barge moorage cells and barge access area.

To minimize the potential for introduction of contaminants, wet concrete to construct the pier nose extensions would be discharged into an area dewatered by a cofferdam/bulkhead. Pre-cast concrete discharged as fill material would be adequately dried prior to placement in the water. Gravel discharged into the constructed moorage cells and behind the sheet pile wall of the barge access area would be washed of any silts and soils prior to placement.

3.5.3 Actions to Minimize Impacts on the Aquatic Environment

Monitoring of ammonia concentrations would be conducted during construction to assess the accuracy of predicted impacts. If, during discharge activities, ammonia levels at monitoring sites exceed state and Federal limits, discharge activities would temporarily cease until ammonia levels at monitoring sites return to levels within state and Federal limits.

Prior to the start of construction, sediment would be analyzed for mercury and elutriation. If mercury were found to be present, elutriated sediments and dissolved mercury in water would be monitored. If mercury levels exceed the Freshwater Criteria (EPA, 1985b) of 0.012 μg/L for 4 days with a 2.4 μg/L per 1 hour maximum average, work would be halted and consultation would be conducted with appropriate state and Federal agencies.

Prior to the start of construction, sediment would be analyzed for zinc and elutriation and water would also be analyzed for hardness. Elutriate would be analyzed to determine if an acute or chronic condition is created for specific species of fish that may be present during construction. If a chronic or acute condition were identified, additional bioassay analysis would be conducted.

Prior to the start of construction, sediment would be analyzed for copper and elutriation and water would be analyzed for hardness. Elutriate would be analyzed to determine if an acute or chronic condition is created for specific species of fish that may be present during construction. If a chronic or acute condition were identified, additional bioassay analysis would be conducted.

Wet concrete used to construct pier nose extensions would be discharged into an area dewatered by a cofferdam/bulkhead to minimize the potential for introduction of contaminants into the water.

Pre-cast concrete discharged as fill material would be adequately dried prior to placement in the water.

Gravel discharged into the constructed moorage cells and behind the sheet pile wall of the barge access area would be washed of any silts and soils prior to placement to minimize the potential introduction of contaminants.

3.6 Aquatic Ecosystem and Organism Determinations

3.6.1 Plankton Effect

3.6.1.1 Phytoplankton and Zooplankton

Most of the phytoplankton and zooplankton species prevalent in the spring that supply the bulk of the nutrition to the ecosystem would be in the resting stage and would not receive dramatic harm from these actions.

3.6.2 Benthos Effects

A large amount of material has been discussed about the effects to the benthic invertebrate community. There would be an inevitable loss to the benthic community by most of these actions. In the large scheme of the reservoir ecosystem, the loss of the few organisms is insignificant when measured against the entire biomass of these animals in the entire system. Implementation of measures identified to minimize impacts would also lessen the effects upon the benthic community.

3.6.3 Nekton Effects

3.6.3.1 Disposal Effects on Juvenile Pacific Lamprey

Juvenile Pacific lamprey (*Lampetra tridentata*) use the areas near the dams from early spring to mid-summer primarily as a migratory corridor. Although the substrate in the forebays are composed of fine materials, a preferred rearing substrate, juvenile lamprey typically rear in shallow, clear water streams downstream from spawning areas (Close et al., 1995, Corps, 1999 [see Appendix M]). Work conducted in the forebays during the winter in-water work window should have no effect on the rearing or outmigration life phases. Short- and long-term effects of the discharge of dredged or fill material in the forebays of the dams would, therefore, be negligible. The permanent sidecasting of dredge material in the forebays of the dams would have no negative effects despite juveniles migrating near the bottom of the reservoirs (Close et al., 1995).

Although juvenile Pacific lamprey use the areas near the dams primarily as a migratory corridor, they do burrow into cobble and boulder substrates to overwinter (Pletcher, 1963). No lamprey have been documented in the winter in the tailrace. Short- and long-term effects of discharging dredged or fill material in the tailraces of the dams would be negligible. The permanent sidecasting of dredged material in the tailraces of the dams would also have no negative effects.

3.6.3.2 Disposal Effects on Adult Pacific Lamprey

Work conducted during the winter in-water work window of December 15 through March 1 would have no effect on the immigration of adult lamprey. Adult Pacific lamprey immigrate from mid-spring to late summer and are not expected to experience any negative effects from the discharge of dredged or fill material in the forebay or tailrace. The construction process for the extension of pier noses and addition and modification of deflections may affect overwintering adult lamprey; however, the actual discharge of dredged and fill material should have no impact. Short- and long-term effects of discharging dredged or fill material in the forebays and tailraces of the dams would be negligible. The permanent sidecasting of dredged material in the forebays of the dams would have no negative effects despite the presumable adult Pacific lamprey migration to the bottom of the sea.

3.6.4 Aquatic Food Web Effects

The winter months have a very different food web when compared to the spring, summer, and fall months. The bioenergetics of the system slow down parallel to the decrease in temperature because most freshwater aquatic organisms are poikilothermic. Some organisms feed very little in the winter and live off stored fat reserves. Aquatic insects do feed and rely on detritus for food sources. The disturbances caused by the localized discharges would interrupt food supplies to the localized benthic organisms but this would be minor and short term. Suspension would also uncover some additional food supplies buried in the interstitial sediments and waters.

Because most of the spring and summer dominant species of plankton are in the resting stage, little effect to the food web is expected. The winter phytoplankton species are relatively unstudied. Only minor changes are expected because the discharges would be small and infrequent. There would be virtually no effect to the food web as it pertains to threatened and endangered species.

3.6.5 Special Aquatic Site Effects

3.6.5.1 Sanctuaries and Refuges

Discharges of dredged and fill material associated with the recommended plan (preferred alternative) would not occur in or close to a sanctuary or refuge complex. Discharges of dredged and fill material associated with the recommended plan (preferred alternative) would have no effect on this special aquatic site.

3.6.5.2 Wetlands

Discharges of dredged and fill material associated with the recommended plan (preferred alternative) would not occur in or close to a wetland. Discharges of dredged and fill material associated with the recommended plan (preferred alternative) would have no effect on this special aquatic site.

3.6.5.3 Mud Flats

Discharges of dredged and fill material associated with the recommended plan (preferred alternative) would not occur in or close to a mudflat. Discharges of dredged and fill material associated with the recommended plan (preferred alternative) would have no effect on this special aquatic site. For purposes of this description, areas in the forebay and in the backwater areas within 4 miles of the dams are not considered mudflats. This is because the deposition is composed of 90 percent sediments and not of soils characteristic of wetlands or shallow flats that would support vegetation or provide habitat for waterfowl.

3.6.5.4 Vegetated Shallows

Discharges of dredged and fill material associated with the recommended plan (preferred alternative) would not occur in or close to vegetated shallows. Discharges of dredged and fill material associated with the recommended plan (preferred alternative) would have no effect on vegetated shallows.

3.6.5.5 Riffle and Pool Complexes

Discharges of dredged and fill material associated with the recommended plan (preferred alternative) would not occur in close to a riffle and pool complex. Discharges of dredged and fill material associated with the recommended plan (preferred alternative) would have no effect on this special aquatic site.

3.6.6 Threatened and Endangered Species

In 1995, the Corps, U.S. Bureau of Reclamation (BOR), and Bonneville Power Administration (BPA) (collectively termed "action agencies") consulted under Section 7 of the Endangered Species Act (ESA) of 1973 as amended on the operation of the Federal Columbia River Power System (FCRPS) with the NMFS and the U.S. Fish and Wildlife Service (USFWS). This particular consultation resulted in three separate biological opinions being issued by NMFS and USFWS covering the anadromous and resident fish species that were listed at the time. The NMFS then issued a supplemental biological opinion in 1998 that addressed the additional listing, since 1995, of upper Columbia steelhead. In 1999, NMFS listed six additional populations of anadromous fish as either threatened or endangered and USFWS listed one additional resident fish species pursuant to the ESA.

In 1999, the action agencies prepared the Multi-species Biological Assessment (BA) of the Federal Columbia River Power System, December 21, 1999 and reinitiated consultation on the FCRPS. The BA evaluated the potential effects of the operation of the FCRPS on the continued existence of all species either listed, proposed, or designated as candidates for listing under the ESA that are potentially affected by these actions. The BA also described ongoing and potential future actions being considered within the system, including the FR/EIS.

Bull trout were addressed in a separate BA also prepared by the action agencies and submitted to the USFWS in December 1999 for reinitiation of consultation.

In response to the action agencies' BAs, the USFWS issued their Biological Opinion, Effects to Listed Species from Operations of the Federal Columbia River Power System, December 20, 2000; and NMFS issued their Biological Opinion, Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin, December 21, 2000.

In their December 21, 2000, Biological Opinion, NMFS concluded the impacts of the FCRPS jeopardize the continued existence of listed Snake River salmon and included a reasonable and prudent alternative the agency believes would avoid jeopardy.

In their December 20, 2000 Biological Opinion, USFWS concurred with the action agencies' determination that the proposed action may affect, but is not likely to adversely affect, the threatened or endangered species or species proposed for listing as threatened or endangered (see Table 3-9).

Table 3-9. Endangered Species Act Listings

Common Name	Scientific Name	Listing
Mammals		
Grizzly bear	*Ursus arctos horribilis*	Endangered
Gray wolf	*Canis lupus*	Endangered
Woodland caribou	*Rangifer torandus caribou*	Endangered
Canada lynx	*Lynx canadensis*	Threatened
Northern Idaho ground squirrel	*Spermophilus brunneus brunneus*	Threatened
Plants		
Macfarlane's four o'clock	*Mirabilis macfarlenei*	Threatened
Water howellia	*Howellia aquatilis*	Threatened
Ute's ladies tresses	*Spiranthes diluvialis*	Threatened
Spalding's silene	*Silene spauldinii*	Proposed

Source: USFWS, 2000

The USFWS also indicated that the effects of FCRPS operations on the bald eagle were documented in previous BAs and consultations with the USFWS and that a biological opinion regarding effects on the bald eagle was issued on March 1, 1995. The USFWS further explained that, because they were not aware of any changes in FCRPS operations that would warrant reinitiation of consultation, effects of operations on the bald eagle were not addressed in their December 20, 2000, Biological Opinion.

The December 20, 2000, Biological Opinion also analyzed the effects of the FCRPS on the bull trout in areas downstream of Hells Canyon Dam.

The Corps selected the recommended plan (preferred alternative) for the FR/EIS consistent with the contents of the above referenced biological opinions.

3.6.7 Aquatic Life Forms

3.6.7.1 Anadromous Fish

Most Snake River Basin juvenile and adult anadromous salmonids use the lower Snake River as a migratory corridor. The salmonids swim primarily in the upper water column from early spring to late fall. Exceptions to this include juvenile fall chinook and both juvenile and adult steelhead. Individuals of these species are present in the reservoir environment throughout the year. Of these, juveniles of both species are most likely to be present in low densities along sandy, shallow water shorelines and adults are typically not observed during the winter.

The discharge of dredged and fill material in the forebays would occur during the winter in-water work window. No anticipated short- or long-term effects to any salmonids are expected because anadromous salmonid densities in this area are extremely low at this time of year and fish do not typically occur at the depths of the proposed discharge. In addition, no short- or long-term effects of sidecasting the material are expected for fish migrating through the area because most salmonids are found in the upper water column.

The discharge of dredged or fill material in the tailraces would also occur during the winter in-water work window. Again, anadromous salmonid densities in this area are extremely low at this time of year. Although salmonids may be present in some of the shallower tailrace areas during the winter (e.g., the barge slip area), they typically prefer areas of sand substrate rather than the probable substrate of silt at that location. In addition, migrating fish are more likely to avoid backwater areas during the spring outmigration. Therefore, no short- or long-term effects to anadromous salmonids are anticipated from the discharge of dredged or fill materials. In addition, no short- or long-term effects of sidecasting the material are expected during the outmigration or immigration because most salmonids typically avoid using the backwater areas.

3.6.7.2 Resident Fish

Fish species in the reservoirs of the lower Snake River and McNary Dams include a mixture of native riverine and introduced species that typically are associated with lake-like conditions (Bennett et al., 1983; Bennett and Shrier, 1986; Hjort et al., 1981; Mullan et al., 1986). Introduced species are more common in the forebay zone and backwater areas while native species are more common in the flowing water regions found in the tailrace. Although adults will use various habitats, lake-dwelling species are generally more abundant in shallow, slower velocity backwater areas, and native riverine species occur more abundantly in areas with flowing water (Bennett et al., 1983).

In the forebay areas, very few fish are known to inhabit the reservoir floor near the proposed discharge locations. Most resident species reside in the photic zone and not in the deep-water environment of the forebay. Scavenger fish, including the native white sturgeon and various introduced species of catfish, may be present in these areas in very low densities throughout the year. Discharge of dredged and fill material in the forebays would have negligible effects on resident fish. Sidecasting of material may actually serve as a short-term benefit to bottom-dwelling species by exposing or re-distributing invertebrates that serve as a food source. No long-term benefits would be expected.

In the tailraces of the dams, the resident fish of most concern are the native and introduced predatory fish, white sturgeon, and bull trout. These species are of concern because enhancement of piscivorous fish habitat is undesirable, while enhancing habitat for sturgeon and bull trout is desirable. Other species, including suckers, peamouth, carp, etc., while important to the food web and overall health of the ecosystem, would be minimally impacted.

Backwaters and embayments generally provide low water velocity, slightly warmer water, finer substrate, and submerged and emergent vegetation. Backwaters and embayments are used by predatory fish such as bass, black crappie, white crappie, bluegill, pumpkinseed, and yellow perch for spawning and rearing (Bennett et al., 1983; Bennett and Shrier, 1986; Hjort et al., 1981; Bennett et al., 1991; Zimmerman and Rasmussen, 1981). At Lower Granite Dam, the work in the barge cells is expected to have the most impact to resident predatory fish. The disposal of dredged material in this area may serve as a short-term benefit to these fish by re-distributing and exposing invertebrates commonly preyed upon by these species. In addition, the sidecast material may provide increased long-term shallow water habitat in the embayment, enhancing spawning and rearing habitat for predatory fish.

White sturgeon probably use the backwater area as a foraging and resting area. The disposal of dredged material in this area may serve as a short-term benefit to these fish by redistributing and exposing invertebrates commonly preyed upon by these species. No short- or long-term impacts are expected to occur with the discharge of fill material at this location.

Bull trout, listed as threatened under the ESA, are found primarily in colder streams, although individual fish are found in larger river systems throughout the Columbia River Basin (Fraley and Shepard, 1989; Rieman and McIntyre, 1993, 1995; Buchanan and Gregory, 1997). The density of bull trout in the backwater embayment at Lower Granite Dam is not known; however, any occurrence of these fish in the backwater during any time of the year is unexpected. No short- or long-term effects to bull trout from discharge of fill or dredged material are anticipated.

3.6.7.3 Other Aquatic Organisms

The northwestern species of crayfish (*Pacifasticus lenensculis)* inhabits most of the lower Snake River drainage. This decapod is important to the ecosystem because of its scavenger life style and its importance as a food source for bass and other sport fish. This animal prefers to feed on dead and decaying fish and other aquatic organisms. This animal is important in keeping the bottom cleaned of rotting carcasses.

Small impacts to this species could occur. During excavation and discharge, some animals could be crushed or merely displaced, requiring them to seek shelter elsewhere. In addition, placement of the fill could crush some animals. The amount of fill and timing of the event would preclude any but a few possible casualties. No serious disruptions should occur except for the moorage excavations that are discussed in other areas of this document.

3.6.8 Land-based Life Forms

Extensive information on the occurrence of mammals, birds, amphibians, and reptiles is contained in Section 4.6 of the FR/EIS. Discussion of the effects of the recommended plan (preferred alternative) upon wildlife are presented in Section 5.5 of the FR/EIS and in Appendix M, Fish and Wildlife Coordination Act Report.

The discharge of dredged and fill material would not result in the loss of or change in the nesting and breeding areas, escape cover, travel corridors, or preferred food sources for mammals, birds, amphibians, or reptiles. Turbidity resulting from the discharge of dredged and fill material is not expected to affect wildlife species that rely upon sight to feed.

3.6.9 Actions Taken to Minimize Impacts

All in-water work would be conducted during the standard in-water work window of December 15 through March 1 to minimize impacts upon Federally listed anadromous species, unless coordinated with resource agencies.

3.7 Proposed Disposal Site Determinations

3.7.1 Mixing Zone Determination

Ecology will determine mixing zones. Historically, the mixing zones were established at 300 meters downstream. The practical mixing zone for work upstream of the powerhouse in the winter is the area between the construction site and the turbines. Monitoring at the outfall of the operating units has proven to be the most useful area even if it is only 200 meters downstream. This is because it reflects the extent of the true point of release into the downstream environment. The turbines also have flow-mixing effects on the affected waters that minimize the disturbances or chemical impacts.

3.7.2 Determination of Compliance with Applicable Water Quality Standards and Regulations

3.7.2.1 Section 401 Certification

Section 401 of the Clean Water Act requires applicants requesting a Federal license or permit to conduct activities that may result in a discharge in waters of the United States to provide to the licensing or remitting agency a certification from the state that says any such discharge complies with the applicable water quality standards. As individual actions are ready for implementation, they would be evaluated and Section 401 Certification obtained, if necessary, prior to discharges in waters of the United States.

3.7.3 Potential Effects on Human Use Characteristics

3.7.3.1 Municipal and Private Water Supply

There are no municipal or private water supply intakes in the Snake River near the four dams. Eight active large-scale pumping plants located upstream of Ice Harbor Dam supply irrigation water for circle irrigation systems, vineyards, orchards, pulp trees, and numerous row crops (FR/EIS, Appendix D, Natural River Drawdown Engineering). Water intakes in Lewiston, Idaho, and just south of Lewiston, provide water for two commercial industrial operations. In addition, the cities of Clarkston, Washington, and Lewiston, Idaho, each operate a water intake to supply irrigation water to golf courses.

The eight irrigation pumping plants are located upstream of the work site at Ice Harbor Dam and approximately 16 miles downstream of the work site at Lower Monumental Dam. Water intakes at or near Lewiston, Idaho, and Clarkston, Washington, are located upstream of the work site at Lower Granite Dam. No impacts on water quality at the sites of the intakes are expected because of the remoteness of these intakes from the work sites.

3.7.3.2 Recreational and Commercial Fisheries

No commercial fishing activities are conducted in the lower Snake River; therefore, the discharges associated with the recommended plan (preferred alternative) would not impact commercial fisheries.

Recreational fishing for anadromous and resident fish occurs throughout the Snake River. Among resident species, the reservoirs are host to 18 native species and 17 introduced fish. A list of resident fish species compiled from several sources with common and scientific names is shown in Table 3-3 of Appendix B, Resident Fish to the FR/EIS. Estimates of sport fishing harvest of selected fish in the lower Snake River reservoirs are presented in Table 3-7 of Appendix B to the FR/EIS.

White and black crappie, smallmouth bass, and channel catfish represent introduced species that are highly sought by sport anglers throughout the reservoir system (Normandeau Associates et al., 1998). The native northern pikeminnow is the focus of population reduction efforts via a sport reward program that pays bounties for removal of large individuals (Friesen and Ward, 1997). Sport anglers pursue northern pikeminnow largely in Lower Granite Lake, mostly due to the bounty paid by the sport reward program (Freisen and Ward, 1997). Black crappie and white crappie are two of the more important sport fish in backwater habitats in the lower Snake River reservoirs (Knox, 1982; Normandeau Associates et al., 1998). They are highly habitat-specific in the reservoirs and are chiefly limited to embayment areas off the main channel. Smallmouth bass is one of the more abundant and widely distributed species in the lower Snake River reservoirs (Bennett et al., 1997) and an important sport fish (Normandeau Associates et al., 1998). More extensive information on these and other resident species is available in Appendix B, Resident Fish of the FR/EIS.

Among anadromous species, the Snake River steelhead is the only species for which there currently is an annual recreational harvest season in the Snake River. On May 1, 2001, a portion of the Snake River also opened for a limited harvest season of hatchery spring chinook (Washington Department of Fish and Wildlife, 2001).

The area of the forebay at each of the four dams is not open to boat access; therefore, direct impacts of construction upon recreational fishing in the forebay is expected to be negligible.

The sites of dredged and fill activity for barge moorage cells and the barge access area at Lower Granite is accessible to boaters. It is anticipated that the area would be restricted to boat access during construction of these facilities. This would result in a temporary minor impact upon recreational fishing activity due to limited access.

As indicated in Section 3.4.3.3 above, typically in freshwater systems, primary productivity decreases during the winter months due in part to decreases in photoperiod and temperature. As a result, zooplankton decreases, causing sight feeders to alter feeding habits to more benthic-oriented prey items (e.g., snails, worms, etc.). In addition, the activity and metabolism of poikilothermic organisms tends to slow with decreases in temperature, resulting in lower feeding rates. No negative impacts are expected to affect feeding habits in the areas of activity because the disposal of fill and dredged material is to occur in the in-water work window. In addition, the dredging and disposal process may benefit sight feeders by exposing and redistributing benthic prey items from below the substrate to where fish may have access to them. Because steelhead would not be adversely affected and this activity may be beneficial to some species, no more than negligible impacts to recreational fishing are anticipated.

See Sections 3.6.7.1 and 3.6.7.2 above for further information on anadromous and resident fish.

3.7.3.3 Water-related Recreation

The sites of the discharges of dredged and fill material are restricted from public access; therefore, no effects to water-related recreation would result.

3.7.3.4 Aesthetics

Aesthetic impacts may result from turbidity generated by the discharge of dredged material. Based on findings related to turbidity, impacts upon aesthetics are anticipated to be localized, short-term, and minor. Actions identified in Section 3.4.4 to minimize impacts related to turbidity would also minimize potential impacts of turbidity upon aesthetics.

3.7.3.5 Parks, National Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves

No National Historical Monuments, National Seashores, Wilderness Areas, or Research Sites occur in the vicinity of the four Snake River dams. Various park facilities (campgrounds, day-use, and boat launches) are situated near each of the dams. The discharges of dredged and fill material would not reduce or eliminate the uses for which the parks/facilities are set aside and managed.

3.7.3.6 Actions to Minimize Impacts

The general construction area of the reservoir for the barge moorage cells and barge access area at Lower Granite would be signed to restrict access to boaters for public safety. Access restrictions would be removed immediately upon completion of construction to allow resumption of recreational fishing activity.

Actions identified in Section 3.4.4 to minimize impacts related to turbidity would also minimize potential impacts of turbidity related to mixing zone and upon aesthetics.

3.8 Determination of Cumulative Effects on the Aquatic Ecosystem

EPA's Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR Part 230 December 24, 1980) defines cumulative effects as "the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems" (40 CFR Part 230.11).

The following analysis identifies the array of discharges proposed in the recommended plan (preferred alternative) and potential future discharges that are likely to occur in the foreseeable future. The analysis attempts to predict, to the extent reasonable and practical, the cumulative effects attributable to those discharges. The goal of the analysis is to assess whether the cumulative effects may result in major impairment of the water resources and interfere with the productivity and water quality of the lower Snake River.

3.8.1 Summary of Discharges Associated with the Proposed Action

Table 3-10 provides a summary of the actions proposed under the recommended plan (preferred alternative) and indicates by the placement of an "x" which of those actions would involve the discharge of dredged and/or fill material. A more complete description and summary, including estimated dimensions and volumes, may be found in Section 2.7.2 above.

3.8.2 Summary of Potential Corps Future Discharges

Table 3-11 identifies a range of potential activities that, based on past history and needs, could inherently involve discharges of dredged material and are likely to occur in the future. These include the general categories of maintenance dredging for navigation, maintenance dredging to keep port basins and boat basins open and accessible, maintenance dredging at public recreation areas, and maintenance dredging to maintain irrigation intakes. These projected dredging activities are currently under evaluation in the Corps' DMMS, as described in Section 2.3.2 above. Alternatives under investigation in the DMMS for accomplishing these activities include the following: 1) continue the present practice of maintaining the navigation channels, dredging of access channels to port and moorages (boat basins), public recreation areas, irrigation intakes for wildlife Habitat Management Units (HMUs), and flow conveyance capacity of the Lower Granite Lake and disposing of the material in water; 2) continue the dredging, but formalize the disposal method to create shallow water fishery habitat with the selective disposal of material; 3) continue the dredging practices but with upland disposal of dredged material; and 4) continue the dredging, but dispose of dredged material with emphasis upon beneficial uses such as creating aquatic and wildlife habitat, replenishing beaches, or filling upland commercial sites.

Table 3-10. Summary of Proposed Dredged and Fill Material Discharges

Actions	Lower Granite		Little Goose		Lower Monumental		Ice Harbor	
	Dredged Material Discharges	Fill Material Discharges	Dredged Material Discharges	Fill Material Discharges	Dredged Material Discharges	Fill Material Discharges	Dredged Material Discharges	Fill Material Discharges
RSW	x	x	x	x	x	x	x	x
BGS	x	x			x	x	x	x
SBC	x	x	x	x	x	x		
Pier Nose Extension		x		x		x		
Add End Bay Deflectors				x		x		
Modify Existing Deflectors		x		x		x		
Bank Stabilization		x						
Bypass Outfall Support Column		x						
Barge Moorage Cells	x	x						
Barge Access Area		x						

Table 3-11. Summary of Potential Corps Future Discharges

Activity	Lower Granite		Little Goose		Lower Monumental		Ice Harbor	
	Dredged Material Discharges	Fill Material Discharges	Dredged Material Discharges	Fill Material Discharges	Dredged Material Discharges	Fill Material Discharges	Dredged Material Discharges	Fill Material Discharges
Navigation Dredging	x		x		x		x	
Port Dredging	x		x		x		x	
Boat Basin Dredging	x		x		x		x	
Public Recreation Area Dredging	x		x		x		x	
Irrigation Intake Dredging	x		x		x		x	
Stilling Basin Repair					x	x		

Source: Corps, 2001

3.8.2.1 Potential Future Public and Private Port Maintenance

Table 3-12 represents an inventory of public and private ports along the lower Snake River. No ports are located within Lake West (Lower Monumental Reservoir). No projections are made regarding which of these may require future maintenance dredging. It is reasonable to assume during the next 20 years, maintenance dredging would be required on some or all of the ports.

3.8.2.2 Maintenance Dredging for Boat Basin Access and Public Recreation Areas

Table 3-13 identifies boat basins and recreation areas within the lower Snake River that may require future maintenance dredging. Additional sites could be identified for future maintenance dredging. Not all of the sites identified may require maintenance dredging. RM locations identified in the table are approximate.

3.8.2.3 Maintenance Dredging for Irrigation Intakes

The Corps manages 10 HMUs at which irrigation intakes are operated. The Corps also operates irrigation intakes at various recreation areas. The potential exists for discharges of dredged material to occur in association with maintenance of these intakes. Maintenance generally occurs on an in-frequent basis.

Table 3-12. Maintenance Dredging Locations for Potential Future Public and Private Port

Lower Granite Lake	Lake Bryan	Lake Sacajawea
Tidewater Terminal Company	Pomeroy Grain Growers Dock	Walla Walla Grain Growers, Shefler Dock
Port of Whitman County	Columbia Grain	Louis Dreyfus Windust Station Dock
Potlatch Corporation	Central Ferry Elevator	Columbia County Grain Growers
Mountain Fir Lumber Company, Wilma Dock	Central Ferry Terminal	Lyons Ferry Dock
Stegner Grain Terminal Dock	McGregor Terminal	
Port of Whitman County Docks	Almota Elevator Company Dock	
Port of Clarkston Dock	Port of Almota Dock, S&R Grain	
Clarkston Grain Terminal Dock		
Mountain Fir Lumber Company		
Port of Lewiston Container Terminal		
Continental Grain Company, Lewiston Dock		
Lewis-Clark Terminal Association Dock		
Source: BPA et al., 1995 (Appendix H, Table 8-1)		

Table 3-13. Maintenance Dredging Locations for Potential Future Boat Basin and Recreation Area

Lower Granite Lake		Lake Bryan		Lake West		Lake Sacajawea	
Basin	**Snake River Mile**	**Basin**	**Snake River Mile**	**Basin**	**Snake River Mile**	**Basin**	**Snake River Mile**
Blyton Landing	119.0	Boyer Park and Marina	105.5	Ayer Boat Basin	52.0	Big Flat Recreation Area	16.0
Chief Looking Glass	144.0	Central Ferry State Park	83.5	Devils Bench	42.0	Charbonneau Recreation Area	11.5
Chief Timothy State Park	131.0	Illia Landing	104.0	Lower Monumental Dam	41.5	Fishhook Park	18.0
Greenbelt Ramp	140	Little Goose Dam	70.5	Lyons Ferry Marina	58.5	Ice Harbor Dam Recreation Area	9.0
Hells Canyon Resort	137.5	Little Goose Landing	71.0	Lyons Ferry State Park	59.0	Levey Park	13.0
Hells Gate State Park	142.5	Willow Landing	89.0	Riparia Recreation Area	67.0		
Nisqually John Landing	120.5			Texas Rapids Recreation Area	67.0	Matthews Recreation Area	41.5
Offield Landing	108					Windust Park	39.0
Southway Ramp	140.9						
Swallows Park	142.0						
Wawawai Landing	111.0						
Swallows Swim Beach	141.7						

Source: Corps, 2001

3.8.2.4 Other Potential Future Discharges

Dam Breaching

The NMFS 2000 Biological Opinion directs the Corps to develop plans for potential future recommended actions relating to dam breaching (Actions 147 and 148 of the Biological Opinion). Discharges of dredged and fill material would occur in association with implementation of a drawdown alternative. Further information on dam breaching may be found in Appendix D, Natural River Drawdown Engineering to the FR/EIS.

Irrigation Intakes for Agriculture

There are eight active large-scale pumping plants in the 21-kilometer (13-mile) reach of the Snake River upstream of Ice Harbor Dam (Appendix D, Natural River Drawdown Engineering) that supply irrigation water for circle irrigation systems, vineyards, orchards, pulp trees, and numerous row crops. The potential exists for discharges of dredged material to occur in association with maintenance of these intakes.

Highway and Railroad Bridge Repair and Replacement

Nine highway or railroad bridges cross the reservoirs of the lower Snake River (Appendix D, Natural River Drawdown Engineering). The potential exists for discharges of dredged and fill material to occur in association with repair or replacement of these structures.

Railroad and Highway Embankment Maintenance

Various sections of railroad and highway embankments located adjacent to the reservoirs ordinary high water mark are armored with riprap. Maintenance of these sections could occur through the addition of riprap. No estimates of quantities or frequency of discharge are available.

3.8.3 Summary of Predicted Cumulative Effects upon the Aquatic Ecosystem

3.8.3.1 Cumulative Substrate Effects

The discharges of dredged and fill material associated with the proposed action would permanently eliminate portions of the substrate. The overall area eliminated would be miniscule in comparison to the overall area of substrate of the lower Snake River.

Potential future discharges of dredged material associated with the Corps' maintenance dredging could have long term substrate impacts under the DMMP/EIS Alternative 1, in which standard in-water dredged material disposal would occur. For Alternative 2, beneficial substrate effects would occur through selective dredged material disposal for shallow water fish habitat. Under the recommended plan (preferred alternative), upland disposal of dredged material and substrate effects from the discharge of dredged material would not occur. Beneficial substrate effects would occur under Alternative 4 through beneficial use of the dredged material. The Draft DMMP/EIS (January 2001) identified Alternative 4 as the Corps' recommended plan (preferred alternative). Because substrate effects from the proposed action would be minor and because potential future discharges of dredged material associated with the Corps' maintenance dredging incorporates mitigation features that would restore valuable aquatic habitat to the system through beneficial use of dredged material, the cumulative effects of the Corps' proposed and future actions should not pose an irreversible loss of valuable aquatic resources.

Other discharges associated with potential future maintenance of irrigation intakes for agriculture, highway and railroad embankment repairs, and bridge repair and/or replacement could have minor to major substrate effects. Prediction of effects from these activities upon the substrate is extremely difficult. Estimation of the degree and duration of future effects is virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential effects upon the substrate would be imposed, as has been done for the Corps' proposed action. If actions to minimize these potential effects were implemented, the cumulative effect of the Corps' proposed and future discharges as well as irrigation intakes and rail and highway embankment and bridges should not result in major impairment of the water resources and interfere with the productivity and water quality of the existing aquatic ecosystem of the Snake River. Absent implementation of any actions to minimize impacts resulting from potential future discharges, significant cumulative substrate effects would likely occur.

3.8.3.2 Cumulative Water Salinity, Circulation, and Fluctuation Effects

Predicted effects of the proposed action upon water salinity, circulation, and fluctuation ranged from "no change" to "minor" to "localized and of short-duration," with incorporation of various actions to minimize potential effects. Prediction of effects upon water salinity, circulation, and fluctuation resulting from potential future discharges associated with the Corps' maintenance dredging for navigation, maintenance dredging to keep port basins and boat basins open and accessible, maintenance dredging at public recreation areas, and dredging to maintain irrigation intakes, is extremely difficult. Estimation of the degree and duration of future effects is virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential impacts upon water salinity would be imposed, as has been done for the proposed action. If actions to minimize were implemented, the cumulative effect of proposed and future discharges should not pose an irreversible loss of valuable aquatic resources. Absent implementation of any actions to minimize impacts resulting from the proposed action and the Corps' potential future discharges, significant cumulative substrate effects would likely occur.

Other discharges associated with potential future maintenance of irrigation intakes for agriculture, highway and railroad embankment repairs, and bridge repair and/or replacement could have minor to major substrate effects. Prediction of effects from these activities upon the substrate is extremely difficult. Estimation of the degree and duration of future effects for these actions is also virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential impacts upon the substrate effects would be imposed, as has been done for the Corps' proposed action. If actions to minimize these potential effects were implemented, the cumulative effect of the Corps' proposed and future discharges as well as repairs to irrigation intakes and rail and highway embankment and bridges should not result in major impairment of the water resources and interfere with the productivity and water quality of the existing aquatic ecosystem of the Snake River. Absent implementation of actions to minimize impacts resulting from potential future discharges, significant cumulative substrate effects would likely occur.

3.8.3.3 Cumulative Current Patterns and Circulation Effects

Determination of the effects of the Corps' proposed discharges of dredged and fill material upon current patterns and circulation ranged from "no effect," to "minor," "negligible," "insignificant," and "localized short-term." Additionally, alteration of flows due to SBCs was predicted to be beneficial to attracting anadromous fish.

Prediction of effects upon current patterns and circulation resulting from the Corps' potential future discharges associated with maintenance dredging for navigation, maintenance dredging to keep port basins and boat basins open and accessible, maintenance dredging at public recreation areas, and maintenance dredging to irrigation intakes, is extremely difficult. Estimation of the degree and duration of future effects is virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential impacts upon current patterns and circulation would be imposed, as has been done for the proposed action. If actions to minimize effects were implemented, the cumulative effect of proposed and future discharges should not pose an irreversible loss of valuable aquatic resources, based on the anticipated predominance of predicted minor, negligible, insignificant, and no effects of the various actions. Absent implementation of any actions to minimize impacts resulting from potential future Corps' discharges, significant cumulative effects upon current patterns and circulation could occur. Other discharges associated with potential future maintenance of irrigation intakes for agriculture, highway and railroad embankment repairs, and bridge repair and/or replacement could have minor to major impacts on current patterns and circulation.

Prediction of effects from these activities upon the substrate is extremely difficult. Estimation of the degree and duration of future effects for these actions is also virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential impacts upon the substrate would be imposed, as has been done for the Corps' proposed action. If actions to minimize these potential effects were implemented, the cumulative effect of the Corps' proposed and future discharges as well as repairs to irrigation intakes and rail and highway embankment and bridges should not result in major impairment of the water resources and interfere with the productivity and water quality of the existing aquatic ecosystem of the Snake River. Absent implementation of actions to minimize impacts resulting from non-Corps potential future discharges, significant cumulative substrate effects would likely result.

3.8.3.4 Cumulative Suspended Particulates and Turbidity Effects

Determination of the effects of the discharges of dredged and fill material upon suspended particulates and turbidity ranged from "no effect," to "minor," "negligible," "insignificant," and "localized short-term." Additionally, potential adverse chemical and physical effects from ammonia in the Lower Granite pool were judged to be extremely high because the elutriate ammonia average (3.6 mg/L @ 8.5 pH) could exceed the early life stage criterion three-fold and could also exceed both acute criterions (2.14 mg/L and 3.20 mg/L). Potential impacts upon ammonia in the Little Goose, Lower Monumental, and Ice Harbor pools were judged to be moderate because the elutriate ammonia average could exceed the chronic early life stage criterion. Actions to minimize the risk in the form of monitoring would be implemented.

Prediction of effects from suspended particulates and turbidity resulting from potential future Corps' discharges associated with maintenance dredging for navigation, maintenance dredging to keep port basins and boat basins open and accessible, maintenance dredging at public recreation areas, and maintenance dredging irrigation intakes is extremely difficult. Estimation of the degree and duration of future effects is virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential impacts upon suspended particulates and turbidity would be imposed, as has been done for the proposed action. If actions to minimize effects were implemented, the cumulative effect of proposed and future Corps' discharges should not pose an irreversible loss of valuable aquatic resources. Absent implementation of any actions to minimize impacts resulting from potential future Corps' discharges, significant cumulative effects from suspended particulates and turbidity could occur.

Other discharges associated with potential future maintenance of irrigation intakes for agriculture, highway and railroad embankment repairs, and bridge repair and/or replacement could have minor to major impacts on suspended particulates and turbidity. Prediction of effects from these activities upon the substrate is extremely difficult. Estimation of the degree and duration of future effects for these actions is also virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential effects upon the substrate would be imposed, as has been done for the Corps' proposed action. If actions to minimize these potential effects were implemented, the cumulative effect of the Corps' proposed and future discharges as well as repairs to irrigation intakes and rail and highway embankment and bridges should not result in major impairment of the water resources and interfere with the productivity and water quality of the existing aquatic ecosystem of the Snake River. Absent implementation of actions to minimize impacts resulting from non-Corps potential future discharges, significant cumulative effects would likely result.

3.8.3.5 Cumulative Contaminant Effects

Determination of effects of the Corp's proposed discharge of dredged material revealed the potential for adverse effects from contaminants. Potential effects from ammonia in the Lower Granite pool were judged to be extremely high because the elutriate ammonia average (3.6 mg/L @ 8.5 pH) could exceed the early life stage criterion three-fold if sediments are suspended. The elutriate ammonia could also exceed both acute criterions (2.14 mg/L and 3.20 mg/L). Potential effects upon ammonia in the Little Goose, Lower Monumental, and Ice Harbor pools were judged to be moderate because the elutriate ammonia average could exceed the chronic early life stage criterion. Monitoring of ammonia concentrations would be conducted during construction to minimize potential effects. Elutriation of manganese could cause a very minor localized effect of lower dissolved oxygen in the immediate area of the discharge. Prior to the start of construction, sediment would be analyzed for mercury and elutriation. Elutriation of zinc in the sediments has the potential to surpass the acute condition criteria for rainbow trout (EPA, 1976). This poses a moderate or higher risk to fish. Monitoring would be conducted to minimize the potential effect. Elutriation of copper located in the sediments has the potential to surpass the acute condition criteria for rainbow trout (EPA, 1976). This also poses a moderate or higher risk to fish. Monitoring would also be conducted to minimize potential effects. If monitoring is conducted for the occurrence of the various contaminants and appropriate actions are taken in response to the results, the cumulative effects of proposed Corps' discharges should not pose an irreversible loss of valuable aquatic resources.

Prediction of effects upon contaminants resulting from potential future Corps' discharges associated with maintenance dredging for navigation, maintenance dredging to keep port basins and boat basins open and accessible, maintenance dredging at public recreation areas, and dredging to maintain irrigation intakes, is extremely difficult. Estimation of the degree and duration of future effects is virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential impacts from contaminants would be imposed, as has been done for the proposed action. Sampling and monitoring would be necessary to determine contaminants present and facilitate assessment of potential risks. If monitoring and sampling were not conducted, the level of risk would not be known. Absent monitoring and sampling for Corps' proposed and potential future actions, cumulative adverse contaminant impacts could be significant.

Other discharges associated with potential future maintenance of irrigation intakes for agriculture, highway and railroad embankment repairs, and bridge repair and/or replacement could have minor to major impacts on contaminants. Prediction of effects from these activities upon contaminants is extremely difficult. Estimation of the degree and duration of future effects for these actions is also virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential impacts upon the substrate would be imposed, as has been done for the Corps' proposed action. If actions to minimize these potential effects were implemented, the cumulative effect of the Corps' proposed and future discharges as well as repairs to irrigation intakes and rail and highway embankment and bridges should not result in major impairment of the water resources and interfere with the productivity and water quality of the existing aquatic ecosystem of the Snake River. Absent implementation of actions to minimize impacts resulting from the non-Corps potential future discharges, significant cumulative effects would likely result.

3.8.3.6 Cumulative Aquatic Ecosystem and Organisms Effects

Determination of the effects of the discharges of dredged and fill material upon the aquatic ecosystem and organisms ranged from "no effect," to "minor," "negligible," "insignificant," and "localized short-term." Additionally, potential chemical and physical effects from ammonia in the Lower Granite pool were judged to be extremely high because the elutriate ammonia average (3.6 mg/L @ 8.5 pH) could exceed the early life stage criterion three-fold. The elutriate could also exceed both acute criterions (2.14 mg/L and 3.20 mg/L). Potential impacts upon ammonia in the Little Goose, Lower Monumental, and Ice Harbor pools were judged to be moderate because the elutriate ammonia average could exceed the chronic early life stage criterion. Actions to minimize effects in the form of monitoring would be implemented and appropriate action taken in response to the data.

Prediction of effects upon the aquatic ecosystem and organisms resulting from potential future Corps' discharges associated with maintenance dredging for navigation, maintenance dredging to keep port basins and boat basins open and accessible, maintenance dredging at public recreation areas, and maintenance dredging irrigation intakes, is extremely difficult. Estimation of the degree and duration of future effects is virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential impacts upon the aquatic ecosystem and organisms would be imposed, as has been done for the proposed action. Sampling and monitoring would be necessary to determine contaminants present and facilitate assessment of potential risks. If monitoring and sampling were not conducted, the level of risk would not be known. Absent monitoring and sampling for Corps' potential future actions, cumulative adverse effects from proposed and potential discharges upon the aquatic ecosystem and organisms could be significant.

Other discharges associated with potential future maintenance of irrigation intakes for agriculture, highway and railroad embankment repairs, and bridge repair and/or replacement could have minor to major impacts on the aquatic ecosystem and organisms. Prediction of effects from these activities is difficult. Estimation of the degree and duration of future effects for these actions is also virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential impacts upon the aquatic ecosystem and organisms would be imposed, as has been done for the Corps' proposed action. If actions to minimize these potential effects were implemented, the cumulative effect of the Corps' proposed and future discharges as well as repairs to irrigation intakes and rail and highway embankment and bridges should not result in major impairment of the water resources and interfere with the productivity and water quality of the existing aquatic ecosystem of the Snake River. Absent implementation of actions to minimize impacts resulting from the non-Corps potential future discharges, significant cumulative effects upon the aquatic ecosystem and organisms would likely result.

3.8.3.7 Cumulative Effects upon Human Use Characteristics

Determination of the effects of the Corps' proposed discharges of dredged and fill material upon human use characteristics ranged from "no effect," to "minor," "negligible," and "localized short-term." Prediction of effects upon human use characteristics resulting from potential future Corps' discharges associated with maintenance dredging for navigation, maintenance dredging to keep port basins and boat basins open and accessible, maintenance dredging at public recreation areas, and maintenance dredging irrigation intakes, is extremely difficult. Estimation of the degree and duration of future effects is virtually impossible when the scope and frequency of the actions are unknown; however, it is reasonable to anticipate that actions to minimize potential impacts upon human use characteristics would be imposed, as has been done for the proposed action. If actions to minimize effects were implemented, the cumulative effect of proposed and future discharges would likely be non-existent or minor, based on the anticipated predominance of predicted no effect, minor, negligible, and localized short-term effects of the various proposed actions. Absent implementation of any actions to minimize impacts resulting from potential future discharges, significant cumulative effects upon human use characteristics could occur in the future.

Other discharges associated with potential future maintenance of irrigation intakes for agriculture, highway and railroad embankment repairs, and bridge repair and/or replacement could have minor to major impacts on human use characteristics. Prediction of effects from these activities is extremely difficult. Estimation of the degree and duration of future effects for these actions is also virtually impossible when the scope and frequency of the actions are unknown. Non-Corps discharges would be subject to permit requirements under Section 404 of Clean Water Act. Therefore, it is reasonable to anticipate that actions to minimize potential impacts upon human use characteristics would be imposed, as has been done for the Corps' proposed action. If actions to minimize these potential effects were implemented, the cumulative effect of the Corps' proposed and future discharges as well as repairs to irrigation intakes and rail and highway embankment and bridges should not result in irreversible impacts upon human use characteristics. Absent implementation of actions to minimize impacts resulting from the non-Corps potential future discharges, significant cumulative effects on human use characteristics would likely result.

3.9 Determination of Secondary Effects on the Aquatic Ecosystem

3.9.1 Substrate

Presence of the RSWs, BGSs, and SBCs would provide additional habitat for attachment or occupancy by benthic organisms. Some benthic organisms that may attach to the hard structure of the RSWs may be disturbed or destroyed by operation of the structure.

3.9.2 Water Salinity, Circulation, and Fluctuation

No secondary effects upon water salinity, circulation, and fluctuation are anticipated.

3.9.3 Current Patterns and Flow

Operation of the RSWs, BGSs, and SBCs would create intentional, minor, localized alterations in current patterns and flow. The alterations are an intended result for facilitating passage of juvenile salmon through the lower Snake River dams. Pier nose extensions and added and modified deflectors would provide beneficial secondary impacts on current patterns by diminishing the mixing of water that passes through the spillway, thereby, reducing potential increases in TDG.

3.9.4 Suspended Particulates and Turbidity

No secondary effects on suspended particulates and turbidity are anticipated.

3.9.5 Contaminants

The presence and operation of the multiple proposed structures is not expected to cause secondary impacts upon existing contaminants that may be present in the lower Snake River. Operation and maintenance of the RSWs would increase the potential for the release of lubricants into the Snake River.

Operation of barges in the vicinity of the moorage cells and barge access area at Lower Granite would increase the potential for the release of lubricants and fuels.

3.9.6 Aquatic Ecosystem and Organisms

The presence and operation of the various structures would provide beneficial secondary effects upon the aquatic ecosystem through improved passage and survival of juvenile salmonids through the lower Snake River dams.

3.9.7 Human Use Characteristics

Future beneficial economic and recreational impacts could occur as secondary effects in response to potential future improved juvenile passage through the lower Snake River.

4. Summary of Compliance with 404(b)(1) Guidelines

4.1 Alternatives Test

Based on the discussion in Section 2.4, there are available, practicable alternatives having less adverse impact on the aquatic ecosystem and without other significant adverse environmental consequences that do not involve discharges into "waters of the United States" or at other locations within these waters?
(   )Yes (X)No

Based on Section 2.4, if the project is in a special aquatic site and is not water dependent, are there reasonable and practicable sites available? (   )Yes (   )No (X)NA (Project is water dependent)

4.2 Special Restrictions

Will the discharge:

- Cause or contribute to violations of any state water quality standard? (   )Yes (X)No
- Violate toxic effluent standards? (   )Yes (X)No
- Jeopardize endangered or threatened species or their critical habitat? (   )Yes (X)No

  NMFS' December 21, 2000, Biological Opinion concluded that the impacts of the FCRPS jeopardize the continued existence of listed Snake River salmon. NMFS also included a reasonable and prudent alternative the agency believed would avoid jeopardy.
- Violate standards set by the Department of Commerce to protect marine sanctuaries?
  (   )Yes (X)No

4.3 Evaluation and Testing

Evaluation of the information in Section 3.5 above indicates that the proposed discharge material meets testing exclusion criteria for the following reason(s):

(   ) Based on the above information, the material is not a carrier of contaminants [Subpart G 230.60(a)].
(   ) The levels of contaminants are substantially similar at the extraction and disposal sites and the discharge is not likely to result in degradation of the disposal site and pollutants will not be transported to less contaminated areas 230.60(c).
(X) Acceptable constraints are available and will be implemented to reduce contamination to acceptable levels within the disposal site and prevent contaminants from being transported beyond the boundaries of the disposal site 230.60(d).

4.4 Other Restrictions

Will the discharge contribute to significant degradation of "waters of the United States" through adverse impacts to the following:

Human health or welfare, through pollution of municipal water supplies, fish, shellfish, wildlife or special aquatic sites? ( )Yes (X)No

Life stages of aquatic life or other wildlife? ( )Yes (X)No

Diversity, productivity, and stability of the aquatic ecosystem, such as loss of fish or wildlife habitat or loss of the capacity of wetland to assimilate nutrients, purify water, or reduce wave energy?
( )Yes (X)No

Recreational, aesthetic, or economic values? ( )Yes (X)No

4.5 Actions to Minimize Potential Adverse Impact (Mitigation)

Will all appropriate and practicable steps be taken to minimize the potential adverse impacts of the discharge on the aquatic ecosystem? (X)Yes ( )No

The following appropriate and practicable measures would be included to minimize potential adverse impacts of the discharge on the aquatic ecosystem:

1. Sidecast dredged material would be confined to areas immediately adjacent to the excavation site to minimize transport distance of the material and minimize the footprint of the discharge.
2. Excavation would be held to the necessary minimum to lessen impacts to the substrate.
3. Pre-cast concrete would be adequately cured before placement in the water.
4. Cast-in-place concrete would be placed within tightly sealed forms.
5. One YSI 6600 upg® sonde would be placed in the forebay and one YSI 6600 upg® sonde would be placed at the turbine exit of the dam to assess the accuracy of the predicted impacts for RSWs and SBCs as it relates to salinity. An estimated two sondes would be placed downstream, four sondes alongside, and two sondes upstream of BGSs to assess the accuracy of the prediction as it relates to salinity and the BGSs. One sonde would be placed in the forebay and 12 sondes would be placed in a grid array downstream of the pier nose extensions to assess the accuracy of the prediction as it relates to pier nose extensions. One sonde would be placed in the forebay and 12 sondes would be placed in a grid array downstream of the moorage cells and barge access area to assess the accuracy of the prediction as it relates to salinity, the moorage cells, and barge access area. Sondes would collect pH, conductivity, and depth. Backup instrumentation would be on standby at all times. Alkalinity, hardness, and calcium ion analysis would be conducted by titration before, during, and after construction. Flame photometry or ISE electrodes would be used to measure sodium and potassium. Sulfate ion would be measured by turbidimetric analysis and fluoride ion concentration would be measured by ISE to determine their contribution to salinity changes. The data would be provided to Ecology, if requested.
6. Water samples would be collected and analyzed for ions and cations before, during, and after construction of moorage cells and the barge access area to assess the accuracy of the predicted impact upon salinity.
7. Washed gravel, used as fill material in construction of moorage cells and the barge access area, would be obtained from a local gravel source to reduce the potential for incorporation of materials having elevated levels of salts and, thereby, minimize potential impacts to salinity and conductivity.

8. Water samples would be collected and analyzed for ions and conductivity before, during, and after construction of pier nose extensions to identify effects of accidental releases of wet concrete into the water column and to identify remedial actions.
9. Actions such as controlling the amount and duration of discharge, minimizing discharges, and performing work in the winter months would be utilized to minimize impacts to water chemistry. Water samples would be collected and analyzed for changes in water chemistry before, during, and after construction of the RSWs, BGSs, SBCs, pier nose extensions, moorage cells, and barge access area to assess accuracy of the associated predicted impacts.
10. Water samples would be collected and analyzed for clarity, color, organic nitrogen, phosphorus parameters, and ions before, during, and after construction of RSWs, BGSs, pier nose extensions, barge moorage cells, and barge access area to assess accuracy of the predicted impact.
11. Sediment samples would be collected and analyzed for ammonia before, during, and after construction of RSWs, BGSs, SBCs, pier nose extensions, moorage cells, and barge access area to assess accuracy of the predicted impact.
12. One YSI 6600 upg® sonde would be placed in the forebay and one YSI 6600 upg® sonde would be placed at the turbine exit of the dam to assess the accuracy of the prediction for RSWs and SBCs as it relates to turbidity. An estimated two sondes would be placed downstream, four sondes alongside, and two sondes upstream of BGSs to assess the accuracy of the prediction as it relates to turbidity and the BGSs. One sonde would be placed in the forebay and 12 sondes would be placed in a grid array downstream of the pier nose extensions to assess the accuracy of the prediction as it relates to pier nose extensions. One sonde would be placed in the forebay and 12 sondes would be placed in a grid array downstream of the moorage cells and barge access area to assess the accuracy of the prediction as it relates to turbidity, the moorage cells, and barge access area. Sondes would collect turbidity and depth 24 hours per day, 7 days per week. Backup instrumentation would be on standby at all times. Secondary readings would be taken using a Hach 2100 P nephelometer for QA/QC. The data would be provided to Ecology, if requested.
13. Turbidity would be monitored 300 feet downstream of the dam during in-water excavation and discharge activities associated with construction of RSWs, BGSs, SBCs, sheet pile barge moorage cells, and the barge access area. In compliance with WAC 173 201A-030, if, during in-water excavation and discharge activity, turbidity levels at the monitoring site exceed 5 NTUs over background turbidity when the background turbidity is 50 NTUs or less; or, if turbidity levels at the monitoring site increase by more than 10 percent when the background turbidity is more than 50 NTUs, in-water excavation and discharge activity would temporarily cease until turbidity levels at the monitoring site returned to levels within these limits.
14. Monitoring of ammonia concentrations would be conducted during construction to assess the accuracy of predicted impacts. If, during discharge activities, ammonia levels at monitoring sites exceed state and Federal limits, discharge activities would temporarily cease until ammonia levels at monitoring sites return to levels within state and Federal limits.
15. Sediment samples would be collected and analyzed for DDT before construction of RSWs, BGSs, barge moorage cells, and the barge access area to determine the presence of DDT. Where DDT is found above the screening level or elutriate value, the specific material would be taken to an approved upland disposal site.
16. Prior to the start of construction, sediment would be analyzed for mercury and elutriation. If mercury were found to be present, elutriated sediments and dissolved mercury in the water would be monitored. If mercury levels exceed the Freshwater Criteria (EPA, 1985b) of 0.012 μg/L for 4 days with a 2.4 μg/L per 1 hour maximum average, work would be halted and consultation would be conducted with appropriate state and Federal agencies.

17. Prior to the start of construction, sediment would be analyzed for zinc and elutriation and water would be analyzed for hardness. Elutriate would be analyzed to determine if an acute or chronic condition is created for specific species of fish that may be present during construction. If a chronic or acute condition were identified, additional bioassay analysis would be conducted.
18. Prior to the start of construction, sediment would be analyzed for copper and elutriation, and water would be analyzed for hardness. Elutriate would be analyzed to determine if an acute or chronic condition is created for specific species of fish that may be present during construction. If a chronic or acute condition were identified, additional bioassay analysis would be conducted.
19. Wet concrete used to construct pier nose extensions would be discharged into tightly sealed forms.
20. Pre-cast concrete discharged as fill material would be adequately dried prior to placement in the water.
21. Gravel discharged into the constructed moorage cells and behind the sheet pile wall of the barge access area would be washed of any silts and soils prior to placement to minimize the potential introduction of contaminants.
22. All in-water work would be conducted during the standard in-water work window of December 15 through March 1 to minimize impacts upon Federally listed anadromous species, unless coordinated with resource agencies.
23. The general construction area of the reservoir for the barge moorage cells and barge access area at Lower Granite would be signed to restrict access to boaters for public safety. Access restrictions would be removed immediately upon completion of construction to allow resumption of recreational fishing activity.
24. Actions identified in Section 3.4.4 to minimize impacts related to turbidity would also minimize potential impacts of turbidity related to mixing zone and upon aesthetics.

5. Determination of Compliance/Non-compliance of the Recommended Plan (Preferred Alternative)

( ) The discharge complies with the guidelines.

(X) The discharge complies with the guidelines, with the inclusion of the appropriate and practicable conditions listed above in Section 4.5 to minimize pollution or adverse effects to the affected ecosystem.

( ) The discharge fails to comply with the requirements of these guidelines because:

- ( ) there is a practicable alternative to the proposed discharge that would have less adverse effect on the aquatic ecosystem and that alternative does not have other significant adverse environmental consequences.
- ( ) the discharge will result in significant degradation of the aquatic ecosystem under 40 CFR 230.10(b) or (c).
- ( ) the discharge does not include all appropriate and practicable measures to minimize potential harm to the aquatic ecosystem.
- ( ) there is not sufficient information to make a reasonable judgment as to whether the proposed discharge will comply with the guidelines.

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7. Glossary

Acute: A sudden onset or sharp-rise response from toxicity due to a contaminant that exhibits a toxic effect on aquatic animals. This term may also be directly associated with published LD 50 or LC 50 dose rates. (See LC 50 and LD 50)

Aesthetics: Of or pertaining to the sense of the beautiful.

Amictic: In rotifers, producing diploid eggs that are incapable of being fertilized.

Anadromous fish: Fish, such as salmon or steelhead trout, that hatch in freshwater, migrate to and mature in the ocean, and return to freshwater as adults to spawn.

Anion: A negatively charged ion.

Anthropogenic: Changes made by human activity.

Behavioral guidance structure (BGS): Long, steel, floating structure designed to simulate the natural shoreline and guide fish toward the surface bypass collection system by taking advantage of their natural tendency to follow the shore.

Benthic community: Aquatic organisms and plants that live on the bottom of lakes or rivers, such as algae, insects, worms, snails, and crayfish. Benthic plants and organisms contribute significantly to the diets of many reservoir fish species.

Benthivore: An organism that consumes bottom-dwelling organisms.

Biota: The animal and plant life of a particular region considered as a total ecological entity.

Cation: A positively charged ion.

Centrarchid: Centrarchid is a colloquial term for the spiny-ray fishes of the Centrarchidae family.

Chironomid: An insect, midge, which has a benthic larval stage.

Cladocera: An order of small, freshwater branchiopod crustaceans, commonly known as water fleas.

Chlorophyll *a*: A green plant pigment necessary for plants to produce carbon from sunlight.

Comp Plan: Plan for compensation of fish and wildlife losses resulting from construction of the four lower Snake River dams. Environmental Impact Statement - Lower Snake River Fish and Wildlife Compensation, 1976.

Copepod: Any of various small marine and freshwater crustaceans of the order *Copepoda*.

Dam breaching: In the context of this FR/EIS, dam breaching involves removal of the earthen embankment section at Lower Granite and Little Goose Dams and formation of a channel around Lower Monumental and Ice Harbor Dams.

Diploid: Having a homologous pair of chromosomes for each characteristic except sex, the total number of chromosomes being twice that of a gamete.

Dissolved gas supersaturation: Caused when water passing through a dam's spillway carries trapped air deep into the waters of the plunge pool, increasing pressure and causing the air to dissolve into the water. Deep in the pool, the water is "supersaturated" with dissolved gas compared to the conditions at the water's surface.

Drawdown: In the context of this document, drawdown means returning the lower Snake River to its natural, free-flowing condition via dam breaching.

Eluate: Type of water sample created by mixing sediment and water.

Endangered species: A native species found by the Secretary of the Interior to be threatened with extinction.

Entrainment: The movement of an organism downstream out of a reservoir due to discharges from dam operations.

Eutrophic: A body of water in which the increase of mineral and organic nutrients reduces dissolved oxygen, producing an environment that favors plant over animal life.

Extended submerged bar screen (ESBS): Screens extending in front of the turbines to guide fish away from the turbines and up to the juvenile fish collection channel inside the dam. These are an alternative to the submerged traveling screens.

Fauna: Animals collectively, especially the animals of a particular region or time.

Fecal coliform bacteria: A group of organisms belonging to the coliform group and whose presence denotes recent fecal pollution from warm-blooded animals.

Federal Columbia River Power System: Official term for the 14 Federal dams on the Columbia and Snake rivers.

Fish collection/handling facility: Holding area where juvenile salmon and steelhead are separated from adult fish and debris by a separator and then passed to holding ponds or raceways until they are loaded onto juvenile fish transportation barges or trucks.

Flora: Plants collectively; especially the plants of a particular region or time.

Flow augmentation: Increasing river flows above levels that would occur under normal operation by releasing more water from storage reservoirs upstream.

Foraging habitat: Areas where wildlife search for food.

Forebay: The area of water directly upstream of a dam.

Freshet: A sudden overflow of a stream resulting from a heavy rain or thaw.

Gas chromatograph mass spectrometer: An analytical device used in the detection and quantification of organic compounds that have a degree of volatility and provide a distinct chromatogram.

Haploid: Having half of the diploid or full complement of chromosomes, as in mature gametes.

Hydrology: The science dealing with the continuous water cycle of evapotranspiration, precipitation, and runoff.

Impoundment: Accumulated water in a reservoir.

Inundation: The covering of pre-existing land and structures by water.

Irrigation: Artificial application of water to usually dry land for agricultural use.

Juvenile fish transportation system: System of barges and trucks used to transport juvenile salmon and steelhead from the lower Snake River or McNary Dam to below Bonneville Dam for release back into the river; alternative to in-river migration.

Kjeldahl nitrogen: The sum of organic nitrogen and ammonia nitrogen.

Lacustrine: Of or pertaining to a lake.

Larva/larvae: An early life stage of an animal.

LC 50: The median lethal concentration, that is the concentration (expressed as ppm or ppb) of a toxicant to the environment (usually water) that produces a designated effect (most often measured as death) to 50 percent of the population of test organisms exposed. These tests are used to determine acute environmental health and safety limits of chemicals but do not necessarily measure chronic effects.

LD 50: The median lethal dose, that is the milligrams of a toxicant per kilogram of body weight that is lethal to 50 percent of the test animals to which it is administered under the conditions of an experiment. It is sometimes referred to as experimental dose or experimental LD 50.

Limnology: The study of the physical, chemical, and biological aspects of rivers, lakes, or reservoirs. It is derived from the Greek word “limnos” which pertains to lake of freshwater. A limnologist in freshwater science is analogous to the marine biologist in saltwater science.

Lower Snake River Project: The name for the Corps’ four lower Snake River facilities combined.

Macroinvertebrate: Organism without a backbone generally measuring more than 0.5 to 1 mm in size.

Mictic: Of or pertaining to eggs which, without fertilization, develop into males and, with fertilization, develop into amictic females, as occurs in rotifers.

Mollusk: Any member of phylum Mollusca, largely marine invertebrates.

National Environmental Policy Act (NEPA): An act, passed by Congress in 1969, that declared a national policy to encourage productive harmony between humans and their environment, to promote efforts that will prevent or eliminate damage to the environment and the biosphere, to stimulate the health and welfare of humans, to enrich the understanding of the ecological systems and natural resources important to the nation, and to establish a Council on Environmental Quality. This act requires the preparation of environmental impact statements for Federal actions that are determined to be of major significance.

Navigation: Method of transporting commodities via waterways; usually refers to transportation on regulated waterways via a system of dams and locks.

Nekton: Free swimming aquatic animals that normally move about their environment independent of current and wave action.

Overwinter: To spend or survive the winter.

Parthenogenic: Produced by a special type of sexual reproduction (common among rotifers) in which an egg develops without entrance of a sperm.

pH: A logarithmic index of the hydrogen ion concentration in water, measured on a scale of 0 to 14. A value of 7 indicates a neutral condition; values less than 7 indicate acidic conditions, and values greater than 7 indicate alkaline conditions.

Phytoplankton: Drifting plants such as microscopic algae that nourish themselves from the energy of the sun; they are at the base of the food chain and provide a food source for bacteria, water molds, and zooplankton.

Piscivorous: Feeding on fishes.

Planktivorous: Feeding on planktonic organisms.

Photoperiod: The light period during which conditions are satisfactory for active photosynthesis in aquatic plants and algae.

Poikilothermic: An organism that does not have to maintain a constant body temperature to process its metabolic pathways.

Pumping stations: Facilities that draw water through intake screens in the reservoir and pump the water uphill to corresponding distribution systems for irrigation and other purposes.

Removable spillway weir (RSW): A removable steel structure that is attached to the forebay of an existing spill bay, creating a raised overflow weir above and upstream of the existing spillway crest.

Resident fish: Fish species that reside in freshwater throughout their lifecycle.

Riparian: Ecosystem that lies adjacent to streams or rivers and is influenced by the stream and its associated groundwater.

Riprap: A permanent, erosion-resistant groundcover constructed of large, loose, angular, or subangular rounded stone.

Rotifer: Any of various minute multicellular aquatic organisms of the phylum Rotifera, having at the anterior end a wheel like ring of cilia.

Salmonid: Of or belonging to the family Salmonidae, which includes salmon, trout, and whitefishes.

Spill: Water released through the dam spillways, rather than through the turbines. Involuntary spill occurs when reservoirs are full and flows exceed the capacity of the powerhouse or power output needs. Voluntary spill is one method used to pass juvenile fish without danger of turbine passage.

Spillbay: One of the eight openings in the entire spillway. Water passes over each spillbay.

Stilling basin: A concrete-lined pool below the dam where water dissipates energy prior to flowing downstream.

Submerged traveling screens: Structures with a moving (traveling) screen extending in front of the turbines to guide fish away from the turbines, up to the juvenile fish collection channel inside the dam. These are an alternative to the extended submerged bar screens.

Substrate: Substances used by organisms for growth in a liquid medium; surface area of solids or soils used by organisms to attach.

Surface bypass collection (SBC) system: System designed to divert fish at the surface before they have to dive and encounter the existing turbine intake screens. SBCs direct the juvenile fish into the forebay, where they are passed downstream either through the dam spillway or via the juvenile fish transportation system of barges and trucks.

Tailrace: The canal or channel that carries water away from a dam.

Tailwater: The water surface immediately downstream from a dam.

Threatened species: A native species likely to become endangered within the foreseeable future. **Total Maximum Daily Load (TMDL):**

Total suspended solids (TSS): The portion of the sediment load suspended in the water column. The grain size of suspended sediment is usually less than one millimeter in diameter (clays and silts). High TSS concentrations can adversely affect primary food production and fish feeding efficiency. Extremely high TSS concentrations can impair other biological functions such as respiration and reproduction.

Toxic equivalent: A scaled value used to determine the toxic capacity of a series of related compounds in various concentrations in comparison to the primary toxic constituent.

Turbidity: An indicator of the amount of sediment suspended in water. It refers to the amount of light scattered or absorbed by a fluid. In streams or rivers, turbidity is affected by suspended particles of silts and clays, and also by organic compounds like plankton and microorganisms. Turbidity is measured in Nephalometric Turbidity Units.

Wetland: An ecosystem in which groundwater saturates the surface layer of soil during a portion of the growing season, often in the absence of surface water. This water remains at or near the surface of the soil layer long enough to induce the development of characteristic vegetative, physical, and chemical conditions.

Zooplankton: Tiny, floating animals that provide a food source for larger aquatic organisms such as snails and small fish.